CO&G/SL/MOEF/20/05/01

26th May 2020

The Member Secretary,
IA (II) Division,
Ministry of Environment, Forest & Climate Change,
Indira Paryavaran Bhawan,
Jor Bagh Road,
New Delhi – 110 003

Subject: Expansion of Offshore and Onshore Oil and Gas Exploration, Development & Production in existing Ravva Field, PKGM-1 Block (of 331.26 km2) located near Surasniyanam Village (S. Yanam) in Krishna-Godavari Basin, East Godavari District, Andhra Pradesh by M/s Vedanta Limited (Division Cairn Oil & Gas) – Reconsideration of Environmental & CRZ Clearance related Request for Relisting of the Project

Reference: **Proposal No. IA/AP/IND2/102271/2013, MoEFCC File No. J-11011/41/2018-IA-II (I)**

Dear Sir,

This refers to Minutes of the 15th Meeting of Expert Appraisal Committee (EAC - Industry-2) held from December 30-31, 2019 to January 01, 2020 of the agenda item no. 15.5.12 and 11th meeting of EAC – Industry-2 held from August 28 – 29, 2019 of the agenda item no. 11.5.3 for Environmental & CRZ Clearance of the above mentioned subject. The Committee after deliberations sought additional information.

Presently, the above-referred Project has been delisted due to non-reply of ADS (sought by EAC/Ministry) within the prescribed limit of 90 days. We could not submit the ADS due to COVID-19 lockdown situation.

We request you for relisting of the Project for submission of ADS.

Thanking you in advance for your time.

Yours truly,

J Thomas Christopher
Head – Offshore Operations

VEDANTA LIMITED

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CIN: L13209MH1965PLC291394

26 May 2020

Submission of Additional Information in response to ADS reference 15th EAC Industry-2 meeting, agenda item no. 15.5.12

Proposal No.	[IA/AP/IND2/102271/2013, J-11011/81/2013-IA II(I)] File no. J-11011/41/2018-IA-II (I)
TOR letter No.	IA-J-11011/41/2018-IA-II(I); dated 24th March 2018
Name of the Project	Environmental and CRZ Clearance of "Expansion of Offshore and Onshore Oil and Gas Exploration, Development & Production in existing Ravva Field, PKGM-1 Block (of 331.26 km2) located near Surasniyanam Village (S.Yanam) in Krishna-Godavari Basin, East Godavari District, Andhra Pradesh by M/s Vedanta Limited (Division Cairn Oil & Gas)".
EAC Reference	Minutes of the 15th Meeting of Expert Appraisal Committee (EAC - Industry-2) held from 30th Dec 2019 to 1st Jan 2020 of the agenda item no. 15.5.12 and 11th meeting of EAC – Industry-2 held from August 28 to 29, 2019 of the agenda item no. 11.5.3 for Environmental & CRZ Clearance of the above mentioned Project.

In response to ADS, the additional information is as following:

S. N.	Information Desired by the EAC	Response from Vedanta Limited (Cairn Oil & Gas) per Letter no. CIL/GGN/MOEF/19/11/01 dated Nov 20, 2019	Remarks of the EAC [As per Minutes of 15th meeting of EAC-(Ind-2) of MoEFCC]	Response from Vedanta Limited (Cairn Oil & Gas) through this ADS Response
1	Project proponent to provide approval of DGH to the MoEFCC for the five onshore drilling wells which are located outside the PKGM-1 Block and belong to ONGC.	Vedanta Limited (Cairn Oil & Gas) will extract hydrocarbon resources only from the allocated PKGM-1 Block (within the Block boundary). All the potential hydrocarbons bearing sands intersected from onshore well pads profile are located in shallow water depths within the block where rig mobilization offshore is difficult. Thus, it is proposed to carry out drilling from onshore engage through onshore drilling from adjacent land area, which falls outside the block. Before commencement of drilling, Vedanta Limited (Cairn Oil & Gas) will obtain due approval from DGH and ONGC. This commitment was included in the affidavit submitted to MoEFCC with covering letter no. CIL/GGN/MOEF /19/9/01 dated 09 Sep 2019. Affidavit has been submitted through covering letter dated 09 September 2019.	Information provided is not addressing the concerns raised by the EAC. PP has failed to provide the information. The Project proponent need to provide approval of DGH for the five onshore drilling wells which are located outside the PKGM-1 Block and belong to ONGC.	Vedanta Limited (Cairn Oil & Gas) on behalf of the Ravva JV has decided to drop development of onshore five well pads (Well Pads # 1 to 5) proposed to be located outside the PKGM-1 Block. Drilling of onshore wells 33 nos. (11 exploratory + 23 developmental) will be done only from the two onshore well pads [numbered as WP-7 (or RX-8) and WP-8 (or RX-9)] located within the PKGM-1 Block. No activities including drilling will be carried outside the PKGM-1 Block area. There is no change in the proposal related to drilling of 90 offshore wells (73 exploratory + 17 developmental wells) from within the block. Thus, total number wells to be drilled will be 123 (33 from onshore + 90 from offshore) within PKGM-1 Block. No drilling will be carried outside the PKGM-1 Block area.

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2	The proposal requires CRZ approval from the MOEFCC as the on land wells are located between 200-500 meters from the Coastline. However, the PP has approval of State authorities.	Vedanta Limited (Cairn Oil & Gas) is seeking Environmental and CRZ Clearances from MoEFCC for the proposed expansion Project. APCZMA recommended the Project through their No Objection Certificate Letter no.138/APCZMA/CRZ/IND/ 2019-91 dated 03-04-2019 received on 06-05 2019. Copy of the APZMA approval is submitted.	The project proponent needs to submit the copy of NOC and communication addressed to the Ministry by the APCZMA. In addition, conditions imposed and plan for achieving the same shall be submitted. The Committee also suggested that the comments of CRZ Sector also needs to be obtained.	Copy of NOC and communication addressed to the Ministry by APCZMA is enclosed as **Annexure 1A**. In addition, conditions imposed and plan for achieving the same is submitted as **Annexure 1B**. The same has also been included in the Environment Management Plan (Table 9.4) of the updated EIA report.
3	Copy of Coast Guard approved Oil Spill Contingency Plan with available trained manpower and equipment shall be submitted to the ministry.	Oil Spill Contingency Response plan (OSRP) has been prepared as per the National Oil Spill Disaster Control Plan (NOSDCP) Guidelines issued by the Indian Coast Guard (ICG). The Plan was reviewed by the Indian Coast Guard (ICG) and all the comments of the Indian Coast Guard (ICG) were incorporated in the revised OSRP and submitted back to ICG. The final approval is awaited. Copy of the acknowledgement letter dated 22 May 2019 for final approval of OSRP (submitted to the Assistant Commandant Indian Coast Guard, Kakinada), together with oil spill response equipment and trained manpower is submitted.	Copy of Oil Spill Contingency Plan which is submitted to Indian Coast Guard shall be submitted along with agreement of copy of International Oil Spill Response Service Provider as desired by the EAC for perusal.	Copy of Oil Spill Contingency Plan submitted to the Indian Coast Guard is enclosed as **Annexure 2B**. Copy of the agreement with International Oil Spill Response Service Provider is included as **Annexure 2A**. The same is also included as Annex 24 of the Revised EIA report (Volume 2).
4	Chapter Environment Management Plan has no integration of data generated in Chapter-3 i.e. from baseline; Description of Environment', for decision making. This shall be revised based on studies conducted for the purpose.	Environmental Management Plan is updated by including a column in Table 9.1 on baseline covered under Chapter 3 (i.e. Description of Environment). The updated EMP also includes reference to public hearing issues raised and related response. Copy of the Updated EIA (Volume 1) including revised EMP is submitted.	The project proponent shall ensure complying with EMP. The Committee noted that the Consultant/PP needs to read the documents before uploading on the Parivesh Portal.	Vedanta Limited (Cairn Oil & Gas) is committed to comply with the EMP mentioned as part of the EIA report. M/s ERM India Pvt Ltd is the Consultant for this project. And ERM has reviewed all the documents and followed the instructions regarding uploading of the documents on Parivesh Portal.

S. N.	Information Desired by the EAC	Response from Vedanta Limited (Cairn Oil & Gas) per Letter no. CIL/GGN/MOEF/19/11/01 dated Nov 20, 2019	Remarks of the EAC [As per Minutes of 15th meeting of EAC-(Ind-2) of MoEFCC]	Response from Vedanta Limited (Cairn Oil & Gas) through this ADS Response
5	Treatment and disposal of Additional produced water generated not mentioned in EIA. Treatment and disposal do not depend on assumptions.	EIA report covers treatment of produced water in the existing Produced Water Re-injection (PWRI) Treatment system as described in Sections 2.4.1, 4.49 & 4.6.3. Schematic of produced water treatment is given in Figures 2.8 & 2.9 of Section 2.4.1 of the EIA report. Section 2.4.1.11 of the EIA describes existing API Separator and Effluent Treatment Plant (of 3,000 m^3/day capacity). At higher water cut conditions also, the effluent generation will remain well within the existing ETP operating capacity of 3000 m3/day. The wastewater is treated and discharged into the sea through a submerged sub-sea pipeline and through a pipe diffuser system. The outfall is located 540 m from the shore at 5 m water depth. The treated produced water from PWRI Treatment system will continue to be injected into the confined hydrocarbon reservoir after comingling it with ground water to fill up the void created due to hydrocarbon extraction and maintain reservoir pressure. Refer to Section 24.1.11 of the Updated EIA (Volume 1) with additional information on produced water generation including revised EMP. Also, refer to Annexure 5 for standalone information on produced water generation and effluent treatment.	Commitment towards ZLD needs to be submitted. Effluent treatment plan to be revised separately for onshore and offshore.	Commitment towards Zero Liquid Discharge and documents related to onshore and offshore effluent treatment is included in **Annexure 3**. The same is also included in the updated Section 2.12.1 of EIA report (Volume 1).
6	On page 229 of EIA the values of S present in HSD has been reported 0.1%, need to be checked.	Sulphur content in HSD BS-IV grade is 50 ppm by wt. However, for air dispersion modelling the Sulphur content of 0.1% was considered, which is higher value than the actual Sulphur content present in the diesel. The ground level concentrations for emission of SO_2 with 0.1% Sulphur content in diesel remained well within the prescribed standards as against the HSD BS IV grade limit of 50 ppm (i.e. 0.005%) by wt.	The justifications found to be satisfactory.	No action required.

S. N.	Information Desired by the EAC	Response from Vedanta Limited (Cairn Oil & Gas) per Letter no. CIL/GGN/MOEF/19/11/01 dated Nov 20, 2019	Remarks of the EAC [As per Minutes of 15th meeting of EAC-(Ind-2) of MoEFCC]	Response from Vedanta Limited (Cairn Oil & Gas) through this ADS Response
7	Public hearing issues discussed by the EAC at length. Unless these serious issues are addressed by the project proponent, the EAC cannot recommend the project for grant of EC. There are serious allegations about the project proponent's functioning as per the recorded minutes of the PH meeting, for example non fulfilment of earlier commitment, pollution issues, drinking water, compensation, sludge and oily waste discharge into sea and reduction in yield of fishes, prawn including other sea food etc.	Issues raised during Public Hearing and related responses are given in Annexure 6. Vedanta Limited (Cairn Oil & Gas) will also submit six monthly compliance status of implementation of actions identified in response to issues raised during the public hearing. Vedanta Limited (Cairn Oil & Gas) has submitted an affidavit dated 25 October 2018 to the State Government of Andhra Pradesh acting through Joint Collector, East Godavari District (refer to Annexure 2), addressing key issues raised during the public hearing as well as commitment of annual contribution of INR 6.0 Crores towards CSR and CER initiatives. This amount will be annually deposited with office of District Collector, East Godavari District, Andhra Pradesh towards implementing community development works/ projects. This fund will be utilized by district administration for improving livelihood of the people residing in S. Yanam and surrounding villages. The amount to be spent and need of each program will be decided by the district administration based on the needs of the local community.	Public hearing issues, commitment, action plan along with budgetary provisions to be resubmitted incorporating the suggestions of the EAC.	Vedanta Limited (Cairn Oil & Gas) is committed to spend INR 20 Crores for next 10 years exclusively towards **CER activities** and address the concerns raised during the Public Hearing. Public hearing points, commitment, action plan with time and budgetary provisions is being resubmitted in **Annexure 4**. This is also included in Table 9.3 of the Environment Management Plan of the updated EIA report.
8	Item wise details of the budget allocated for Corporate Environment Responsibility (CER) need to be submitted for next five years.	In compliance with the requirements included in the MoEFCC office memorandum dated 1 May 2018 on Corporate Environment Responsibility, Vedanta Limited (Cairn Oil & Gas) on behalf of Ravva Joint Venture is committed to contribute every year INR 6.0 Crores towards implementing the CSR and CER projects as per affidavit dated 25 October 2018 submitted to the State Government of Andhra Pradesh acting through Joint Collector, East Godavari District (refer to Annexure 2). The amount of INR 6.0 Crores per annum (i.e. ~INR 30 Crores in five years) works out to	As proposed in the meeting, CER plan to be revised with Rs. 20 crore budget allocation along with detailed activities proposed to be carried out.	Vedanta Limited (Cairn Oil & Gas) is committed to spend INR 20 Crores for next 10 years exclusively towards **CER activities** and address the concerns raised during the Public Hearing. Commitments including on budget allocation for CER activities is included in Annexure 7. Actions on CER are included in Table 9.5 of the Environment Management Plan of the updated EIA report (Volume 1).

S. N.	Information Desired by the EAC	Response from Vedanta Limited (Cairn Oil & Gas) per Letter no. CIL/GGN/MOEF/19/11/01 dated Nov 20, 2019	Remarks of the EAC [As per Minutes of 15th meeting of EAC-(Ind-2) of MoEFCC]	Response from Vedanta Limited (Cairn Oil & Gas) through this ADS Response
		be more than INR 19.1 Crores i.e. 0.25% of the investment proposed (of INR 7,640 Crores). This amount will be annually deposited with office of District Collector, East Godavari District, Andhra Pradesh towards implementing community development works/ projects. This fund will be utilized by district administration for improving livelihood of the people residing in S. Yanam and surrounding villages. The amount to be spent and need of each program will be decided by the district administration based on the needs of the local community. The fund will be utilized by the administration towards implementing the following programs/initiatives: a) Drinking water: Setting of potable water system b) Infrastructure: Construction of roads, bridges/culverts, developing the parks with walking tracks, installation of the solar lights etc. c) Health: Supporting district medical department for effective operation and maintenance of the public health centre d) Solid waste and Sanitation: Provision of supporting the "Swatch Bharat" initiative for the effective waste management e) Education: Supporting the Government schools and Anganwadis towards improving the educational standards by supporting additional teachers, establishment of libraries, providing bus passes for the students, providing scholarships to the meritorious students etc. f) Sports: Supporting physical education in schools and youth such as providing sports kits, creating play area for the basketball, volleyball and cricket. g) Skill development of the youth: By developing IT training centres in the villages by providing computers and organizing training programs h) Natural Resource Management (NRM): Development of NRM related		

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		projects in the villages through plantation of the native species for increasing the green cover, providing fruit bearing saplings to the local villagers etc. i) Financial support: Financial support shall be provided to the villagers such as pension for widows and physically disabled persons. The amount to be paid will be decided by ROO. j) Need based assessment study: Carry out a need based (social) assessment study in the S.Yanam and the surrounding villages through Smart Andhra Pradesh Foundation or through any reputed institutions. The outcome of the study will be discussed with the district administration and financial support will be focused on the study outcome related program. As guided in the OM on CER dated 1 May 2018, the District Collector may add or delete the activities as per the requirements of the district.		
9	The project proponent is directed to submit an affidavit on each issue raised by the public and also on suggestions of ADM toward compliance of these issues with budget and time frame. The EMP which is given in EIA do not have mention of anything about compliances of the public hearing issues. Therefore, the proposal in present form shall not be recommended for EC and is deferred till	Vedanta Limited has already submitted the following affidavits 1) Affidavit dated October 25, 2018 submitted to the State Government of Andhra Pradesh acting through Joint Collector, East Godavari District (refer to Annexure 2) addressing key issues raised during the public hearing as well as commitment of annual contribution of INR 6.0 Crores towards CSR and CER initiatives; and 2) Affidavit with covering letter dated September 09, 2019 submitted to MoEFCC mentioning the commitment towards community initiative programs, no forestland involved for the Project, obtain of necessary approvals before start of any activity outside the block area, carry out of process safety and risk assessment study using 3D modelling and addressing the public hearing issues in consultation with the district administration (refer to Annexure 1). Item wise response to Public Hearing issues raised are	Action plan for CER to be revised.	Refer to **Annexure 7** on commitments and action plan including on budget allocation for various CER activities to be undertaken. This is also included in Table 9.3 of the Environment Management Plan of the Revised EIA report (Volume 1).

S. N.	Information Desired by the EAC	Response from Vedanta Limited (Cairn Oil & Gas) per Letter no. CIL/GGN/MOEF/19/11/01 dated Nov 20, 2019	Remarks of the EAC [As per Minutes of 15th meeting of EAC-(Ind-2) of MoEFCC]	Response from Vedanta Limited (Cairn Oil & Gas) through this ADS Response
	submission of above.	included in the revised EMP (Section 9) of the Updated EIA as enclosed. Also refer to Annexure 6 for details.		
Additional Clarification/Inputs				
i)			Revised Form 2 to be submitted vis-à-vis the updated EIA report.	Revised Form 2 in Annexure 8 vis-à-vis the updated EIA report (after dropping of onshore five well pads outside PKGM-1 Block) is submitted.
ii)			Details of project block, separately for onshore and offshore along with proposed drilling locations. Details of wells proposed to be dropped from the scope of the work.	Details of project block, separately for onshore and offshore along with proposed drilling locations together with information on five onshore well pads dropped from the scope of work is enclosed as **Annexure 5**.
iii)			The Project proponent either need to provide an approval of DGH for the five onshore drilling wells which are located outside the PKGM-1 Block and belong to ONGC or surrender these wells by an undertaking.	As the process of obtaining approval of DGH for development of well pads outside the PKGM-1 Block is taking time, therefore, Vedanta Limited (Cairn Oil & Gas) on behalf of the Ravva JV has decided to drop development of five onshore well pads (Well Pads # 1 to 5) proposed to be located outside the PKGM-1 Block. No drilling of wells will be carried outside the PKGM-1 Block area. The development of five well pads that were located outside in the ONGC Block area proposed as part of the EIA study will not carried out further.
iv)			The project proponent needs to submit the copy of NOC and communication addressed to the Ministry by the APCZMA. In addition, conditions imposed and plan for achieving the same shall be submitted. The comments of CRZ needs to be obtained by the Sector	Copy of NOC and communication addressed to the Ministry by APCZMA is enclosed as **Annexure 1A**. In addition, conditions imposed and plan for achieving the same is submitted as **Annexure 1B**. The same has been also been included in the Environment Management Plan (Table 9.4) of the Revised EIA report (Volume 1).

S. N.	Information Desired by the EAC	Response from Vedanta Limited (Cairn Oil & Gas) per Letter no. CIL/GGN/MOEF/19/11/01 dated Nov 20, 2019	Remarks of the EAC [As per Minutes of 15th meeting of EAC-(Ind-2) of MoEFCC]	Response from Vedanta Limited (Cairn Oil & Gas) through this ADS Response
v)			Copy of marine EIA report, maps and other documents submitted for CRZ recommendation to be provided.	The EIA Report for Expansion of Offshore & Onshore Oil & Gas Exploration, Development & Production in existing Ravva Field, PKGM-1 Block covered both terrestrial and marine components and was submitted to APCZMA during the process of issuance of NOC from APCZMA. The EIA study covers both onshore and offshore (marine) components as following: ▪ Onshore Baseline in Sections 3.3 to 3.11 while marine baseline is covered in Sections 3.13, 3.14 & Annex 1 on as detailed marine baseline done by Andhra University in Volume 2 of the EIA study. ▪ Impact Assessment for onshore component is covered in Section 4.4 while for offshore component in Section 4.5 ▪ Risk Assessment for onshore component is covered in Sec 7.2.1 while for offshore component in Sec 7.2, 7.3 & 7.4. ▪ EMP for onshore and offshore activities is also separately covered in Tables 9.1, 9.2 The Revised EIA report (volume 1) after dropping of development of onshore five well pads proposed to be located outside the PKGM-1 Block is being submitted.
vi)			Copy of Oil Spill Contingency Plan which is submitted to Indian Coast Guard shall be submitted along with agreement of copy of International Oil Spill Response Service Provider as desired by the EAC for perusal.	Copy of Oil Spill Contingency Plan submitted to the Indian Coast Guard is enclosed as **Annexure 2B**. Copy of the agreement with International Oil Spill Response Service Provider is included as **Annexure 2A**. The same is also included as Annex 24 of the Revised EIA Report (Volume 2)

S. N.	Information Desired by the EAC	Response from Vedanta Limited (Cairn Oil & Gas) per Letter no. CIL/GGN/MOEF/19/11/01 dated Nov 20, 2019	Remarks of the EAC [As per Minutes of 15th meeting of EAC-(Ind-2) of MoEFCC]	Response from Vedanta Limited (Cairn Oil & Gas) through this ADS Response
vii)			Commitment towards ZLD needs to be submitted. Effluent treatment plan to be revised separately for onshore and offshore.	Commitment towards Zero Liquid Discharge and documents related to onshore and offshore effluent treatment is included in **Annexure 3**. The same is also included in the Section 2.12.1 of the Revised EIA report (Volume 1).
viii)			AAQ data and GLC due to the project needs to be revisited.	AAQ data and GLC due to the Project activities has been revisited and updated results are included in Section 4.4.4 and Section 4.5.1 of the updated EIA Report.
ix)			Certified compliance report of the existing EC from the Regional Office of the Ministry/ Communication, if any, from Regional Office regarding compliance.	Vedanta Limited (Cairn Oil & Gas) approached MoEFCC, Chennai Regional Office on 10 April 2018 requesting to carry out verification of EC compliance report referring to the EIA TOR document. MoEFCC Regional Officer visited Ravva Terminal for EC compliance verification on 07 June 2018, however no report was issued. Subsequently, Vedanta followed up and submitted request letter on 01 October 2018. After that also no report was issued. Thereafter, Vedanta Limited approached APPCB Member Secretary on 07 December 2018 referring to the MoEFCC Circular dated 07 September 2017, which states “Regional Offices of the Ministry are requested to submit certified compliance report within one month of receipt of such requests from the Member Secretary of the sectoral EAC. In case the inspection is not carried out within one month, the certified compliance report from the concerned Regional Offices of Central Pollution Control Board (CPCB) or the Member Secretaries of the respective State Pollution Control Boards shall also be accepted for deliberations by the sectoral EAC.” Referring to the

S. N.	Information Desired by the EAC	Response from Vedanta Limited (Cairn Oil & Gas) per Letter no. CIL/GGN/MOEF/19/11/01 dated Nov 20, 2019	Remarks of the EAC [As per Minutes of 15th meeting of EAC-(Ind-2) of MoEFCC]	Response from Vedanta Limited (Cairn Oil & Gas) through this ADS Response
				MoEFCC Circular, Vedanta's requested APPCB Member Secretary and accordingly, the APPCB Member Secretary advised APPCB Regional Officer (Kakinada) to conduct the site visit and submit the report. APPCB Regional Officer conducted site visit for the EC compliance verification on 28 December 2018 and 18 January 2019 and issued the EC compliance report on 31 January 2019. Copy of compliance status of EC conditions certified by APPCB is included as **Annexure 6**.
x)			Public hearing issues, commitment, action plan with time and budgetary provisions to be resubmitted incorporating the suggestions of the EAC.	Public hearing issues, commitment, action plan with time and budgetary provisions is being resubmitted in **Annexure 4**. This is also included in Table 9.3 of the Environment Management Plan of the Revised EIA (Volume 1) being submitted to MoEFCC.
xi)			As proposed in the meeting, CER plan to be revised with Rs. 20 crore budget allocation.	Vedanta Limited (Cairn Oil & Gas) is committed to spend INR 20 Crores for next 10 years exclusively towards **CER activities** and address the concerns raised during the Public Hearing. Refer to **Annexure 7** on the commitments including on budget allocation for CER activities.

Enclosures:

Annexure 1A: Copy of NOC communication addressed to the Ministry by APCZMA.

Annexure 1B: Conditions imposed by APCZMA in its NOC and plan for achieving the same

Annexure 2A: Copy of the agreement with International Oil Spill Response Service Provider

Annexure 2B: Copy of Oil Spill Contingency Plan submitted to the Indian Coast Guard.

Annexure 3: Commitment towards ZLD together with separately described onshore and offshore effluent treatment process.

Annexure 4: Public hearing issues, commitment, action plan with time and budgetary provisions.

Annexure 5: Details of project block, separately for onshore and offshore along with proposed drilling locations together with information on five onshore well pads dropped from the scope of work.

Annexure 6: Copy of APPCB certified compliance report for the already obtained Environmental Clearances.

Annexure 7: Commitments including on budget allocation for CER activities.

Annexure 8: Revised Form 2 after dropping of five well pads from the Project scope. &

Revised EIA Report (Volume 1 & 2)

Annexure 1A

Copy of NOC and communication by APCZMA addressed to the MoEFCC

O/C

Andhra Pradesh Coastal Zone Management Authority (APCZMA)
Andhra Pradesh
Ministry of Environment Forests & Climate Change
Government of India
D.No.33-26-14 D/2, Near Sunrise Hospital, Pushpa Hotel Centre,
Chalamavari Street, Kasturibaipet, Vijayawada -520010

Letter No. 138/APCZMA/CRZ/IND/2019 92 **Dated:03-04-2019.**

From:
Sri G. Anantharamu, IAS,
Principal Secretary to Government,
E. F. S & T. Department,
Interim Government Secretariat,
Amaravathi.

To
The Secretary,
Ministry of Environment and Forests and Climate Change,
Indira Paryavaran Bhavan, Jorbagh Road,
New Delhi – 110 003.

Sir,

Sub:- M/s. Vedanta Limited (Division: Cairn Oil & Gas) , Expansion of Offshore and onshore Oil and gas Exploration, Development and Production in existing Ravva (PKGM-1) Block, near Surasniyanam Village (S.Yanam), Krishna – Godavari basin, East Godavari District, Andhra Pradesh.– Environmental clearance – Requested - Regarding.

06.05.19 DESPATCHED V.N.

Ref:-1. Letter No: CRZ/RV/GGN/22112018/01 dated 22 November 2018, from Mr.Pankaj Jain,President Offshore SBU, M/s.Vedanta Limited (Division: Cairn Oil & Gas), DLF Atria, Phase – 2, Jacaranda Marg, DLF City, Gurgaon – 122002. Haryana, India.
2. From the Director, IA-II Division, Ministry of Environment and Forests, Government of India, New Delhi Terms of Reference (ToR) Letter No. J-11011/41/2018-IA-II(I), dated 24.03.2018..

In the reference 1st cited , M/s. Vedanta Limited (Division: Cairn Oil & Gas) submitted the proposal for expansion of Offshore and Onshore Oil and gas Exploration, Development and Production in existing Ravva(PKGM-1) Block, near Surasniyanam Village (S.Yanam), Krishna - Godavari basin, East Godavari District, Andhra Pradesh. In order to enhance hydrocarbon production, M/s. Vedanta Limited (Division: Cairn Oil & Gas) has proposed expansion of Offshore & Onshore Oil & Gas Exploration, Development & Production within the existing Ravva (PKGM - 1) Offshore Block. The proposal includes the drilling of 83 Nos.

exploratory and appraisal wells (59 Nos. from standalone offshore locations & 14 Nos. from existing offshore platforms and 10 Nos. from proposed onshore well pads) to assess presence of hydrocarbons in prospects identified. Drilling of 40 Nos. development (production) wells (17 Nos. from the existing offshore platforms and 23 Nos. from proposed onshore well pads). Development of onshore surface facilities including 7 Nos. of well pads and laying of 15km(approx.) of pipeline corridor (for accommodating three pipelines) connecting onshore well pads with the existing onshore oil & gas processing terminal. A pipeline corridor (to accommodate three pipelines) of ~15 m Right of Use (RoU) width, and suitable access roads of ~10m width connecting to the proposed onshore well pads. The estimated cost of the project is Rs.7924 Crores.

2. In the reference 2nd cited, the Ministry of Environment and Forests, Government of India, New Delhi issued Terms of Reference (ToR) vide F.No. J-11011/41/2018-IA-II(I) dated 24.03.2018. wherein, the project proponent was directed to furnish the recommendations of the APCZMA as part of fulfillment of requirement for considering the proposal for environmental clearance along with other conditions. The NOC from APPCB was obtained vide Order No. 281/APPCB/CFE/RO-KKD/HO/2015 dated. 11.05.2018 to obtain clearance under CRZ Notification, 2011.

3. The area on the shore is classified as CRZ-III followed by Inter-tidal zone as CRZ-I(B) and water area in the sea as CRZ-IV(A) as per the approved Coastal Zone Management Plan (CZMP) of East Godavari District. The CRZ demarcation was carried out by National Centre for Sustainable Coastal Management (NCSCM), Chennai an authorised agency of Government of India and CRZ map has been prepared for the project study area in accordance to the CRZ Notification, 2011. The proposed wells are located in the coastal area and fall within the Coastal Regulation Zone (CRZ). The CRZ Mapping indicates that majority of the Ravva Block falls within the Bay of Bengal (CRZ IVA) while part of the block falls within CRZ I(B), CRZ III and CRZ IV(B). The offshore well location fall within CRZ IV(A) while the onshore well pads are located within CRZ I(B) and CRZ III. The connecting roads for access to the onshore well pads and the pipelines for transportation of well fluids from well pads to Ravva Terminal are located within CRZ I(B), CRZ III and CRZ IV(B). No development under the project is proposed in CRZ I(A).

4. The exploration and extraction of oil and natural gas and all associated activities and facilities thereto is a permitted activity as per the paragraph 3(ii), 3 (x)(b) of CRZ Notification 2011. The exploration of natural gas and oil is a regulated activity as provided in paragraph 4.(ii)(d) and (e) of CRZ Notification 2011.

5. The proposal was examined by the APCZMA in the meting held on 19-02-2019. The authority recommended the proposal to the MoEF&CC for clearance subject to the fulfillment of safety regulations including guidelines issued by the Oil Industry Safety Directorate in the Ministry of Petroleum and Natural Gas and guidelines issued by Ministry of Environment and Forests, Government of India and subject to further terms and conditions for implementation of ameliorative and restorative measures in relation to environment.

6. It is, therefore, requested to examine the proposal under paragraph 3(ii) 3 (x)(b) and 4 (i) (d) and (e) of CRZ Notification, dated 06-01-2011 and clearance may please be accorded for the expansion of Offshore and Onshore Oil and gas Exploration, Development and Production in existing Ravva(PKGM-1) Block, near Surasniyanam Village (S.Yanam), Krishna - Godavari basin, East Godavari District, Andhra Pradesh at an early date.

Yours faithfully,

Sd/-
CHAIRMAN
APCZMA

CRZ Form-1
Environmental Monitoring reports,
Environmental Management and Monitoring Plan,
Disaster Management Plan including Quantitative Risk Assessment Plan,
LTL- HTL and CRZ demarcation report

//T.C.F.B.O//

Senior Environmental Engineer (EE)

Annexure 1B

Conditions imposed by APCZMA and Plan to Achieve the Same

Annex 1B Recommendations in NOC issued by Andhra Pradesh Coastal Zone Management Authority (APCZMA) vide Letter No. 138/APCZMA/CRZ/IND/2019 dated 03.04.2019 and Cairn Response

Sl. No.	Ameliorative and Restorative Measures Recommended by APCZMA	Compliance
1.	The proposed constructions shall conform to the norms prescribed in CRZ Notification S. O. No.19 (E), dated 06-01-2011 issued by the Ministry of Environment and Forests, Government of India.	The proposed construction activity will conform the prescribed norms of CRZ Notification S. O. No.19 (E), dated 06-01-2011 issued by the Ministry of Environment and Forests, Government of India. As per the requirement, CRZ maps were prepared by MoEFCC approved agency National Centre for Sustainable Coastal Management, Chennai. Appraisal of the Project was held by APCZMA following which NOC was issued on 07 April 2019.
2.	No activity on ground shall be undertaken without obtaining Environmental Clearance from the Ministry of Environment and Forests, Government of India.	All activities on ground will commence after obtaining Environmental Clearance from Ministry of Environment and Forests, Government of India.
3.	Regular monitoring of sea water of the sea shall be taken up to study the impact on marine organism.	Vedanta Limited (Cairn Oil & Gas Division) has engaged the Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to annually carry out Marine Ecological Study to monitor any adverse impact caused due to its developmental and operation activities in the PKGM-1 Block. The outcome of the marine monitoring study of 2018 has confirmed no adverse impact caused due to existing operations in PKGM-1 Block. The results of seawater and sediment samples at all the stations of the Company operational areas are very low and far below the standards prescribed by ATSDR (Agency for Toxic Substances and Disease Registry 1999) indicating no oil pollution or toxicity. The study also showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. The study report will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEF&CC.
4.	The monitoring of hydrocarbons & other relevant parameters shall be entrusted to an independent agency like Andhra University and any other accredited institutions in addition to in-house monitoring.	
5.	Marker buoy and light indicators shall be established close to the route of the pipeline to avoid fishing net damage.	All the existing and proposed pipelines are laid below the seabed, thus there is no exposure of any pipeline above the seabed. Marker buoys and light indicators are not

		applicable for any offshore route of pipeline, hence there will no damage to fishing nets.
6.	The nearby coastal waters are known to support rich and diverse biotic communities where some of the best fishing grounds for the east coast exist.	Vedanta Limited (Cairn Oil & Gas Division) will ensure that its existing and proposed activities do not cause impact on biotic communities and fishing grounds are well maintained. The Company has engaged the Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to annually carry out Marine Ecological Study to monitor any adverse impact caused due to its developmental and operation activities in the PKGM-1 Block. The study report will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEF&CC.
7.	The industry shall undertake post-project monitoring of estuarine and coastal waters and the industry is advised to follow internationally acceptable protocols while dealing with marine biological aspects.	In normal operations no adverse impact is caused. During offshore drilling a well, drill cuttings and drilling fluids are discharged complying with the requirements of the GSR 546 (E) of Environment (Protection) Rules, 1986. Environmental and biological aspects monitoring will be carried out a) prior to start of drilling; b) during drilling; and c) post drilling. All the monitoring reports will be submitted to MoEFCC as part of six monthly compliance reporting. In addition to the environmental and biological aspects monitoring during drilling, there will also be annual marine study of the PKGM-1 Block area by Andhra University. During offshore drilling activities, best practices will be followed for environmental controls. Discharges from the rig and vessels engaged will follow the Indian and international (e.g. MARPOL) Standards.
8.	The industry shall follow international codes and standards for laying the submarine pipelines.	Vedanta Limited continues to follow submarine pipeline system for acceptance criterial and procedures for pipeline design, fabrication and installation as per DNV-GL-ST-F101. This Standard applies modern limit-state-design principles with "Safety Classes" linked to Consequences of Failure.

9.	All safety measures shall be incorporated to avoid any possible accidents due to structural failures and adequate safety measures shall be provided to prevent blow outs of Natural Gas / Hydrocarbons.	All necessary safety measures such as corrosion control, physical damage and instrumentation controls are incorporated during the initial design life and operation phase of the installations. In addition, periodic monitoring are carried out such as corrosion study, free span survey of pipelines, physical inspection of structures by engaging divers, artificial intelligent pipeline pigging etc. Vedanta Limited will continue to evaluate through competent agencies once in five years the complete risk of operating the pipelines and other structures beyond its design life and submit "fitness-for-service certificate" to OISD specifying the allowable future operations period and conditions implying safe operations. The safe practices for work over operations, well stimulation operations, and blow out prevention equipment systems for drilling wells are carried out in accordance with requirement of Oil Industry Safety Directorate Guidelines i.e. OISD-GDN-182 and Oil Industry Safety Directorate recommended practices OISD-RP-174.
10.	There shall not be any obstruction to fishing activity beyond 500m exclusive drilling zone.	Vedanta Limited (Cairn Oil & Gas) shall ensure that their activities do not cause any obstruction to fishing practices beyond 500m of exclusive drilling zone.
11.	Fish tissue analysis of local fish species shall be conducted to evaluate the bio-accumulation of hydrocarbons and heavy metals.	Fish tissues analysis of local fish species to evaluate the bio-accumulation of hydrocarbons and heavy metals are being carried out annually by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to monitor any adverse impact caused due to its developmental and operation activities in the PKGM-1 Block.
12.	Bio-assay analysis shall be conducted periodically to establish the toxicity levels.	Vedanta Limited (Cairn Oil and Gas) shall be carried out periodically to establish the toxicity levels for marine discharges.
13.	The guidelines issued by the CPCB for extraction of oil and gas shall be followed. The drill cuttings and drilling fluids for offshore installations should confine to the guidelines issued by CPCB.	Vedanta Limited (Cairn Oil and Gas) will continue to follow "Guidelines for disposal of solid wastes, drill cuttings and drilling fluids for offshore and onshore drilling operation" as notified under the Environment (Protection) Rules, 1986. The environmental monitoring will be carried out prior to, during and post drilling of a well.

14.	The industry shall extend necessary assistance to the Forest and Wildlife Department towards conservation and preservation of Coringa Wildlife Sanctuary, which is an Ecologically Sensitive Area.	Vedanta Limited (Cairn Oil and Gas) has agreed to support the Wildlife Institute of India and District Forest Office for protecting endangered species in the Coringa Wildlife Sanctuary, East Godavari District. A Project titled "Ecological and Conservation for Perspectives of Fishing Cat (*Prionailurus viverrinus*)" is being carried out for three FYs starting from 2019-22 with grant of INR 74.03 Lakhs.
15.	Full cooperation shall be extended to all inspecting authorities/ organizations such as APPCB, MoEF&CC, CPCB and local Environment Protection Organizations.	Vedanta Limited (Cairn Oil and Gas) shall extend full cooperation as required to all inspecting authorities/ organizations such as APPCB, MoEF&CC, CPCB and local Environment Protection Organizations.

Annexure 2A

Copy of the agreement with International Oil Spill response Service Provider

For Annex-2A to ADS on

Agreement with Oil Spill Response Limited (OSRL)

Access the document through link below

https://drive.google.com/file/d/15U1qzEzsrU8E0zWwhg-IY6ICdEuxD-2E/view?usp=sharing

Also, refer to Annex-24 of EIA Report Volume 2.

Annexure 2B

Copy of Oil Spill Contingency Plan submitted to the Indian Coast Guard

vedanta
transforming elements

CAIRN

Date: 22nd May 2019

To

The Asst Commandant,
Indian Coast Guard Station,
Beach Road,
Kakinada

Dear Sir,

Sub: Submission of Oil Spill Contingency Plan for Offshore Operations of Ravva Field, East Coast of India, July 2017

We are hereby submitting the Oil Spill Contingency Plan for Offshore Operations of Ravva Field, East Coast of India, July 2017, Doc Ref: VL-RV-QHSE-OSCP-01 to your good self.

We request you to kindly acknowledge the receipt of the same.

Thanking you,

For Vedanta Limited (Cairn Oil & Gas),

Authorized Signatory

23/5/19
Received by
(Ramesh Chandra)
Pradhan Adhikari
ICGS Kakinada.

VEDANTA LIMITED
Cairn Oil & Gas: DLF Atria, Phase 2, Jacaranda Marg, DLF City, Gurugram – 122002, Haryana, India
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Registered Office: Vedanta Limited, 1st Floor, 'C' Wing, Unit 103, Corporate Avenue, Atul Projects, Chakala, Andheri (East), Mumbai – 400093, Maharashtra, India | T +91 22 664 34500 | F +91 22 664 34530 | www.vedantalimited.com
CIN: L13209MH1965PLC291394

Vedanta Limited

Cairn Oil &Gas

Oil Spill Contingency Plan for Offshore Operations of Ravva field, East Coast of India

July 2017

Doc Ref:VL-RV-QHSE-OSCP-01

For Annex-2B to ADS on

Oil Spill Contingency Plan, as submitted to the Indian Coast Guard

Access the document through link below

https://drive.google.com/file/d/1KZxtg4Kmq0TGDRF8aay-_rzRlWLTivhK/view?usp=sharing

Note: The document is ~87 MB, hence, could not be attached due to size restriction

Also, refer to Annex-6 of EIA Report Volume 2 for excerpts of Oil Spill Contingency Plan

Hard copy of the Full Document on Oil Spill Contingency Plan will be submitted to MoEFCC along with other documents during documents submission stage.

Annexure 3

Commitment towards ZLD Together with Separately Described Onshore and Offshore Effluent Treatment

1 ANNEXURE 3: WASTEWATER GENERATION, TREATMENT & DISPOSAL ARRANGEMENT FOR ONSHORE & OFFSHORE DRILLING OF WELLS IN PKGM-1 BLOCK, ANDHRA PRADESH: COMMITMENT TOWARDS ZERO LIQUID DISCHARGE (ZLD) IN ONSHORE WATER BODIES

Vedanta Limited (Cairn Oil & Gas) is committed to maximum recovery and utilization of natural resources and comply with the applicable regulations and standards all the time. The onshore and offshore drilling of wells related wastewater generation, treatment and disposal arrangement is described in the following sub sections.

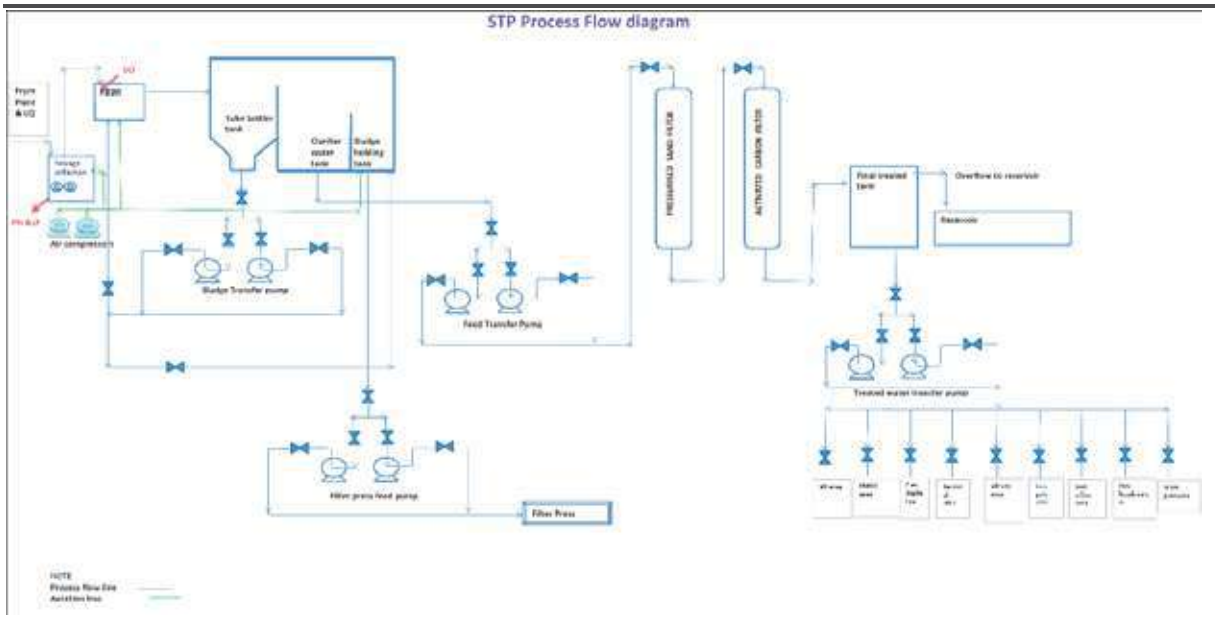
1.1 ONSHORE DRILLING OF WELLS & RELATED WASTEWATER GENERATION, TREATMENT & DISPOSAL ARRANGEMENT

In the onshore part of the PKGM-1 Block, there is a proposal to drill 33 wells (10 exploratory and 23 developmental wells) over a period of 10 years from two onshore well pads, developed previously in 2006-07. Drilling of a well is achieved in average 45 to 50 days.

1.1.1 Domestic Wastewater

During proposed exploratory and development drilling of wells in the onshore, domestic wastewater of 4.5 m^3/day will be generated by engaging 80 number of manpower. All domestic wastewater will be collected in a modular STP for primary treatment followed by its collection into a tanker for its final treatment in the existing Sewage Treatment Plant (STP) of 175 m^3/day capacity at the Ravva Living Quarters as shown in schematic of STP in *Figure 1.1*.

Figure 1.1 Schematic Flow Diagram of Operating STP at Ravva Living Quarters



The treated domestic wastewater is used in watering the plantation in Ravva Terminal and Living Quarters, to ensure zero discharge of domestic wastewater. Thus domestic wastewater generated from drilling activities will have **zero discharge** in any water body.

1.1.2 *Wash Wastewater from Onshore Drilling of a Well*

For onshore drilling of a well, wash wastewater of ~5 m^3/day (containing high-suspended solids, oil and grease and traces of heavy metals) will be generated during washing of drill cuttings on a shale shaker. All wash wastewater will be collected in a HDPE line pit will. From the pit, drill cuttings wash wastewater will be taken into a **skid mounted mobile effluent treatment plant** fitted with primary, and secondary treatment process comprising of the following:

a) **Neutralization of extreme pH values:** Neutralization of extreme pH values in effluent will be done at optimum dose of chemicals and acids;
b) **Chemical treatment for coagulation and flocculation of effluent**: Coagulation and flocculation will be done in chambered flash mixer and flocculator provided with agitator for chemical mixing at desired rate.
c) **Sedimentation, clarification and filtration of separated effluent:** Sedimentation of separated effluent, by the use of dual chambers for separation of oil & grease and smaller solid particles from the separated effluent
d) **Clarification in tube clarifier chamber:** Clarification chamber is provided for removal of suspended particles in clarifier with conical bottom for periodic removal of the solid particles.

A typical skid mounted mobile effluent treatment plant is shown in *Figure 1.1*

Figure 1.2 A Typical skid mounted Mobile Effluent Treatment Plant

The quality of effluent from the skid mounted ETP is expected to be as given in the following *Table 1.1*.

Table 1.1 Expected Quality of Effluent from Skid Mounted Mobile ETP

SN	Parameter	Results
1	pH	5.0 to 9.0
2	Oil and Grease, mg/L	<10.0
3	COD, mg/L	<250
4	Total Suspended Solids, mg/L	<100

Treated effluent from the skid mounted mobile ETP will be taken through a tanker to the existing ETP at Ravva Terminal for further treatment and conformance to the applicable

regulatory norms before its final treatment and disposal through existing marine outfall (as per description given in *Section 1.1.3* below). There will be **no onshore disposal** of effluent in any onshore water body from drilling of any onshore well.

1.1.3 Description of Effluent Treatment in Existing ETP at Onshore Ravva Terminal & Disposal Arrangement

From the existing operations at Ravva Terminal, produced water is generated from well head fluid which is treated onshore in Produced Water Re-Injection (PWRI) System to achieve oil in water content of less than 10 mg/l. Through maximum recovery and utilization of produced water generated from well fluid, up to 85% is treated and comingled with brackish groundwater for water injection into the confined reservoir to maintain hydrocarbon pressure.

The drained residual produced water (up to 15%) from the process units that is not routed through PWRI is routed to the API separator. The API separator is provided with a slotted pipe type free oil collection and removal system. Sufficient settling time for separation of oil from water and for the gravity settling of oily sludge and inert sediments is provided. Treated water from the API separator is pumped to the equalization tank of the Effluent Treatment Plant (ETP) of 3,000 m^3/ day capacity at Ravva Terminal as shown in *Figure 1.2*.

There exists an operating Effluent Treatment Plant (ETP) of 3,000 m^3/ day capacity at the Ravva Terminal. The ETP at Ravva Terminal consists of primary, secondary and tertiary treatment system. The primary treatment involves free and floating oil separation and gravity settling of heavier sediments. The secondary treatment is an aerobic activated sludge biological treatment to reduce BOD levels. The tertiary treatment involves polishing the treated effluent through a dual media filtration.

The quality of treated effluent from ETP as monitored by Vimta Labs during January to December 2019 is shown in *Table 1.2*.

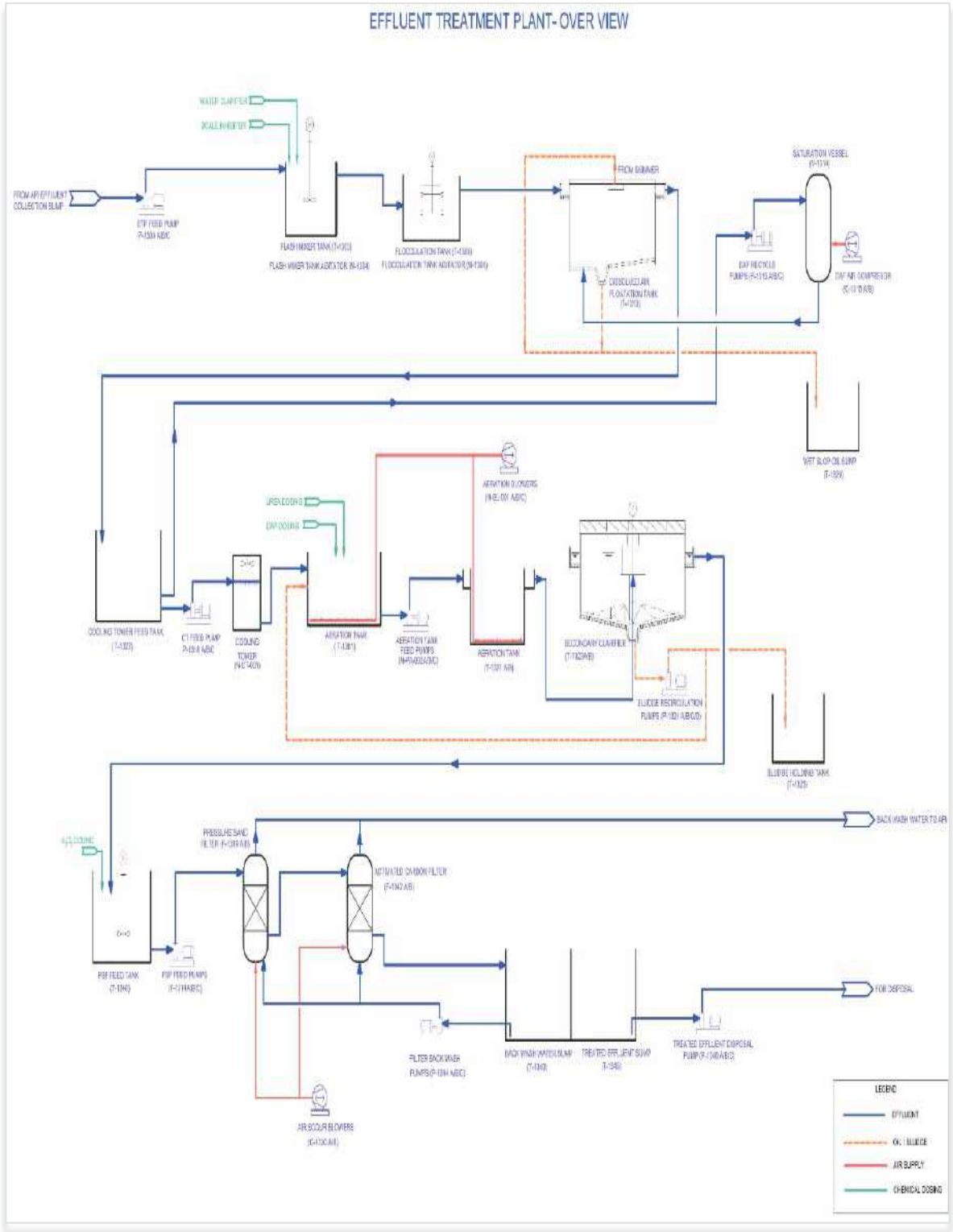
Table 1.2 Quality of Treated Effluent from Effluent Treatment Plant at Ravva Terminal

SN	Parameter	Results of Treated Effluent from ETP Observed in 2019									EP Rules, GSR 546 (E) Limits
		Jan to March		Apr-Jun		July – Sep		Oct-Dec		Ann. Avg.	
		Min	Max	Min	Max	Min	Max	Min	Max		
1	pH	7.2	7.8	7.8	8.0	7.7	7.9	7.5	7.8	7.7	5.5 to 9.0
2	Oil and Grease mg/L	6.0	7.0	7.0	8.0	6.0	8.0	6.0	8.0	7.0	10.0
3	COD, mg/L	177.0	218.0	158.0	196.0	152.0	175.0	138.0	157.0	171.4	250
4	BOD (3 days, 27°C), mg/L	13.0	18.0	15.0	17.0	12.0	14.0	14.0	16.0	14.9	30
5	Total Suspended Solids, mg/L	48.0	66.0	57.0	68.0	42.0	53.0	56.0	62.0	56.5	100
6	Fluoride, mg/L	0.7	0.9	0.7	0.9	0.6	0.8	0.7	1.0	0.8	1.5
7	Total Chromium as Cr, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
8	Lead, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
9	Copper, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
10	Zinc, mg/L	0.02	0.04	0.04	0.07	0.03	0.06	0.05	0.07	0.0	0.1
11	Mercury, mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
12	Cyanide, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.005
13	Nickel, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1

Source: As per analysis by Vimta Labs for January to December 2019.

The treated wastewater from the ETP at Ravva Terminal is discharged into the sea complying with the discharge standards as prescribed in the EP Rules (1986), GSR 546 (E) through 20

inches pipeline leading to existing marine outfall located at 82°06'22"E and 16°28'17"N. The effluent pipeline at the marine outfall is ended with T-shaped 2 port diffuser (of diameter 3 inches each, 3.5 m length each at 90º) which is submerged at 5 m depth (1 m above seabed) at 540 m from the shore. There is **no onshore discharge** of treated effluent in any onshore water body. *Figure 1.3* Schematic of Effluent Treatment Plant at Ravva Terminal.



1.2 OFFSHORE DRILLING OF WELLS AND RELATED WASTEWATER GENERATION, TREATMENT &

1.3 DISPOSAL ARRANGEMENT

From offshore, there is a proposal to drill 90 wells (73 exploratory and 17 developmental wells) from existing platforms and from standalone locations within the PKGM-1 Block. Drilling of a well in offshore is achieved in average 45 days from the date of rig mobilization.

1.3.1 Domestic Wastewater from Offshore Rig

Domestic wastewater from kitchen, shower, toilets and laundry area on board drilling rig will be ~30 m^3/day. All domestic wastewater will be treated in IMO approved sewage treatment plant (STP) to be installed on board the rig. The STP will be IMO certified complying with the MARPOL Standards.

Domestic wastewater will be treated in on board STP for physico–chemical and biological treatment through extended aeration system. The treated and disinfected sewage on board STP is disposed offshore beyond 3 nautical miles (nm) from shore complying with the Indian discharge requirements and MARPOL requirements.

Also there is generation of bilge water consisting of rainwater/seawater containing diesel and oil will be ~10 m^3/well. Bilge water will be collected into a sludge tank and then to a water/oil separator on board drilling rig before offshore disposal with less than 15 mg/l of oil and grease content.

The typical quality of treated sewage from a certified sewage treatment plant and treated bilge water from an oil in water separator from an offshore rig is given in *Table 1.3*.

Table 1.3 Typical Quality of Treated Sewage and Treated Bilge Water from an Offshore Rig

SN	Parameter	Typical Treated Sewage Quality	Typical Treated Bilge Water Quality	Indian General Standards of Discharge for Marine Coastal Areas	MARPOL Standards #
1	pH	6.0 to 8.5	6.0 - 8.5	5.5 to 9.0	6.0 to 8.5
2	Total Suspended Solids, mg/L	<35	<35	100	35 above ambient seawater quality
3	Oil & Grease	<15	<15	20	<15
4	COD, mg/L	<125	<125	250	125
	BOD (5 days), mg/L	<25	<25	100	25

Note: # India is a signatory to International Convention on the Prevention of Pollution from Ships (MARPOL) and all its annexes.

1.3.2 Wash Wastewater from Offshore Drilling of a Well

Wash wastewater is generated during drill cutting washing on shale shaker. Most of the wash wastewater is reused in mud preparation. A maximum of 200 m^3/well wash wastewater generated will be treated on board to ensure oil in water content of less than 15 mg/l before its disposal offshore.

Annexure 4

Public Hearing Issues, Commitment, Action Plan with Time and Budgetary Provisions

Action Plan on Issues Raised during Public Hearing held on 11 Oct 2018

Vedanta Limited (Cairn Oil & Gas) is committed to Spend INR 20 Crores for next 10 years under CER Activities to comply with the concerns raised during the Public Hearing. This CER amount will be in addition to CSR and Environmental Pollution Control & Monitoring Related Budget.

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
1	**Sri Nagini Nageswar Rao, ZPTC, Katrenikona**			
1 a)	Expressed concerns that promises made in the earlier public hearings by ONGC, GSPC, Reliance & Vedanta Limited had not been implemented.	The company has been implementing CSR activities since beginning of its operations. Till today, Vedanta has deposited INR 33.64 Crores with district administration.	Vedanta Limited (Cairn Oil & Gas) on behalf of Ravva Joint Venture (the Company) is committed to spend INR 2.0 Crores per annum on CER initiatives / projects in consultation with the District Collector, East Godavari District, Andhra Pradesh towards implementing the community development works as proposed during the public hearing held on 11th October 2018 at Surasaniyanam (S Yanam) Village, East Godavari District, Andhra Pradesh. The CER fund will be utilized towards implementing the following programs / initiatives. a) **Drinking water:** Setting up of community drinking water system for S. Yanam village. b) **Infrastructure:** Construction of roads, bridges / culverts, canal, stormwater & backwater drains, developing the parks with walking tracks, installation of the solar lights etc. c) **Tourism:** Promotion of the beach front tourism in the surrounding villages. d) **Health:** Supporting district medical department for expansion and effective operation and maintenance of public health center. e) **Solid waste and Sanitation:** Provision of Supporting the "Swatch Bharat" initiative for the effective waste management. f) **Education:** Supporting the Government schools and Anganwadis towards improving the educational standards, establishment of libraries, providing scholarships to the meritorious students etc. g) **Sports:** Supporting physical education in schools	Annually Recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
			and youth such as providing sports kits, creating play area etc. h) **Skill development of the youth**: By developing training and competitive exam coaching centers in the villages and organizing skill development training programs. i) **Natural Resource Management (NRM):** Development of NRM related projects in the villages through plantation of the native species for increasing the green cover, providing fruit bearing saplings to the local villagers etc. j) **Fisheries and aqua culture development**: Development schemes for fishermen and aqua culture farmers including assistance for their livelihood development will be carried out in consultation with the Department of Fisheries, Andhra Pradesh, Central Marine Fisheries Research Institute etc. k) **Need based assessment study:** Carry out a need based (social) assessment study in the S.Yanam and the surrounding villages through Smart Andhra Pradesh Foundation or through any reputed institutions. The outcome of the study will be discussed with the district administration and financial support will be based on the study outcome related program. In addition, the Company is also committed to contribute towards CSR projects by annually depositing INR 6.00 Crores to the State Government of Andhra Pradesh acting through Joint Collector, East Godavari District towards implementing community development works / projects. This fund will be utilized by the district administration for improving livelihood of the people residing in S. Yanam and surrounding villages. The amount to be spent and need of each program will be decided by the district administration based on the needs of the local community.	

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
1 b)	Expressed concerns that due to exploration of oil & gas in the area, soil subsidence witnessing in the entire coast, thereby causing earthquakes in the area.	A study was carried out by IIT (BHU) regarding land subsidence due to oil & gas exploration and it was reported that no land subsidence occurring due to oil & gas exploration in the block area.	The Company is ensuring continuous monitoring of land subsidence through installation of high precision geodetic grade GPS system to understand any adverse impact caused due to extraction of hydrocarbon resources from the reservoir. The data collected from this equipment will be processed and findings will be submitted to MoEFCC as part of six monthly compliance reporting. Annual Budget of INR ~10 Lakhs has been earmarked for the Land Subsidence Study.	Annually Recurring
1 c)	Opined that monthly allowance shall be provided to the entire fishermen communities and agriculturalists in this area.	The proposed developmental and operation phases activities do not likely to cause impact to the fishing and agriculture activities. Thus, there is no direct provision to give compensation / money to the families.	As per the company policy, developmental activities are being taken up in consultation with the village representatives and district administration for improving the livelihood of the people of the nearby villages. The community development activities will continue to be taken up for S. Yanam and surrounding villages under CSR and CER programs / initiatives.	Annually recurring
1 d)	Fish death in this area due to pollution and the project authorities managed the higher officials and got a report stating that fish death in this area was not due to pollution from the plant.	The Company has been carrying out its operations for past 25 years and all operations comply with the environmental regulatory requirements. The Company has given a contract to Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to carry out Marine Ecological Study annually to monitor any adverse impact caused due to the operation of the Company in PKGM-1 Block. The outcome of the recent study of 2018, showed TPH concentration observed in seawater and sediment samples at all the stations of the Company operational areas are very low and far below the standards prescribed by ATSDR (Agency for Toxic Substances and Disease Registry 1999) indicating no oil pollution or toxicity.	The study by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC. Annual Budget of INR ~22 Lakhs has been earmarked for the Annual Marine Ecological Study.	Annually Recurring
1 e)	Demanded monthly compensation, as they have been loosing their wealth, similarly given by Reliance Industries @ Rs.6700 / - per month and	The Company activities do not likely to cause impact to the livelihood of the people residing adjacent to the proposed operational activities.	As per the Company policy, developmental activities are being taken up in consultation with the village representatives and district administration for	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	also informed that GSPC announced monthly compensation to about 16000 families till the completion of drilling activities, but, they have given compensation for 6 months only instead of 23 months as per agreement.	Thus, there is no likely issue of giving compensation / money to the families.	improving the livelihood of the people of the nearby villages. Community development activities will continue to be taken up for S. Yanam and surrounding villages under CSR and CER programs / initiatives.	
1 f)	Pollution problems from the proposed project and questioned that why turtles, disappeared in this area. The project authorities drilled two wells in Gatchakayalapuram and Katrenikona, due to which the roads in this area are completely damaged. The Government sanctioned Rs.8.0 Crores for laying of roads in this area, and apprehended that if the project authorities re-start their activities, again roads would be damaged.	The proposed onshore drilling activities will be carried out ensuring that there is no impact on turtle species.	The Company will ensure no damage of public roads due to the movement of vehicles for the proposed activities. Recently, the Company has carried out a survey of the public roads to be used for this project, which is yet to start in the area and found them with pot-holes and damages, for which the Company has deposited INR 50 Lakhs as a first instalment to get the roads repaired by district administration. The Company proposes to have a MoU with Jawaharlal Nehru Technological University, Kakinada (JNTUK) for carrying out road damage assessment before and after the proposed project activities. As per the JNTUK recommendation, if any road damage is occurred the estimated cost for its repair will be provided to district administration. During the project developmental and operational phases, periodic environmental monitoring will be carried out and report will be submitted to MoEFCC as part of six monthly compliance reporting.	During the Project life cycle Annually recurring
1 g)	Alleged that due to pollution from the drilling activities, the sea food productivity in this area completely damaged and due this, the youth from the villages are migrating to other areas for their livelihood. Alleged that earlier, they got about 5 kg of fish by each fisherman, and now they could not get even ½ kg due to pollution problem.	The Company has been carrying out its operations for past 25 years and all operations comply with the environmental regulatory requirements. The block remains in the less or no fishing zone area. The Company has given a contract to Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to carry out Marine Ecological Study annually to monitor any adverse impact caused due to its developmental and operation activities in the PKGM-1 Block.	The Company will ensure that all the pollution control measures for developmental and operation phases will be in place as per the EMP, the environmental norms and conditions of APPCB and MoEFCC. / The Company will also take up environmental monitoring during the drilling campaign. Annual Budget of INR ~40 Lakhs has been earmarked for environmental monitoring during drilling program.	During the Project life cycle Annually recurring for environmental monitoring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
		The outcome of the recent study of 2018, showed TPH concentration observed in seawater and sediment samples at all the stations of the Company operational areas are very low and far below the standards prescribed by ATSDR (Agency for Toxic Substances and Disease Registry 1999) indicating no oil pollution or toxicity. The study also showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers.	The study by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC	Annually recurring
1 h)	Informed that the impact of drilling activity is not confined to this area only, the impact would be more up to 1000 of km in the underground and questioned the project authorities that how many tankers of oil they have been producing and re-injecting how many tankers of water into the well.	The Company will carry out drilling of wells as per the requirement of OISD, DGH and DGMS. The Company submits all the well production details together with well fluid production and water injection to DGH periodically. The DGH is the Indian regulatory body under the Ministry of Petroleum and Natural Gas (MoPNG). For the last 25 years of the Company's operations, no impact in terms of subsidence in and around the block area has been observed.	The Company will continue to inject the treated produced water co-mingling it with deep saline groundwater into the confined hydrocarbon reservoir zone to maintain the reservoir pressure. The Company is ensuring continuous monitoring of land subsidence through installation of high precision geodetic grade GPS system to understand any adverse impact caused due to extraction of hydrocarbon resources from the reservoir. Annual Budget of INR ~10 Lakhs has been earmarked for the Land Subsidence Study.	Ongoing Annually Recurring
1 i)	Demanded that a committee shall be constituted with members of Revenue, people representatives, village elders for obtaining concrete proposal for fixation of monthly compensation particularly to the fisherman community and agricultural farmers from the project authorities.	The proposed developmental and operation phases activities do not likely to cause adverse impact on livelihood of communities engaged in fishing and agriculture activities. Thus, there is no likely issue of giving compensation / money to the families.	As per the Company policy, developmental activities are being taken up in consultation with the village representatives and district administration for improving the livelihood of the people of the nearby villages. The Company will continue to spend on community initiatives / activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages.	Annually recurring
1 j)	Alleged that no employment was given to locals even for security guards by the existing plants	Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam &	The Company will continue to engage with local communities and comply with the requirements specified in the AP Employment of Local Candidates in	During the Project life cycle

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	and demanded for employment and livelihood for the locals.	surrounding villages and 16 from other areas of Andhra Pradesh.	Industries and Factories, Bill 2019 that mandates requirement of at least 75% of the state candidates in the respective units.	
1 k)	Expressed concerns that due to exploration of oil & gas the sea food wealth was considerably decreased in the area. Reiterated that due to pollution from the drilling activities, sea food productivity, agricultural productivity completely damaged in this area and the farmers are converting the fertile agricultural lands into ponds, as no other way. Informed that the people of this area are not against establishment of oil companies. If any proposal established, it would be beneficial for development of this area citing the example of development of S.Yanam Village.	The drilling and completion of a well is carried out in average 45 days per well. After the completion of well drilling, no physical activity is required. The well fluid flowing from an offshore well is transported to onshore Ravva Terminal through subsea pipeline. The offshore well is remotely controlled from onshore Ravva Terminal. The export of crude oil from Ravva Terminal is carried out through offshore Single Point Mooring (SPM) facility into offshore vessel tankers with maximum 20 vessel trips per annum. Each vessel trip is completed in ~2 days. The recently conducted study in 2018 by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. Thus, there is no evidence of reduction of fish in the block area. The block remains in the less or no fishing zone area.	The study by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC. The Company will undertake development schemes for fishermen and aqua culture farmers including assistance for their livelihood development will be carried out in consultation with the Department of Fisheries, Andhra Pradesh, Central Marine Fisheries Research Institute etc.	Annually recurring Annually recurring
1 l)	Demanded again for compensation to the lands damaged due to drilling activities, and also suggested that the project authorities shall adopt the villages for development.	No onshore drilling activity has been carried out in past 10 years, thus no damage to the land has been caused due to onshore drilling activities. The Company has been implementing CSR - CER activities since beginning of its operations. Until March 2019, the Company has deposited INR 33.64 Crores with the district administration. Out	The Company will ensure that all the pollution control measures for developmental and operation phases will be in place for the proposed Project as per the EMP, the environmental norms and conditions of APPCB and MoEFCC. The Company will also take up environmental monitoring during the Project life cycle. In case any	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
		of this, the predominant part of the budget was spent on improving the livelihood and infrastructure of S Yanam Village.	damage to the adjacent land is caused, the Company will provide adequate compensation as per the Land Acquisition Officer nominated by the government of Andhra Pradesh. The Company will continue to spend community initiatives / activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages.	As and when need arises. Annually recurring
1 m)	He also expressed his concerns that the project authorities had not been implementing the promises made during the public hearing, citing the example that earlier, during the Sri G.M.C. Balayogi period, CSR fund was earmarked initially to S.Yanam Village only, latter allocation of funds extended to mandal level and further to constituency level.	The Company has been implementing CSR - CER activities since beginning of its operations. Until March 2019, the Company has deposited INR 33.64 Crores with the district administration. Out of this, the predominant part of the budget was spent on improving the livelihood and infrastructure of S Yanam Village.	The Company will continue to spend community initiatives / activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages. The Company will request the district administration to focus and spend more on community initiatives in and around the company operating villages including S. Yanam	Annually recurring
2	**M Sri Isukapatla Ravi Babu, resident of Challapalli,**			
2 a)	About 2% of the profits shall be earmarked for CSR activities and accordingly, the Ravva plant should earmark at-least Rs.10.0 Crores annually. CSR funds and CSR fund allocation started with Rs.1.0 Crore annually and gradually increased to Rs.5.0 – Rs.6.0 Crores at present.	The Company has been complying with the requirement as mentioned in the Companies Act, 2013 towards spent on CSR activities.	The Company will continue to take up CSR and CER activities as described in serial no. A1 a) above.	Annually Recurring
2 b)	No infrastructure facilities provided in S.Yanam including Challapalli village except laying of roads in S.Yanam Village.	The Company has established Mini Libraries, Public Health Centre, RO Plants, Community Health Centre, provided playing material / equipment in nearby schools etc. besides laying of roads and other infrastructure facilities in S Yanam and Challapalli Villages.	The Company will continue to spend community initiatives / activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages	Annually Recurring
2 c)	No supply of drinking water in the villages. People in this villages facing water scarcity and during the summer it is more intensive.	Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up to provide clean and safe drinking water to ~ 6,000 people.	The Company will set up an additional (third) RO Plant in Cherriyanam Village.	June 2020
2 d)	Expressed concerns on chemical, water and noise pollution due to operations of Ravva Plant.	The Company has been carrying out its operations duly complying with environmental regulatory requirements for last 25 years. Periodical environmental monitoring reports are	The Company will continue to carry out environmental monitoring through reputed third party agency. The Company will also continue to conduct internal and external environmental audits to ensure the Ravva	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
		being submitted to regulatory agencies such as APPCB, MoEF&CC and APWALTA.	Terminal operations comply with the environmental regulatory requirements. Annual budget of INR 10 Lakhs has been earmarked for the environmental audits.	Annually recurring
2 e)	People witnessing health problems such as hair fall, gastric, cancer and pregnancy problems and requested the Government authorities to enquire the people about the same.	The Company has been operating Cairn JV Charity Clinic for last 25 years. No such health issues have been reported due to Ravva operations.	The Company will continue to operate the Cairn JV Charity Clinic through tie up with Apollo Hospitals, Kakinada to provide health related services to the nearby communities. The Company will initiate a comprehensive secondary data study to understand community health issues, and decide suitable mitigation measures as applicable. Annual budget of INR 20 Lakhs has been earmarked for conduct of Community Health Assessment and Status of Health Interventions Study of the surrounding villages.	Annually recurring
2 f)	Facilities provided at newly constructed hospital are not fully adequate.	The Company has provided medical equipment, setting up of operation theatre, related infrastructure, ambulance and medicines in the Public Health Centre at S. Yanam at a cost of INR 20 lakhs.	The Company plans to support additional infrastructure, salary of additional support staff etc. to improve medical services of the existing Public Health Centre at S. Yanam.	One time – December 2020
2 g)	The Project authorities to give permanent employment to 36% local youths. Provided permanent employment to 8 nos. of local people only, out of 105 employees working. At present, recruited 333 local people as contract employees and about 200 people recruited non-local people engaged from about 2000 km of Chennai. Questioned the project authorities that why they engaged non-local people despite availability in the local area.	The statement provided is incorrect. Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh.	The Company will continue to engage with local communities and comply with the requirements specified in the AP Employment of Local Candidates in Industries and Factories, Bill 2019 that mandates requirement of at least 75% of the state candidates in the respective units.	During the Project life cycle

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
2 h)	Due to wells and drilling activities in offshore, due to discharge of sludge, oil wastes into sea, fish breeding capacity has been decreasing.	The drilling and completion of a well is carried out in average 45 days per well. After the completion of well drilling, no physical activity is required. During drilling activities, treated drill cuttings and drilling fluid is discharged offshore at the drilling location complying with the requirements laid down in the Environment (Protection) Rules, 1986 GSR546 E. Environmental monitoring of sea water and sediments is carried out before start, during drilling and post drilling activities carried out to monitor the environmental conditions and take up actions if any adverse impact is caused. The reports are being submitted to MoEFCC as part of six monthly compliance reporting. No sludge and oil wastes are discharged offshore at any stage of the Project implementation. The treated effluent from ETP at Ravva Terminal is discharged at marine outfall complying with the APPCB and MoEFCC discharge norms. The recently conducted study in 2018 by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. Thus, there is no evidence of reduction of fish in the block area.	The Company will continue to carry out environmental monitoring through reputed third party agency. The Company will also continue to conduct internal and external environmental audits to ensure the Ravva Terminal operations comply with the environmental regulatory requirements. The study with Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC.	Annually recurring Annually recurring Annually recurring
2 i)	The project shall adopt sage culture and shall support the fisherman community providing latest technology. Provide mechanized boats, nets to the local fisherman community, as these people depends only on fishing activity. Because of oil & gas exploration in this area, local people loosing their livelihood and asked the project authorities are directly or indirectly reason for that.	In the past 25 years, the livelihood opportunities have improved through infrastructure development, increased employment and overall socio-economic development of the area.	The Company will also consult Fisheries Department, East Godavari District, Kakinada to engage with fishing community in the area to improve their livelihood and also seek support in providing technology and fishing equipment.	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	Always very co-operative for development of India, exploration, production and usage of Oil & Gas locally and also to decrease the imports of Oil & Gas. He re-iterated that the project authorities shall solve the local problems and shall give employment to the locals.		The Company will implement sage culture under CSR – CER activities as described with a budget as per serial no. A1 a) above.	Annually recurring
2 j)	Questioned where and how many acres of greenbelt developed for the past 24 years. If land not available, the project authorities may take land from local farmers on lease basis for development of greenbelt.	The Company has developed greenbelt in > 35% (83 acre) of Ravva Terminal area. The Company has planted additional 3,000 fruit bearing plants in S Yanam Village through micro vendors in the community centre and public areas.	The Company will develop greenbelt in the villages by planting minimum 5,000 saplings and where required tree guards will also be provided. Greenbelt development in other villages will be taken-up periodically. Annual budget of INR 5.0 Lakhs has been earmarked for the promotion natural resource management in the surrounding area.	Annually recurring
2 k)	Questioned job mela conducted in the recent past, whom they have given the employment and requested for employment should be given to locals only, as people of this area are prone to accidents due to the exploration activity citing the example of Mamidikuduru accident. Out of thousand families in the village, about 600 families are getting benefitted by way of employment, small contracts and he demanded that the project authorities shall pay the current bills, shall provide daily commodities on monthly basis to the remaining 400 un-benefited poor families as monthly package.	A job mela was conducted for unemployed youths. About 2,500 youths participated, out of them 700 were employed by 40 different employers. The Company do not have provision to financially support unemployed youths.	The Company will continue to conduct job mela for local youths as on need basis. The Company will continue to conduct various skill development programs for the local youths to enable them for suitable employment.	As and when need arises
2 l)	He informed that they would support the project duly implementing the local issues pertaining to employment, pollution problems, compensation to the poor families raised in the public hearing.	The Company has been carrying out its operations for past 25 years and all operations comply with the environmental regulatory requirements. Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh.	The Company will continue to carry out environmental monitoring through reputed third party agency. The Company will also continue to conduct internal and external environmental audits to ensure the Ravva Terminal operations comply with the environmental regulatory requirements and on six monthly basis report to MoEFCC. The Company will continue to engage with local communities and comply with the requirements specified in the AP Employment of Local Candidates in	Annually recurring Throughout Project life cycle

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
		The Company has been complying with the requirement as mentioned in the Companies Act, 2013 towards spent on CSR activities.	Industries and Factories, Bill 2019 that mandates requirement of at least 75% of the state candidates in the respective units. The Company will continue to take up CSR-CER activities as described in serial no. A1 a) above.	Annually recurring
2 m)	He informed that lot of unemployed youth with fully technical qualification available in this area and requested the project authorities not to engage people from other places and recruit the local people in contract employment, as thousands of crores of wealth from this area has been taken out by the project authorities.	Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh. The Company prefers to engage employment from local villages, however, for outside employees are engaged to meet the requirement of highly skilled oil and gas expertise.	The Company will continue to engage with local communities and comply with the requirements specified in the AP Employment of local candidates in Industries and Factories, Bill 2019 that mandates requirement of at least 75% of the state candidates in the respective units.	Throughout Project life cycle
2 n)	He also opined that the S.Yanam village was developed due to establishment of Cairn Energy and certain development activities is happening in this area but not up to the mark.	The Company is depositing INR 6.00 Crores to the State Government of Andhra Pradesh annually for community development works / projects. This fund will be utilized by the district administration for improving livelihood of the people. The amount to be spent and need of each program are being decided upon by the district administration based on the needs of the local community.	The Company is committed to spend INR 2.0 Crores per annum for CER initiatives / activities as per the need assessment done periodically. The Company will continue to spend community initiatives / activities in consultation with the district administration as part of CSR activities in and around the surrounding villages.	Annually recurring
2 o)	The Konaseema area is covered with sea mashes, rivers and Sea and hundreds of fisherman families depending on them, because of oil & gas exploration in this area, the local people loosing their livelihood and asked the project authorities are directly or indirectly reason for that.	The existing and proposed developmental activities do not likely to cause adverse impact on livelihood of communities engaged in fishing and agriculture activities. In the past 25 years of operations, there is no evidence of livelihood of people getting affected due the Vedanta Limited (Cairn Oil and Gas) operations. Rather there have been improvement in per capita income generation of S Yanam and Chirrayanam villages.	As per the Company policy, developmental activities are being taken up in consultation with the village representatives and district administration for improving the livelihood of the people of the nearby villages. The Company will continue to spend on community initiatives / activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages.	Annually recurring Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
2 p)	He suggested that if, requisite land is not available for development of greenbelt, and the project authorities may take land from local farmers on lease basis for development of greenbelt.	The Company has developed greenbelt in > 35% (83 acre) of Ravva Terminal area. The Company has planted additional 3,000 fruit bearing plants in S Yanam Village through micro vendors in the community centre and public areas.	The Company will develop greenbelt in the villages by planting minimum 5,000 saplings and where required tree guards will also be provided. Greenbelt development in other villages will be taken-up periodically.	Annually Recurring
2 q)	The project authorities have not been giving employment to other villagers except S.Yanam, citing that the people of S.Yanam have not been willing to give employment to other villages. He also informed that while explaining the project detail by the authorities stated that about 50% of the employment has been giving to local people and requested the project authorities about 30% employment may be given to S.Yanm Village and 20% to other villages.	Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh.	The Company will discuss the local employment opportunity for surrounding villages with the District Administration.	FY 21
3	**Resident of S.Yanam**			
3 a)	Demanded monthly compensation of Rs.5000/- per family, employment and medical compensation to each family, only they would allow the proposed project, otherwise, people in this area will protest.	The Company activities do not likely to cause impact to the livelihood of the people residing adjacent to the proposed operational activities. Thus, there is no likely issue of giving compensation/money to the families.	As per the Company policy, developmental activities are being taken up in consultation with the village representatives and district administration for improving the livelihood of the people of the nearby villages. Community development activities will continue to be taken up for S. Yanam and surrounding villages.	Annually recurring
3 b)	Expressed concerns of facing health problems due to pollution problems from the plant and informed that earlier, 200-woman protest for medical compensation and all the 200 women arrested during the protest. Particularly fisherman community in this area has been losing their livelihood due to the plant operations and many people migrated for work.	The Company has been operating Cairn JV Charity Clinic for last 25 years. No such health issues have been reported due to Ravva operations. The recently conducted study in 2018 by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers.	The Company will continue to operate the Cairn JV Charity Clinic through tie up with Apollo Hospitals, Kakinada to provide health related services to the nearby communities. The Company will initiate a comprehensive secondary data study to understand community health issues, and decide suitable mitigation measures as applicable. The study by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
		Thus, there is no evidence of reduction of fish in the block area. The block remains in the less or no fishing zone area. The reported incident of arrest of 200 women has not happened during the tenure of the Company's operation in the Ravva Block and outside their sphere of influence. The Company is not directly and indirectly responsible for the same.	annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC. The Company will also consult Fisheries Department, East Godavari District, Kakinada to engage with fishing community in the area to improve their livelihood and also seek support in providing technology and fishing equipment.	Annually recurring
4	**Sri Lanke Bhimaraju, resident. of S.Yanam**			
4 a)	Fish productivity in this area has been gradually decreasing for the past 30 years due to operations of oil & gas exploration industries. Due to decrease in livelihood to fisherman community, many families migrated to other areas as casual labour and requested the environment department to study the issue in detail. Whether it is a misconception or real, the health problems of cancer and gastric increased in this area for the last 20 years and requested the environment department to study the issue in detail and reasons may be found out.	The Company has been carrying out its operations duly complying with all the pollution norms such as APPCB, MoEF&CC conditions and corrective actions would be initiated if any pollution caused. The Company has been operating Cairn JV Charity Clinic for last 25 years. No such health issues have been reported due to Ravva operations. The recently conducted study in 2018 by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. Thus, there is no evidence of reduction of fish in the block area. The block remains in the less or no fishing zone area.	The study with Andhra University will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC. The Company will continue to operate the Cairn JV Charity Clinic through tie up with Apollo Hospitals, Kakinada to provide health related services to the nearby communities. The Company will initiate a comprehensive secondary data study to understand community health issues, and decide suitable mitigation measures as applicable.	Annually recurring Annually recurring Annually recurring
4 b)	Vedanta Limited have been carrying out drilling activities in S.Yanam and Chirra Yanam villages and during operations excess gas would flared and the other wastes such as water, oil if releases	Drilling activities and related wastes management including flaring will comply with the regulatory requirement of the Environment (Protection) Rules, 1986 GR 546 E.	The Company will ensure that all the pollution control measures for developmental and operation phases will be in place for the proposed Project as per the EMP, the	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	in to local water sources and back waters, the lands would not be suit for agriculture and particularly the fisherman community would face inconvenience and if it happened, compensation shall be given to the land owners and fisherman community of the area and same should be incorporated in the activities proposed.	There is no discharge of wastes outside the onshore well pads into any intertidal area and backwater, thus there is no likelihood of adverse impact caused to the fishing communities. No compensation due to pollution is applicable.	environmental norms and conditions of APPCB and MoEFCC. The Company will continue to carry out environmental monitoring through reputed third party agency. The Company will also continue to conduct internal and external environmental audits to ensure the Ravva Terminal operations comply with the environmental regulatory requirements and report to MoEFCC on six monthly basis.	
4 c)	He also informed that earlier, the project authorities encouraged education benefits to the local fisherman community, same is slow down gradually in the recent past and suggested that the project authorities shall re-start, continue and increase educational benefits to children of fisherman community of this area under the chairmanship of the District Collector.	The Company will continue to support education benefits to local fishermen and other communities as has been carried out during the last 25 years.	Education benefits to local fishermen and other communities are included in the CSR – CER program.	Annually recurring
4 d)	He also informed that earlier, during the oil & gas exploration activity compensation was given in Yanam Village as well as in Gadimoga Village by the industries and in the same way the project authorities shall give compensation to all the affected villages. While welcoming the project, the project authorities shall take all the measures and shall carry their operations without causing any inconvenience to the local people.	For the proposed developmental and operational activities, the land cost will be duly compensated as per the norms laid by the Land Acquisition Officer nominated by the government of Andhra Pradesh. The Company has been carrying out its operations duly complying with environmental regulatory requirements for last 25 years.	Compensation of land cost will be done as per the norms to be specified by the Land Acquisition Officer nominated by the government of Andhra Pradesh. The Company commits to carry out all the operations in environmentally responsible manner.	During land acquisition Throughout the Project life cycle
5	**Sri A.Narasimha Murthy, Resident of Chirrayanam, Ex.Sarpanch**			
5 a)	He informed that due to activities of GSPC, fish productivity has been decreasing and turtle nesting grounds, which were existing earlier, were also disappeared due to activities of ONGC.	Not relevant to Vedanta Limited (Cairn Oil and Gas).	Not Applicable (NA)	NA

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
5 b)	He requested the project authorities to adopt their village i.e. Chirrayanam for solving water problem and shall carryout different development activities. While welcoming the project he requested the project authorities to carry their operations without causing any convenience to the local people.	Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up to provide clean and safe drinking water to ~ 6,000 people.	The Company will set up an additional (third) RO Plant in Chirrayanam Village. The Company commits to carry out all the operations in environmentally responsible manner.	June 2020 Throughout the Project life cycle
6	**Sri M.Annavaram, Resident of Chirrayanam, Ex.Sarpanch**			
6 a)	He informed that earlier, the ONGC carried out its operations and promised hospital and CC roads in the village, and completed its operations for 3 – 4 years and not even allocated Rs.1000/- to their village for development. He also informed that no development activities promoted in the village, for which they also staged protest.	Not relevant to Vedanta Limited (Cairn Oil and Gas).	The Company will continue to take up CSR-CER activities as described in serial no. A1 a) above.	Annually recurring
6 b)	He also informed that development by the industry confined to the S.Yanam village only, they could not have even transport facilities during the emergency for maternity, and it would take at least one hour time to reach nearest hospital.	The Company has provided medical equipment, setting up of operation theatre, related infrastructure, ambulance and medicines in the Public Health Centre at S. Yanam at a cost of INR 20 lakhs.	The Company plans to support additional infrastructure, salary of additional support staff etc. to improve medical services of the existing Public Health Centre at S. Yanam.	One time – December 2020
6 c)	He also informed that the roads in this area are completely damaged due to activities of oil & gas exploration industries and minimum three hours-time is taking to reach hospital at Amalapuram by auto in the emergency. While welcoming the project, he suggested that the Government authorities shall obtain a concrete proposal from the project authorities pertaining to implementation of CSR activities in the area.	The Company has supported through its CSR-CER programs for the development of infrastructure including construction of roads in and around the Company's operational areas.	The Company will continue to support by repairing of roads as part of the CSR-CER programs. As per the company policy, developmental activities will continue to be taken up in consultation with the village representatives and district administration for improving the livelihood of the people of the nearby villages. The Company ensures that no damage of the roads are caused due to its vehicular movements.	Annually recurring Throughout the Project life cycle
7	**Resident of Katrenikona**			
7 a)	He informed that the ONGC authorities have been carrying its activities in this area since long time. During the drilling activities, the project authorities have been giving very small amount of compensation to the adjacent land owners and	Not relevant to Vedanta Limited (Cairn Oil and Gas).	NA	NA

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	there is no mention about the specific amount to be given. After completion of the drilling activity, the un-succeed bore wells are filling with soil of 3 – 4 tractors capacity only, which is in sufficient and the farmer could not carry agricultural activity immediately.			
7 b)	Suggested that instead of giving small amount of compensation to the land owners, a fixed amount shall be given equal to the amount lost due to unfavourable condition for agriculture per year. He requested the project authorities that more CSR funds shall be allocated in this area towards education, establishment of playgrounds and laboratories, libraries and computers, as they would be help the people. Nobody can stop the activities of oil & gas exploration in this area and these would be explored either by the present management or some other company. He also informed that a special package should be given to each family, besides allocation of more CSR funds for development of infrastructure in this area.	For the proposed developmental and operational activities, the land cost will be duly compensated as per the norms laid by the Land Acquisition Officer nominated by the government of Andhra Pradesh. The Company has been implementing CSR-CER activities since beginning of its operations. Until today, the Company has deposited INR 33.64 Crores with the district administration.	Compensation of land cost will be done as per the norms specified by the Land Acquisition Officer nominated by the government of Andhra Pradesh. The Company is committed to contribute towards CSR and CER projects by annually depositing INR 6.00 Crores to the State Government of Andhra Pradesh acting through Joint Collector, East Godavari District towards implementing community development works / projects including Drinking water, Infrastructure development, Health, solid waste and sanitation, Education, Sports: , Skill development of the youth, Natural Resource Management, Financial support etc.	During land acquisition Annually recurring
7 c)	Suggested that monthly package shall be given to poor families in this area. More CSR funds shall be allocated and advised the project authorities that a residential school shall be established for the merit students of Katrenikona & Uppalaguptam mandals, so that all the engineering people required for ONGC would be produced here only.	The Company has been engaged in providing the following with respect to educational support in the surrounding villages: 200 mini libraries set up in Uppalaguptam Mandal; ~ 1500 students benefitted Supporting 14 additional teachers in Government Schools in S Yanam - wages for teachers of INR 30 lakhs per annum. Learning aids & playing material / equipment provided in schools Competitive examination coaching provided to local youths.	The Company will provide scholarship to the meritorious students from affected villages (based on criteria as finalized with the coordination of district administration for scholarship amount and number of students). Establishment of libraries with weekly and monthly magazines to the surrounding villages. Develop IT training centres in the surrounding villages by providing computers for training. Develop parks with gravel walking tracks of 150 to 200 m length.	March 2021

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
7 d)	He also suggested that greenbelt shall be developed in these villages duly giving employment to the local people, so that the people in this area developed socio economically.	The Company has planted 3,000 well grown fruit bearing plants in S Yanam Village through micro vendors in the community centre and public areas. Greenbelt development in other villages will be taken-up periodically.	The Company will develop greenbelt in the villages by planting minimum 5,000 saplings and where required tree guards will also be provided.	Annually Recurring
8	**Sri B.Suri Babu, Resident of Chirrayanam – Gachikayalapuram MPTC**			
8 a)	He expressed his concerns that due to activities of ONGC, Cairn Energy, GSPC and Reliance sea fish productivity was decreased.	The Company has been carrying out its operations for past 25 years and all operations comply with the environmental regulatory requirements. The Company has given a contract to Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to carry out Marine Ecological Study annually to monitor any adverse impact caused due to the operation of the Company in PKGM-1 Block. The study has revealed no adverse impact on fish species has been observed in the block area.	The study to Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC.	Annually Recurring
8 b)	He and on behalf of his village opposed the proposed oil & gas exploration activity. Earlier, they protest against the activities of oil & gas exploration due to which sea fish productivity decreased and the oil companies promised compensation for two years to each fisherman family, but, compensation was given for only 6 months to few people only.	The recently conducted study in 2018 by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. Thus, there is no evidence of reduction of fish in the block area. The Company has given a contract to Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to carry out Marine Ecological Study annually to monitor any adverse impact caused due to the operation of the Company in PKGM-1 Block. The study has revealed no adverse impact on fish species has been observed in the block area.	The study to Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC.	Annually Recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
8 c)	Expressed his concerns that they would allow the processing of public hearing only after obtaining concrete proposal from the project authorities.	The company has been carrying out its operations duly complying with all the pollution norms such as APPCB and MoEF&CC.	The Company has entered a MoU on 25 October 2018 with the State Government of Andhra Pradesh through Joint Collector East Godavari District on commitment of various community initiatives and programs with time line and budget.	Annually recurring
8 d)	Alleged that the Government has not been taken care about the endangering of fisherman community in the area and the Government has not showing the interest like protecting wild life to the fisherman community.	The Company has been carrying out its operations for past 25 years and all operations comply with the environmental regulatory requirements. No adverse impacts have been caused to the livelihood of the fishing community.	The Company will work together with the Wildlife Institute and District Forest Office for protecting endangered species in the Coringa Wildlife Sanctuary, East Godavari District. A budget of INR 70 Lakhs for three years period from FY19 to 21 has been earmarked.	For three FYs starting from 2019 - 22
8 e)	Suggested that the project authorities shall provide boats & nets to the local fisherman community.	In the past 25 years, the livelihood opportunities have improved through infrastructure development, increased employment and overall socio-economic development of the area.	The Company will also consult Fisheries Department, East Godavari District, Kakinada to engage with fishing community in the area to improve their livelihood and also seek support in providing technology and fishing equipment.	Annually recurring
8 f)	Drinking water infrastructure facilities shall also be provided to their fisherman society. 100 Nos. of additional solar lights shall be provided, as they have facing poor visibility of roads particularly during the cyclones. Hospital facility shall also be provided each at Chirrayanam and Gatchakayalapuram panchayaths and shall provide efficient doctors	Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up to provide clean and safe drinking water to ~ 6,000 people.	The Company agrees to provide the following additional support: Setting up of an additional RO Plant in Chirrayanam Providing 50 nos. of Solar lights at S Yanam, Chirrayanam and Gatchakayalapuram The review of existing medical facility available in Chirrayanam and Gatchakayalapuram Panchayats and plan for support as part CSR-CER initiatives and programs in the coming years.	Annually recurring
8 g)	Similarly, Reliance Industries, arrangements for corporate education to every 10th passed students of this area shall be provided. Employment opportunities to the un-employed youth shall be provided.	The Company will continue to support education through its CSR activities.	The Company will continue to take up CSR –CER activities as described in serial no. A1 a) above for improving education and job opportunities.	Annually recurring
8 h)	He also requested for employment to their youth at ONGC, S.Yanam. An amount of Rs.15,000/- shall be given as additional matching grant in addition to the Government's Rs.15,000/- grant for construction of toilets. Similarly by the	The Company has been implementing CSR activities since beginning of its operations. As on March 2019, the Company has deposited INR 33.64 Crores with the district administration.	The Company has entered a MoU on 25 October 2018 with the State Government of Andhra Pradesh through Joint Collector East Godavari District on commitment	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	Reliance Industries Limited, an amount of Rs.1.0 Lakh financial support shall be given to all the fisherman community brides in this area by the project authorities. Financial assistance for daily commodities shall also be given by the project authorities to fisherman community during the declaration of cyclone emergency by the Government. Preference should be given to locals for employment while drilling wells.		of various community initiatives and programs with time line and budget. The Company will continue to spend on community initiatives / activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages.	
8 i)	He also requested that an amount of Rs.1.0 Lakh shall be given by the project authorities as additional matching grant in addition to the Government's Rs.2.0 Lakh for construction of houses for poor.			
8 j)	He also requested that the project authorities shall give compensation of Rs.5,000/- per month each fisherman family during the ban of fish catch from April to May every year by the Government. He also requested that project authorities shall give compensation of Rs.2.0 Lakhs to fisherman family, if loose their life due to any accident.	Not relevant to Vedanta Limited (Cairn Oil and Gas), as the operating block is in no fishing or less fishing zone.	NA	NA
8 k)	He also requested the project authorities that CSR funds of minimum Rs.1.0 Crore shall be allocated every year to Chirrayanam and Katrenikona Villages, until completion of the proposed project.	The Company has been complying with the requirement as mentioned in the Companies Act, 2013 towards spent on CSR activities.	The Company will continue to take up CSR and CER activities as described in serial no. A1 a) above.	Annually Recurring
9	**Sri Jogi Arjuna Rao, Resident of S.Yanam, Ex. MPP, Uppalaguptam**			
9 a)	He informed that the canals which were damaged by ONGC earlier shall be repaired by the present management. He also informed that the people in the S.Yanam village are very poor and they lost a lot of employment opportunities.	Not relevant for Vedanta Limited (Cairn Oil & Gas)	NA	NA
9 b)	He expressed his concerns that the Vedanta Limited has been releasing gas during the night time, due to which they have been facing heart problems. They have also been facing lot of health problems due to the nearby plant.	There is no cold vent release of natural gas from Ravva operations. All emergency releases of natural gas are routed through flare. The company has been carrying out its operations duly complying with all the pollution norms such as APPCB and MoEF&CC.	The Company will continue to operate the Cairn JV Charity Clinic through tie up with Apollo Hospitals, Kakinada to provide health related services to the nearby communities.	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
		The Company has been operating Cairn JV Charity Clinic for last 25 years. No such health issues have been reported due to Ravva operations.	The Company will initiate a comprehensive secondary data study to understand community health issues, and decide suitable mitigation measures as applicable.	
9 c)	He also informed that they have not even getting sufficient drinking water. The canal bund which was damaged by the ONGC authorities shall also be repaired by the present management. The present management has been carrying its operations for the past 20 – 25 years and about 90% of the people in the S.Yanam village are poor and the management has not taken any concrete proposals for development of the village. Rs.50,000/- shall be given by the project authorities to each poor families for construction of houses.	Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up to provide clean and safe drinking water to ~ 6,000 people. The Company has been implementing CSR activities since beginning of its operations. As on March 2019, the Company has deposited INR 33.64 Crores with the district administration. The Company is depositing INR 6.00 Crores annually to the State Government of Andhra Pradesh annually for community development works/projects. This fund will be utilized by the district administration for improving livelihood of the people. The amount to be spent and need of each program is being decided upon by the district administration based on the needs of the local community. The district administration will duly consider about repair of the canal bund and may accordingly take up the work.	The Company has entered a MoU on 25 October 2018 with the State Government of Andhra Pradesh through Joint Collector East Godavari District on commitment of various community initiatives and programs with time line and budget. The Company will continue to spend on community initiatives/activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages. The Company will follow up with the district administration on the canal bund issue.	Annually recurring
9 d)	He also requested that employment to the local people in any form shall be given.	Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh.	The Company will continue to engage with local communities and comply with the requirements specified in the AP Employment of Local Candidates in Industries and Factories, Bill 2019 that mandates requirement of at least 75% of the state candidates in the respective units.	During the Project life cycle
10	**A Woman, Resident of S.Yanam**			
10 a)	She expressed her concerns that the project authorities have not been implementing any development activity for the poor in the village. She also informed that they would not allow the	The Company has been complying with the requirement as mentioned in the Companies Act, 2013 towards spent on CSR activities.	The Company will continue to take up CSR and CER activities as described in serial no. A1 a) above.	Annually Recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	proposed project until implementing any developmental activity to them.			
11	**Smt. Satyavathi, Resident of S.Yanam**			
11 a)	While welcoming the project she requested the project authorities that developmental activities such as education to their children, and other facilities shall be provided. No employment opportunities given to them till date.	The Company has been complying with the requirement as mentioned in the Companies Act, 2013 towards spent on CSR activities.	The Company will continue to take up CSR and CER activities as described in serial no. A1 a) above.	Annually Recurring
11 b)	She also informed that they do not have even drinking water facilities. In spite of the promises made by the project authorities, they have not taking up any development activities.	Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up to provide clean and safe drinking water to ~ 6,000 people.	The Company will set up an additional (third) RO Plant in Cherriyanam Village.	June 2020
12	**Sri R.Tirupathi Rao, Resident of S.Yanam**			
12 a)	Informed that it is the responsibility of industries for development of local area as per re-habilitation and re-settlement act. But, the management has not taken any steps for development of local area, even though it has been operating for the past 30 years, citing the example that the management has not even supplying drinking water to the villages till today. He also demanded for release of white paper on the funds released for S.Yanam Village development year wise for the past 30 years, as people of this village have lot of doubts in this regard. He also alleged that due to drilling of deep wells in this area, the entire agriculture land contaminated with salt water intrusion, thereby people of this area lost their livelihood.	The proposed onshore well pad locations only small parcel of land, thus there is no resettlement and rehabilitation involved. The Company has been complying with the requirement as mentioned in the Companies Act, 2013 towards spent on CSR activities. The Company has been implementing CSR activities since beginning of its operations. As on March 2019, the Company has deposited INR 33.64 Crores with the district administration. As the Company's CSR funds are being spent by the district administration, the expense records may be obtained by the complainant directly from the district administration officer. A study was carried out by IIT (BHU) regarding land subsidence due to oil & gas exploration and it was reported that no land subsidence occurring due to oil & gas exploration. The Company carries out aquifer monitoring through dedicated monitoring wells located within Ravva Terminal and Piezo wells outside the Ravva Terminal to monitor the water quality	The Company will continue to take up CSR and CER activities as described in serial no. A1 a) above. The Company is ensuring continuous monitoring of land subsidence through installation of high precision geodetic grade GPS system to understand any adverse impact caused due to extraction of hydrocarbon resources from the reservoir. The data collected from this equipment will be processed and findings will be submitted to MoEFCC as part of six monthly compliance reporting.	Annually Recurring Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
		and levels. There is no change in the baseline data. The compliance reports are being periodically submitted to APWALTA, Government of Andhra Pradesh.		
12 b)	Expressed his concerns that due to release of oily water into sea by the industry, fish productivity completely decreased in the area, thereby fisherman community lost their livelihood. The company management has not provided employment except giving lower grade employment.	The treated effluent from ETP at Ravva Terminal is discharged at marine outfall complying with the APPCB and MoEFCC discharge norms. The recently conducted study in 2018 by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. Thus, there is no evidence of reduction of fish in the block area. Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh. The employment provided is based on skill set requirements.	The Company will continue to carry out environmental monitoring through reputed third party agency. The Company will also continue to conduct internal and external environmental audits to ensure the Ravva Terminal operations comply with the environmental regulatory requirements. The study by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC. The Company will continue to engage with local communities and comply with the requirements specified in the AP Employment of Local Candidates in Industries and Factories, Bill 2019 that mandates requirement of at least 75% of the state candidates in the respective units.	Annually recurring Annually recurring During the Project life cycle
12 c)	Alleged that the PHC constructed by the project authorities handed over to Government instead of maintaining the same.	The PHC was handed over to the Government as per the requirement of local administration. The Company does not have technical capability to operate PHC. The Company has provided medical equipment, setting up of operation theatre, related infrastructure, ambulance and medicines in the Public Health Centre at S. Yanam at a cost of INR 20 lakhs.	The Company plans to support additional infrastructure, salary of additional support staff etc. to improve medical services of the existing Public Health Centre at S. Yanam.	One time – December 2020

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
12 d)	Informed that only 14 nos. of teachers appointed and demanded for education facilities to all the villages to be provided by the project authorities from KG to PG. He suggested that the Government authorities and project authorities shall consider the issues raised by the general public and then only start the expansion proposal. Similar type of public hearing presided by the Joint Collector earlier, but, no action taken against the industry on the issues raised by the public.	The Company has been implementing CSR activities since beginning of its operations. As on March 2019, the Company has deposited INR 33.64 Crores with the district administration. The Company has been supporting the Government schools and Anganwadis towards improving the educational standards by supporting additional teachers, establishment of libraries, providing bus passes for the students, providing scholarships to the meritorious students etc.	The Company has entered a MoU on 25 October 2018 with the State Government of Andhra Pradesh through Joint Collector East Godavari District on commitment of various community initiatives and programs with time line and budget. The Company will continue to spend on community initiatives / activities including education for students in the surrounding villages in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages.	Annually recurring
12 e)	The people in S.Yanam village could not even get drinking water till date, though the ONGC operating unit for the past 30years.	Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up by the Company to provide clean and safe drinking water to ~ 6,000 people.	The Company will set up an additional (third) RO Plant in Cherriyanam Village.	June 2020
12 f)	They could not even breathe fresh air, due to air, water pollution from the plant and every family in the village has been suffering with different type of diseases. The plant has not been taking any steps for control of pollution and the concerned authorities have not taken any action.	The Company has been carrying out its operations for past 25 years and all operations comply with the environmental regulatory requirements. No health issues have been reported due to Ravva operations.	The Company will ensure that all the pollution control measures for developmental and operation phases will be in place as per the EMP, the environmental norms and conditions of APPCB and MoEFCC. The Company will initiate a comprehensive secondary data study to understand community health issues, and decide suitable mitigation measures as applicable.	During the Project life cycle

Annexure 5

Details of Project Block, Separately for Onshore and Offshore along with Proposed Drilling Locations Together with Information on Five Onshore Well Pads Dropped from the Scope of Work

ANNEXURE 5: DETAILS OF PKGM-1 BLOCK WITH ONSHORE AND OFFSHORE DRILLING LOCATIONS

1.1 ABOUT PKGM-1 OIL & GAS BLOCK

PKGM-1 Block is located near Surasaniyanam Village, Uppalaguptam Mandal, Krishna-Godavari Basin in the East Godavari District of Andhra Pradesh. The block extends Latitudes from 16° 20′ 44.8″ N to 16° 33′ 26.6″ N and Longitudes from 82° 04′ 17.3″ E to 82° 19′ 04.3″ E. The sea-coast forms the North-western boundary of the block. Kakinada is the nearest port town located at ~50 km to the north east of the block. The Vishakhapatnam major port is located ~ 200 km to the north east of the block.

Oil and Gas exploration and development activities in the PKGM-1 Block (also referred to as Ravva Field) are being taken up as part of existing Production Sharing Contract (PSC) for PKGM-1 Block signed by Ravva Joint Venture (JV) with the Ministry of Petroleum and Natural Gas through Directorate General of Hydrocarbons, Government of India. The Ravva JV comprises of Oil & Natural Gas Corporation Limited (ONGC) (with 40% participation interest) Vedanta Ltd (Cairn Oil and Gas) (with 22.5%), Videocon Industries Ltd. (with 25%) and Ravva Oil Singapore Pty. Ltd. (with 12.5%). Vedanta Ltd (Cairn Oil & Gas) is the Operator of the block.

1.2 ONSHORE COMPONENT OF PKGM-1 BLOCK RELATED EXISTING & PROPOSED FACILITIES

PKGM-1 Block is spread over in 331.26 km^2 area. Of this area, the onshore component admeasures ~23.26 km^2 which is ~7% of the total area.

1.2.1 Existing Onshore Facilities

1) Existing Onshore Drill Pads: Within the PKGM-1 Block, there exist two previously developed onshore well pads numbered as WP-A also numbered as WP-7 (RX-8) and WP-B also numbered WP-8 (RX-9). These two onshore well pads were earlier developed in 2006-07 and presently lying unutilised.

2) Existing Onshore Wells: Presently, there are no operational onshore wells in the PKGM-1 Block. Only one well was drilled RX-9 was drilled from previously developed well pad WP-B (i.e. WP-8), which was abandoned as per the required safety procedures.

3) Existing Ravva Onshore Terminal: An onshore Ravva Terminal is located outside PKGM-1 Block at ~1 km from shore near Surasaniyanam Village. The existing Ravva Terminal provides for three-stage separation of incoming well fluid through three trains of processing / stabilization units. The terminal includes:

- Gas Recovery compressors and treatment plant;
- Gas lift booster compressor (GLBC);
- Crude oil storage tanks;
- Produced Water Handling and Water Injection Facilities;
- Captive Power Generation facility of 10 MW;
- Effluent and Sewage Treatment Plants.

4) Living Quarters: There exist Living Quarters with 90 rooms to accommodate single and double occupancy (available onshore near Ravva Terminal).

1.2.2 Proposed Onshore Facilities

Details of drilling activities proposed within onshore part of the PKGM-1 Block includes:

i. Establishing 2 nos. of existing onshore well pads i.e. WP-A & WP-B (dimensions of each well pad of ~225m x ~170m)
ii. Drilling of 10 Exploration wells and 23 Development Wells from two onshore Well Pads;
iii. Establishing of ~8 km long onshore pipelines corridor for transfer of hydrocarbon fluid, surface gas lift and injection water at two onshore well pads to and from Ravva Terminal as per the following specifications
   - 8″ sub surface crude oil (well fluid) pipelines connecting onshore well pads to Ravva Terminal
   - 6″ sub surface gas lift pipeline connecting onshore well pads to Ravva Terminal.
   - 14″ sub surface injection water pipeline connecting onshore well pads to Ravva Terminal.

Note:

1) Well pads dropped from Scope of Work: There is a proposal to drop establishing of onshore Well Pads 1 to 5 that were proposed to be located outside the PKGM-1 Block (to tap hydrocarbons resource from within the block through inclined drilling) from scope of this proposal. Well Pad #6 will not be developed to minimize environmental impacts.
2) With the dropping of well pads from the scope of work, the onshore pipelines corridors length has been revised now 8 km as against earlier proposed pipelines corridor of 15 km.

1.3 OFFSHORE COMPONENT OF PKGM-1 BLOCK RELATED EXISTING & PROPOSED FACILITIES

Of 331.26 km^2 of total area of the PKGM-1 Block, the offshore component admeasures ~308 km^2 which is ~93% of the total area of the PKGM-1 Block.

1.3.1 Existing Offshore Facilities

There are presently eight unmanned offshore platforms, a single point mooring (SPM) and subsea pipelines within the offshore areas of the PKGM-1 Bock. Details are as follows

S.N.	Surface Facility	Distance from Coast	Easting, m.	Northing, m.
1	RA Platform	9.1 km	620732.810	1813336.220
2	RB Platform	4.5 km	627387.060	1821896.650
3	RC Platform	9.1 km	620796.250	1813368.590
4	RD Platform	7.2 km	621333.280	1815822.200
5	RE Platform	5.5 km	623600.130	1818798.840
6	RF Platform	5.0 km	625657.150	1820443.190
7	RG Platform	5.65 km	626947.800	1820516.160
8	RH Platform	4.48 km	620010.160	1818267.240
9	Single Point Mooring (SPM)	13.5 km	619864.820	1807452.840

Note: New RI Platform & related facilities previously approved are yet to be installed.

Within the offshore area of the PKGM-1 Block, there are eight unmanned well head platforms (RA, RB, RC, RD, RE, RF, RG and RH) which are connected through subsurface pipelines from and to the operating onshore Ravva Terminal (RT), transporting wellhead production fluid, injection water, non-associated gas, lift gas etc.

Within PKGM-1 Block, 55 wells have been drilled. Presently, 6 are self-flow producing, 16 are gas lift wells and 9 are injectors spread over on eight well head platforms. Details of offshore wells are as following:

S.N.	Well Description	Number of Wells
1	Self-Flow Producing Wells	6
2	Gas Lift Producing Wells	16
3	Shut in Non-Producing wells	12
4	Injector Wells	9
5	Suspended Wells	4
6	Abandoned Wells	8
	Total	**55**

The proposed drilling of exploration and developmental wells in the offshore part of the PKGM-1 Block include 73 Exploration Wells (14 from existing offshore platforms+59 from standalone offshore locations); and 17 Development Wells from existing offshore platforms as detailed in the following Table.

1.3.2 Proposed Offshore Facilities

The proposed drilling of exploration and developmental wells in the offshore part of the PKGM-1 Block include 73 Exploration Wells (14 from existing offshore platforms+59 from standalone offshore locations); and 17 Development Wells from existing offshore platforms as detailed in the following Table.

S N	Well IDs & Location	Latitude, N	Longitude, E	Total No. of Wells	Exploration Wells	Development Wells
A	**Onshore Wells#**					
1	Onshore Pad WP-A i.e. WP-7 (RX-8)	16° 30' 7.237"	82° 8' 54.372"	17	5	12
2	Onshore Pad WP-B i.e. WP-8 (RX-9)	16° 30' 27.742"	82° 9' 36.829"	16	5	11
	Subtotal (A2)			33	10	23
	Total Onshore Wells (A)			*33*	*10*	*23*
B	**Offshore Wells**					
B-1	**Drilling from existing Platforms**					
9	Platform RB	16° 28' 31.366"	82° 11' 36.301"	6	2	4
10	Platform RC	16° 23' 55.116"	82° 7' 52.442"	4	1	3
11	Platform RD	16° 25' 14.853"	82° 8' 11.008"	6	2	4
12	Platform RE	16° 26' 51.288"	82° 9' 28.002"	5	4	1
13	Platform RF	16° 27' 44.405"	82° 10' 37.681"	4	2	2
14	Platform RG	16° 27' 46.533"	82° 11' 21.214"	1	1	0
15	Platform RH	16° 26' 34.650"	82° 7' 26.860"	5	2	3
	Subtotal (B1)			31	14	17
B-2	**Drilling from Standalone Offshore Locations**					
16	Well-E-1	16° 28' 23.444"	82° 7' 36.664"	1	1	0
17	Well-E-2	16° 29' 16.645"	82° 8' 36.273"	1	1	0
18	Well-E-3	16° 29' 53.320"	82° 9' 32.281"	1	1	0
19	Well-E-4	16° 28' 47.705"	82° 8' 6.808"	1	1	0
20	Well-E-5	16° 27' 58.513"	82° 7' 5.183"	1	1	0
21	Well-E-6	16° 27' 30.441"	82° 6' 42.509"	1	1	0
22	Well-E-7	16° 27' 4.947"	82° 6' 6.374"	1	1	0
23	Well-E-8	16° 27' 37.573"	82° 6' 2.435"	1	1	0
24	Well-E-9	16° 31' 3.860"	82° 11' 17.435"	1	1	0

S N	Well IDs & Location	Latitude, N	Longitude, E	Total No. of Wells	Exploration Wells	Development Wells
25	Well-E-10	16° 30' 58.237"	82° 12' 41.572"	1	1	0
26	Well-E-11	16° 31' 34.661"	82° 13' 20.871"	1	1	0
27	Well-E-12	16° 31' 11.455"	82° 13' 52.402"	1	1	0
28	Well-E-13	16° 25' 56.812"	82° 6' 18.901"	1	1	0
29	Well-E-14	16° 24' 8.330"	82° 6' 28.706"	1	1	0
30	Well-E-15	16° 28' 19.514"	82° 10' 2.363"	1	1	0
31	Well-E-16	16° 25' 19.888"	82° 6' 23.281"	1	1	0
32	Well-E-17	16° 28' 7.943"	82° 9' 24.103"	1	1	0
33	Well-E-18	16° 27' 27.778"	82° 8' 15.043"	1	1	0
34	Well-E-19	16° 26' 51.871"	82° 6' 33.568"	1	1	0
35	Well-E-20	16° 27' 5.335"	82° 7' 8.329"	1	1	0
36	Well-E-21	16° 26' 31.436"	82° 6' 12.738"	1	1	0
37	Well-E-22	16° 22' 44.433"	82° 9' 10.258"	1	1	0
38	Well-E-23	16° 23' 26.658"	82° 10' 15.090"	1	1	0
39	Well-E-24	16° 24' 10.136"	82° 11' 17.612"	1	1	0
40	Well-E-25	16° 25' 37.055"	82° 5' 52.001"	1	1	0
41	Well-E-26	16° 26' 6.159"	82° 8' 56.376"	1	1	0
42	Well-E-27	16° 27' 40.052"	82° 8' 57.867"	1	1	0
43	Well-E-28	16° 28' 37.757"	82° 13' 17.471"	1	1	0
44	Well-E-29	16° 29' 10.956"	82° 13' 4.392"	1	1	0
45	Well-E-30	16° 29' 39.419"	82° 13' 27.942"	1	1	0
46	Well-E-31	16° 30' 46.906"	82° 11' 46.304"	1	1	0
47	Well-E-32	16° 26' 15.481"	82° 9' 29.369"	1	1	0
48	Well-E-33	16° 27' 0.777"	82° 8' 0.462"	1	1	0
49	Well-E-34	16° 26' 18.736"	82° 6' 44.679"	1	1	0
50	Well-E-35	16° 24' 11.374"	82° 8' 30.329"	1	1	0
51	Well-E-36	16° 24' 57.764"	82° 8' 28.936"	1	1	0
52	Well-E-37	16° 25' 22.345"	82° 12' 47.019"	1	1	0
53	Well-E-38	16° 26' 2.338"	82° 13' 53.888"	1	1	0
54	Well-E-39	16° 30' 9.768"	82° 10' 28.031"	1	1	0
55	Well-E-40	16° 30' 27.051"	82° 11' 4.464"	1	1	0
56	Well-E-41	16° 26' 15.497"	82° 8' 0.016"	1	1	0
57	Well-E-42	16° 29' 3.539"	82° 11' 27.911"	1	1	0
58	Well-E-43	16° 26' 38.250"	82° 8' 32.625"	1	1	0
59	Well-E-44	16° 27' 40.271"	82° 9' 42.737"	1	1	0
60	Well-E-45	16° 25' 0.084"	82° 9' 2.965"	1	1	0
61	Well-E-46	16° 25' 33.164"	82° 9' 20.647"	1	1	0
62	Well-E-47	16° 26' 40.923"	82° 10' 41.505"	1	1	0
63	Well-E-48	16° 24' 55.157"	82° 10' 28.352"	1	1	0
64	Well-E-49	16° 24' 15.981"	82° 9' 25.129"	1	1	0
65	Well-E-50	16° 25' 18.756"	82° 11' 35.391"	1	1	0
66	Well-E-51	16° 23' 19.562"	82° 8' 33.256"	1	1	0
67	Well-E-52	16° 29' 3.365"	82° 10' 18.460"	1	1	0
68	Well-E-53	16° 29' 44.676"	82° 11' 5.053"	1	1	0
69	Well-E-54	16° 29' 59.142"	82° 11' 55.260"	1	1	0
70	Well-E-55	16° 30' 21.819"	82° 13' 5.364"	1	1	0
71	Well-E-56	16° 28' 1.169"	82° 12' 53.645"	1	1	0
72	Well-E-57	16° 29' 6.129"	82° 14' 0.674"	1	1	0
73	Well-E-58	16° 28' 26.387"	82° 13' 50.747"	1	1	0
74	Well-E-59	16° 28' 50.726"	82° 12' 16.306"	1	1	0
	Subtotal (B2)			**59**	**59**	**0**
	Total offshore wells			*90*	*73*	*17*
	Total (A+B1+B2)	**-**	**-**	**123**	**83**	**40**

Note: # The proposal has been revised for onshore drilling of wells. There will be drilling of wells from two well pads located within the PKGM-1 Block. The well pads that were planned to be located outside the block has been dropped (withdrawn) from this proposal.

Actual geo-graphical surface coordinates of exploratory and development well locations will be within 1km radius of the proposed coordinates except for wells from existing offshore platforms.

Annexure 6

Copy of APPCB Certified Compliance of EC Conditions

Dilip Kumar Bera

From: Pankaj Jain
Sent: Friday, March 1, 2019 1:10 PM
To: Thomas Christopher J; K K Nayak; Dilip Kumar Bera; YNM-Installation Manager
Subject: FW: APPCB-RO-KKD – Request of M/s. Vedanta Limited (Cairn Oil & Gas), S.Yanam Village, Uppalaguptam Mandal, East Godavari District for issuance of certified Environmental Clearance(EC) compliance for obtaining EC & CRZ Clearance for the proposed expan...
Attachments: Vedanta Limited (Cairn Oil & Gas) - EC compliance.pdf

FYI

From: SECRETARIAT, SEIAA A.P. [mailto:apseiaasecretariat@gmail.com]
Sent: Friday, March 1, 2019 12:46 PM
To: Pankaj Jain
Cc: Appikonda Ramarao Naidu; Satish V
Subject: Fwd: APPCB-RO-KKD – Request of M/s. Vedanta Limited (Cairn Oil & Gas), S.Yanam Village, Uppalaguptam Mandal, East Godavari District for issuance of certified Environmental Clearance(EC) compliance for obtaining EC & CRZ Clearance for the proposed expan...

External Sender: Use caution with links/attachments

Sir,
Please find attached the certified copy of the compliance report of EC order of M/s .Vedanta Limited (Cairn Oil & Gas)., for information.
With Regards,
EC Section,
APPCB.

---------- Forwarded message ---------
From: **A.Ramarao Naidu EE** <rokkd-ee1@appcb.gov.in>
Date: Fri, Feb 1, 2019 at 1:33 PM
Subject: APPCB-RO-KKD – Request of M/s. Vedanta Limited (Cairn Oil & Gas), S.Yanam Village, Uppalaguptam Mandal, East Godavari District for issuance of certified Environmental Clearance(EC) compliance for obtaining EC & CRZ Clearance for the proposed expansion of Offshore & Onshrore Oil & Gas exploration, development and production within the existing Ravva (PKGM – I) offshore block – Compliance report - Submitted – Regarding.
To: <apseiaasecretariat@gmail.com>

Sir,

Please find enclosed the EC compliance report of M/s. Vedanta Limited (Cairn Oil & Gas), S.Yanam Village, Uppalaguptam Mandal, East Godavari District for issuance of certified Environmental Clearance(EC) compliance for obtaining EC & CRZ Clearance for the proposed expansion of Offshore & Onshrore Oil & Gas exploration, development and production within the existing Ravva (PKGM – I) offshore block for kind information.

Submitted.

Yours faithfully
EE/RO/KKD

For Annex-6 to ADS on

Certified EC Compliance Report by APPCB

Access the document through link below

https://drive.google.com/file/d/1shGp4UWnUXVR0xDObToX2kS99vmVdsgP/view?usp=sharing

Also, refer to Annex-11 of EIA Volume 2

Annexure 7

Commitments including Budget Allocation for CER Activities

Commitment towards CER Initiatives for Environmental and CRZ Clearance of "Expansion of Offshore and Onshore Oil and Gas Exploration, Development & Production in existing Ravva Field, PKGM-1 Block (of 331.26 km^2) located near Surasniyanam Village in Krishna-Godavari Basin, East Godavari District, Andhra Pradesh by M/s Vedanta Limited (Division Cairn Oil & Gas)".

1. **Ravva JV commits to contribute in total INR 20.0 (Rupees Twenty Crores) towards implementing CER projects, over ten years (considering the project period).**

2. **This amount will be used for the CER initiatives/projects in consultation with the District Collector, East Godavari District, Andhra Pradesh towards implementing the community development works as proposed during the public hearing held on 11th October 2018 at Surasaniyanam Village, East Godavari District, Andhra Pradesh. The CER fund will be utilized towards implementing the following programs/initiatives.**

   a) **Drinking water:** Setting up of community drinking water system for S. Yanam village.

   b) **Infrastructure:** Construction of roads, bridges/culverts, canal, stormwater & backwater drains, developing the parks with walking tracks, installation of the solar lights etc.

   c) **Tourism:** Promotion of the beach front tourism in the surrounding villages.

   d) **Health:** Supporting district medical department for expansion and effective operation and maintenance of public health center.

   e) **Solid waste and Sanitation:** Provision of Supporting the "Swatch Bharat" initiative for the effective waste management.

   f) **Education:** Supporting the Government schools and Anganwadi's towards improving the educational standards, establishment of libraries, providing scholarships to the meritorious students etc.

   g) **Sports:** Supporting physical education in schools and youth such as providing sports kits, creating play area etc.

   h) **Skill development of the youth**: By developing training and competitive exam coaching centers in the villages and organizing skill development training programs.

   i) **Natural Resource Management (NRM):** Development of NRM related projects in the villages through plantation of the native species for increasing the green cover, providing fruit bearing saplings to the local villagers etc.

   j) **Fisheries and aqua culture development**: Development schemes for fishermen and aqua culture farmers including assistance for their livelihood development will be carried out in consultation with the Department of Fisheries, Andhra Pradesh, Central Marine Fisheries Research Institute etc.

   k) **Need based assessment study:** Carry out a need based (social) assessment study in the S.Yanam and the surrounding villages through Smart Andhra Pradesh Foundation or through any reputed institutions. The outcome of the study will be discussed with the district administration and financial support will be based on the study outcome related program.

Annexure 8

Revised Form 2

Form-2

APPLICATION FOR PRIOR ENVIRONMENTAL CLEARANCE

S. No.	Item	Details
1.	Whether it is a violation case and application is being submitted under Notification No. S.O.804(E) dated 14.03.2017 ?	No
	Details of Project:	
	(a)Name of the project(s)	Expansion of Offshore and Onshore Oil and Gas Exploration, Development & Production in existing Ravva Field, PKGM-1 Block (of 331.26 km2) located near Surasniyanam Village (S. Yanam)
	(b)Name of the Company / Organisation	M/s Vedanta Limited(Division Cairn Oil & Gas)
	(c)Registered Address	4th Floor, Vipul Plaza, Suncity Sector 54, Gurgaon, Haryana - 122002
	(d)Legal Status of the Company	Private
	(e)Joint Venture	No
2.	**Address for the correspondence:**	
	(a)Name of the Applicant	Dilip Kumar Bera
	(b)Designation (Owner/ Partner/ CEO)	Sr. Manager – Environment
	(c)Address	NIL
	(d)Pin code	122002
	(e)E-mail	dilipkumar.bera@cairnindia.com
	(f)STD Code.	124(f)Telephone No. 4594176
	(g)Fax No.	4145612
	(h)Copy of documents in support of the competence/authority of the person making this application to make application on behalf of the User Agency .	Annexure-Uploaded Copy of documents in support of the competence/authority
3.	**Category of the Project/Activity as per Schedule of EIA Notification,2006:**	
	(a)Project/Activity	**1(b) Offshore and onshore oil and gas exploration, development & production**
	(b)Category	**A**
	(c)Proposal Number	**IA/AP/IND2/102271/2013**
	(d)Master Proposal Number(Single Window)	**SW/102270/2019**
	(e)EAC concerned (for category A Projects only)	**Industrial Projects – 2**
	(f)Project Type	**Expansion**
4.	**Location of the Project:**	
	(a)Plot/Survey/Khasra No.	Surasaniyan, Uppalaguptam, East Godavari District
	(b)Pincode	533213
	(c)Bounded Latitudes (North)	FROM 16.3467 To 16.5577
	(d)Bounded Longitudes (East)	FROM 82.1186 To 82.3081
	(e)Survey of India Topo Sheet No.	65L3 and 65L6
	(f)Uploaded Topo Sheet File	Copy of Topo Sheet File
	(g)Maximum Elevation Above Means Sea Level(AMSL)	7
	(h)Uploaded (kml) File	Copy of Kml File
	(i)Distance of Nearest HFL from the project boundary within the study area	0
	(j)Seismic Zone	3
5.	(a)Number of States in which Project will be Executed	1
	(b)Main State of the project	Andhra Pradesh

Details of State(s) of the project

S. No.	State Name	District Name	Tehsil Name	Village Name
(1.)	Andhra Pradesh	East Godavari	Uppalaguptam	Surasaniyanam

6.	**Details of Terms of Reference (ToR)/EC:**	
	(a)MoEF&CC / SEIAA File Number	J-11011/41/2018-IA-II (I)
	(b)Date of Apply of TOR	24 Jan 2018
	(c)Date of Issue of TOR / Standard ToR	24 March 2018
	(d)Date of Apply of EC	08 July 2019
	(e)Date of Issue of EC	
	(f)Previous TOR Letter	Copy of Previous TOR letter
	(g)Previous EC Letter	Copy of Previous EC letter
7.	**Details of Public Consultation:**	
	(a)Whether the Project Exempted from Public Hearing?	No
	(b)Whether details of Public Hearing available?	Yes
	(c)Whether Public hearing was presided over by an officer of the rank of Additional District Magistrate or above	Yes

7.1. **Details of Public Hearing**

Sl. No.	Details of Advertisement	Details of Public Hearing	Venue	Location Details	No. of People Attended	Issues Raised	Designation of Presiding Officer	Other Designation of Presiding Officer
(1)	Date of Advertisement : 10 Sep 2018 Copy of advertisement: Copy of Advertisement	Copy of Public Hearing : Copy of Public Hearing Date:11 Oct 2018 Distance of Public Hearing Venue from the Proposed Project: 0.05	At Beach Front, Surasaniyam Beach Road	State: Andhra Pradesh District : East Godavari Tehsil : Uppalaguptam Village : Surasaniyanam	151	Employment, CSR, Social Infrastructure Development	Others	Joint Collector & Additional District Magistrate, East Godavari District

8. **Details of Project Configuration/Product:** **Details Not Applicable**

9.

In case of Expansion / Modernisation / One Time Capacity Expansion (only for Coal Mining) / Expansion under Clause 7(ii) / Modernisation under Clause 7(ii) / Change of Product Mix under Clause 7(ii):	
(a) Details of certified report on compliance of earlier environmental clearance condition	
(i)Certified Compliance By	SPCB
(ii)Details of Regional Office of MoEFCC / Zonal Office of CPCB / SPCB / UTPCC from which certified report on	
(iii)Letter No.	14-R-1040/APPCB/ RO/KKD/2019-1913
(iv)Status of Compliance	Compiled
(v)Certified report on compliance of earlier environmental clearance conditions (Including Monitoring Report)	Copy of Certified Compliance Report
(vi)Date of site visit	Dec 28 2018 12:00AM
(b) Details of Capacity Expansion	

Sl. No.	Product/Activity (Capacity/Area)	Quantity From	Quantity To	Total	Unit	Other Unit	Mode of Transport / Transmission of Product	Other Mode of Transport /Transmission of Product
(1.)	Crude Oil	50000	0	50000	Others	BOPD	Others	Pipelines
(2.)	Natural Gas	2.32	0	2.32	Others	MMSCMD	Others	Pipeline

(c) Details of Configuration

Sl. No.	Plant / Equipment / Facility	Existing Configuration	Proposed Configuration	Final configuration after expansion	Remarks
(1.)	Onshore wellpads	2 existing wellpads	Developing 2 previously established wellpads	2	Typical dimensions of each well pad of ~225m x ~170m
(2.)	Onshore pipelines	Total pipeline length of 192 km in PKGM-1 Block	8 Km	8 Km pipeline corridor	8 Km pipeline corridor will have 3 pipelines for well fluid, gas and subsurface injection water
(3.)	Onshore and offshore well drilling	55 development wells	Total 123 wells (83 exploration wells and 40 development wells)	83 exploration wells and 95 development wells	Exploration wells -73 offshore and 10 onshore and Development wells - 17 offshore and 23 onshore. In addition to 20 developmental and 6 exploratory wells and one RI Platform the previously approved as per EC dtd 23 Feb 2015 & CRZ Clearance dtd 25 May 2017.

9.1

Details of Consent to Operate	
(i)Whether Consent to operate obtained ?	NA
(ii)Copies of all Consent to operate obtained since inception	NA
(iii)Date of Issue	22 Jul 2016
(iv)Valid Upto	31 Oct 2021
(v)File No.	APPCB/VSP/RJY/546/CFO/HO/2016
(vi)Application No.	APPCB/VSP/RJY/546/CFO/HO/2016
(vii)Copy of Consent to operate valid as on date	Copy of Consent to Operate

10

Project Cost:	
(a)Total Cost of the Project at current price level (in Crores)	7924
(b) Funds Allocated for Environment Management (Capital) (in Crores)	0.0
(c) Funds Allocated Towards CER (Corporate Environment Responsibility) (in Crores)	20
(d) Funds Allocated for Environment Management Plan (EMP) (Recurring per Annum) (in Crores)	1.37

11

Whether project attracts the General Condition specified in the Schedule of EIA Notification ?	No

12

Whether project attract the Specific Condition specified in the Schedule of EIA Notification ?	No

13

Raw Material / Fuel Requirement:	
(a)Proposed quantity of raw material/fuel (m3/day/ well)	8
(b)Existing quantity of raw material/fuel	0
(c)Total quantity of raw material/fuel (m3/day/well)	8

13.1 **Raw Material / Fuel Profile**

S. No.	Raw Material / Fuel	Quantity	Unit	Other Unit	Source (incase of Import, please specify country and Name of the port from which Raw Material / Fuel is received)	Mode of Transport	Other Mode of Transport	Distance of Source from Project Site (in Kilometres) (In case of import, distance from the port from which the raw material / fuel is received)	Type of Linkage	Other Type of Linkage	Uploaded Copy of Linkage
(1.)	Fuel Supply	8	Others	Cubic meter/day/well	Domestic Market	Road		.	Others	Attached	Copy of Linkage
(2.)	Drilling Chemicals	200	Others	Tons/Well	Domestic Market	Road		.	Others	Attached	Copy of Linkage
(3.)	Water	85	Others	Cubic meter/well	Ground water	Others	Pipelines	15	Others	Attached	Copy of Linkage

14. **Baseline Data :**

(a)Period of Base Line Data Collection	FROM 06 Jan 2018 To 31 Mar 2018
(b)Season	Winter

14.1. **No. of ambient Air Quality (AAQ) monitoring locations : 8**

S. No.	Criteria Pollutants	Other Criteria Pollutants	Unit	Maximum Value	Minimum Value	98 Percentile Value	Prescribed Standard
(1.)	NOx		Micro Gram per Meter Cube	16.7	10.5	16.49	80
(2.)	Others	CO	Mili Gram per Meter Cube	0.268	0.151	0.253	2
(3.)	SO2		Micro Gram per Meter Cube	14.8	8.7	14.49	80
(4.)	PM10		Micro Gram per Meter Cube	56.3	43.6	56.07	100
(5.)	PM2.5		Micro Gram per Meter Cube	25.7	18.4	25.53	60

14.2. **No. of Ground Water monitoring locations : 4**

S. No.	Criteria Pollutants	Other Criteria Pollutants	Heavy Metal	Unit	Other Unit	Maximum Value	Minimum Value	Desirable Limit	Maximum Permissible Limit
(1.)	TDS			mg/l		5334	397	500	2000
(2.)	Fluoride			mg/l		0.7	0.2	1	1.5
(3.)	pH			Others	NA	7.4	7.1	6.5	8.5
(4.)	Total Hardness			mg/l		1086.40	165.20	200	600
(5.)	Chlorides			mg/l		1857.70	101.60	250	1000
(6.)	Heavy Metals		Iron	mg/l		0.29	0.02	0.3	0.3
(7.)	TSS			mg/l		.	.	100	100
(8.)	Others	Sulphates		mg/l		65.5	3.6	200	400

14.3. **No. of Surface Water monitoring locations : 4**

S. No.	Criteria Pollutants	Other Criteria Pollutants	Unit	Other Unit	Maximum Value	Minimum Value	Classification of inland water body
(1.)	DO		mg/l		6.2	5.6	D
(2.)	BOD		mg/l		3	3	D
(3.)	COD		mg/l		.	.	D
(4.)	pH		NA		8.2	7.2	D
(5.)	Others	TSS	mg/l		35	17	D

14.4. **No. of Ambient Noise monitoring locations : 8**

S. No.	Parameter	Unit	Maximum Value	Minimum Value	Prescribed Standard
(1.)	Leq(Day)	A-weighted decibels(dB(A))	59.4	50	65
(2.)	Leq(Night)	A-weighted decibels(dB(A))	50.7	40.8	55

14.5. **No. of Soil Sample Monitored locations : 5**

S. No.	Parameter	Unit	Other Unit	Maximum Value	Minimum Value
(1.)	pH			7.5	6.1
(2.)	K(Potassium)	Milligram per Kilogram		.	.
(3.)	N(Nitrogen)	Milligram per Kilogram		179.1	24.6
(4.)	P(Phosphorus)	Milligram per Kilogram		145.2	12.6
(5.)	Electric Conductivity	Others	Micro Siemens Per Cm	2350	321

14.6	**Details of Ground Water Table:**
	(a)Range of Water Table Pre-Monsoon Season (Meters Below Ground Level (m bgl))	From 2 To 5
	(b)Range of Water Table Post-Monsoon Season (Meters Below Ground Level (m bgl))	From 2 To 2
	(c)Whether Ground Water Intersection will be there ?	No

15. **Details of Water Requirement (During Operation)**

S. No.	Source	Source Other	Required Quantity	Distance from Source	Copy of Permission from Competent Authority	Mode of Transport	Other Mode of Transport	Method of Water Withdrawal	Other Method of Water Withdrawal	Letter No.	Date of Issue	Permitted Quantity
(1.)	Ground Water		18214	8	Copy of Permission Letter https://drive.google.com/file/d/1xeHg-5afpyOGOTrOz3xePM_0ibjxk_Jt/view?usp=sharing	Pipeline		Others	Bore wells	PRR05-11028/45/2019-SLNA-GIS-CORD	19 May 2020	10413

15.1	(a)Whether Desalination is proposed	No

16 **Waste Water Management(During Drilling of an Onshore and an Offshore Well)**

S. No.	Type/Source	Quantity of Waste Water Generated (Kilolitre per Day)	Treatment Capacity (Kilolitre per Day)	Treatment Method	Mode of Disposal	Other Mode of Disposal	Quantity of Treated Water Used in Recycling/Reuse (Kilolitre per Day)	Quantity of Discharged Water (Kilolitre per Day)
(1.)	Drilling wash waste water per well (onshore)	5	3000	Skit Mounted Mobile ETP of 5 KL/day followed by treatment in existing ETP at Ravva Terminal	Treated wastewater from ETP at Ravva Terminal disposed of offshore through marine outfall			5
(2.)	Bilge water per well (offshore) 10 KL /well	0.25	5	Treated onboard before disposal offshore conforming to the MARPOL requirements	Discharge into Seawater Body			0.25
(3.)	Sewage per well (offshore)	30	40	Treated on-board STP before discharge conforming to MARPOL requirements	Discharge into Seawater Body			30
(4.)	Drilling wash waste water per well (offshore) [200 KL /Well]	5	500	Treated onboard before disposal offshore conforming to the MARPOL requirements	Discharge into Seawater Body			5
(5.)	Sewage per well (Onshore)	4.5	175	STP of 175 KL/day (Ravva Terminal)	Reuse in watering plantation within the onshore Ravva Terminal & and Living Quarters.		4.5	

16.1	(a)Total Waste Water Generation	9.5 KLD per drilling of onshore well + 35.25 KLD per drilling of offshore well
	(b)Total Discharged Water	5.0 KLD per drilling of onshore well + 35.25 KLD per drilling of offshore well
	(c)Total Reused Water	4.5 KLD per drilling of onshore well

17 **Solid Waste Generation/Management**

S. No.	Name of Waste	Item	Other Item	Quantity per Annum	Unit	Distance from Site(KM)	Mode of Transport	Other Mode of Transport	Mode of Disposal	Other Mode of Disposal
(1.)	Drill Cutting per Well Onshore	Hazardous Waste (as per Hazardous and Other Waste Management rules 2016)		250	Kilolitre	220	Road		Treatment, Storage and Disposal Facility(TSDF)	
(2.)	Spent Drilling Mud per Well Onshore	Hazardous Waste (as per Hazardous and Other Waste Management rules 2016)		200	Kilolitre	220	Road		Treatment, Storage and Disposal Facility(TSDF)	
(3.)	Spent Lubricating Oil per Well Onshore	Hazardous Waste (as per Hazardous and Other Waste Management rules 2016)		10	Kilolitre	220	Road		Treatment, Storage and Disposal Facility(TSDF)	
	Spent Drilling Mud per Well	Hazardous Waste (as per Hazardous and Other Waste						Service		As per

(4.)	Offshore	Management rules 2016)		150	Kilolitre	.	Others	vessels and road transport	Others	MoEFCC Guidelines
(5.)	Drilling Cuttings per Well Offshore	Hazardous Waste (as per Hazardous and Other Waste Management rules 2016)		220	Kilolitre	.	Others	-	Others	Discharged offshore as per MoEFCC Guidelines
(6.)	Food Waste per day offshore	Municipal Solid Waste		.025	Tons	.	Others	Not required	Others	Discharged offshore as per MoEFCC Guidelines
(7.)	Food Waste per Day Onshore	Municipal Solid Waste		0.025	Tons	8	Road		Others	Composting in-house or to be sent to piggeries
(8.)	Spent Lubricating Oil per Well Offshore	Hazardous Waste (as per Hazardous and Other Waste Management rules 2016)		5	Kilolitre	220	Others	Service vessels and road transport	Treatment, Storage and Disposal Facility(TSDF)	

18.

18.1 Air Quality Impact Prediction

S. No.	Criteria Pollutants	Other Criteria Pollutants	Unit	Baseline Concentration	Distance GLC	Incremental Concentration	Total GLC	Prescribed Standard
(1.)	SO2		Microgram per Meter Cube	11.6	1.5 km.	0.02	11.62	80
(2.)	NOx		Microgram per Meter Cube	14.2	1.5 km	4.5	18.7	80
(3.)	Others(Specify)	CO	Microgram per Meter Cube	223	1.5 km	8.7	231.7	2000
(4.)	PM10		Microgram per Meter Cube	47.1	1.5 km	0.35	47.45	100
(5.)	PM2.5		Microgram per Meter Cube	.	.	.	.	.

18.2 **Stack Details**

S. No.	Source	Fuel	Stack Height(m)	Stack Diameter(m)	Pollutants	Other Pollutants	Emission (G/S)
(1.)	DG Set (1010 KVA) at onshore wellpad for well drilling	Diesel	10	0.305	NOx		0.89
(2.)	DG Set (1010 KVA) at wellpad for well drilling	Diesel	10	0.305	SO_2		0.004
(3.)	DG Set (1010 KVA) at wellpad for well drilling	Diesel	10	0.305	PM10		0.044
(4.)	DG Set (1010 KVA) at wellpad for well drilling	Diesel	10	0.305	Others	CO	0.78
(5.)	DG Set (350 KVA) at wellpad for well drilling	Diesel	7	0.2	NOx		0.311
(6.)	DG Set (350 KVA) at wellpad for well drilling	Diesel	7	0.2	PM10		0.0156
(7.)	DG Set (350 KVA) at wellpad for well drilling	Diesel	7	0.2	SO2		0.0014
(8.)	DG Set (350 KVA) at wellpad for welldrilling	Diesel	7	0.2	Others	CO	0.272
(9.)	Temporary test flaring at wellpad for well drilling	Gas	5	2.03	SO2		-
(10.)	Temporary test flaring at wellpad for well drilling	Gas	5	2.03	Others	CO	6.1
(11.)	Temporary test flaring at wellpad for well drilling	Gas	5	2.03	PM10		0.52
(12.)	Temporary test flaring at wellpad for well drilling	Gas	5	2.03	NOx		2.52
(13)	Emergency elevated flaring at wellpad for drilling	Gas	30	2.03	PM10		0.52
(14)	Emergency elevated flaring at wellpad for drilling	Gas	30	2.03	NOx		2.52
(15)	Emergency elevated flaring at wellpad for drilling	Gas	30	2.03	SO2		-
(16)	Emergency elevated flaring at wellpad for drilling	Gas	30	2.03	Others	CO	6.1

19. **Power Requirement:**

(a)Quantity (Kilo Volt Amps (kVA))	5700
(b)Source	DG Sets 1X1000 KVA+2X350 KVA (Onshore) & 2X2000 KVA (Offshore)
(c)Uploaded Copy of Agreement	Copy of Agreement
(d)Standby Arrangement (Details of DG Sets)	1X1000 KVA+2X350 KVA (Onshore) & 1X2000 KVA +1X500 KVA (Offshore)
(e)Stack Height (in m)	10

20.

Land Ownership Pattern:	
(a)Forest Land	0
(b)Private Land	0
(c)Government Land	20
(d)Revenue Land	0
(e)Other Land	0
Total Land	**20**

21.

Present Land Use Breakup of the Study Area in Ha:	
(a)Agriculture Area	13059
(b)Waste/Barren Land	0
(c)Grazing/ Community Land	0
(d)Surface Water Bodies	17799
(e)Settlements	1018
(f)Industrial	0
(g)Forest	4807
(h)Mangroves	1157
(i)Marine Area	61824
(j)Others : Casaurina plantation, sand dunes, mudfalts and road	2959
Total	**102623**

22. **Land requirement for various activities**

S. No.	Description of Activity / Facility / Plant / Others	Others	Land Requirement	Remarks
(1)	Others	Onshore wellpad, and pipelines	20	8 ha (for two wellpads) 12 ha (pipelines corridor of ~8km x 15 m width)
	Total		20	

23 **Ecological and Environmental Sensitivity (Within 10 Km):- WLS-Wild Life Species; NPA-Notified Protected Area; ESAs-Eco Sensitive Areas; ESZs-Eco Sensitive Zones :**

23.1 Details of Ecological Sensitivity :

S. No.	Details of Ecological Sensitivity	Name	Distance from the Project (Km)	Remarks
(1.)	Critically Polluted Area	Visakhapatnam	220	Nearest distance from the Block
(2.)	ESAs	Coringa Wildlife Sanctuary	25	From nearest proposed well (E-11)
(3.)	Wildlife Corridors	Coringa Wildlife Sanctuary	25	From nearest proposed well (E-11)
(4.)	NPA	Hope Island	41	Nearest distance from the Block
(5.)	Corridors	Coringa Wildlife Sanctuary	25	From nearest proposed well (E-11)
(6.)	WLS	Coringa Wildlife Sanctuary	25	From nearest proposed well (E-11)
(7.)	ESZs	Coringa Wildlife Sanctuary	25	From nearest proposed well (E-11)

23.2 Details of Environmental Sensitivity :

S. No	Details of Environmental Sensitivity	Other Details of Environmental Sensitivity	Name	Distance from the Project (Km)	Remarks
(1.)	Forest		Kandikoppa Reserve Forest	7	Nearest distance from existing Ravva Terminal
(2.)	Defence Installations		Eastern Command Naval Base, Visakhapatnam	220	Nearest distance from the Block
(3.)	Archaeological Sites		Adurru Budhist Site	35	Nearest distance from the Block

23.

(a)Whether Noc / Permission from the competent authority is required?	No

24.

Forest Land:	
Whether any Forest Land involved?	No

25.

Tree Cutting:	
(a)No. of Trees Cut for the Project (if Forest Land not Involved)	0
(b)Details of Tree Cutting and Planting of Trees	Not Applicable

26.

Land Acquisition Status:	
(a)Acquired Land(Ha)	0
(b)Land yet to be acquired(Ha)	20
(c)Status of Land acquisition if not acquired	Land uptake will be initiated after receipt of EC

27.

Rehabilitation and Resettlement (R&R):	
(a)No. of Villages	0
(b)No. of Households	0
(c)No. of PDFs (Project Displaced Families)	0
(d)No. of PAFs (Project Affected Families)	0
(e)Funds Allocated for R&R(in INR) (in Lacs)	0
(f)Status of R&R	No private land involved

28.

Details of Presence of Schedule-I Species:	
(a)Whether there is Presence of Schedule-I Species ?	Yes
(i)Details of Schedule-I Species	Olive ridley turtle, Indian flapshell turtle, Monitor lizard, Osprey, Brahminy kite, Shikra , Pariah kite, Fishing Cat and Indian Pangolin
(b)Whether conservation plan for Schedule-I Species has been prepared ?	Yes
(i)Uploaded copy of conservation plan	Copy of conservation plan
(ii)Fund Provision made	Yes
(iii)Period of Implementation	2019 – 2024
(c)Whether conservation plan for Schedule-I Species has been approved by competent authority ?	No

29.

Details of Presence of Water Bodies in Core Area:	
(a)Whether there is Presence of Water Bodies in Core Area ?	No
(b)Whether there is Diversion Required ?	No
(c)Whether permission has been obtained from competent authority ?	No

30.

Details of Presence of Water Bodies in Buffer Area:	
(a)Whether there is Presence of Water Bodies in Buffer Area ?	Yes
(i)Details of Water Bodies in Buffer Area	Vrudha Gautami River, Nilarevu River and Vainateyam Godavari River
(ii)Direction of Water Bodies in Buffer Area	East
(iii)Distance of Water Bodies in Buffer Area	4

31.

Manpower Requirement:	
(a)Permanent Employment-During Construction	0
(b)Permanent Employment-During Operation	0
(c)Temporary Employment- During Construction	0
(d)Temporary Employment- During Operation	0
(e)No. of working days	0
(f)Total Manpower	0

32.

Green Belt in Ha:	
(a)Uploaded Green Belt plan	Copy of Green Belt Plan

S. No.	Description	Existing	Proposed	Total
(1.)	Total Area of Green Belt	79	3	82
(2.)	Percentage of Total Project Area	35	1	36
(3.)	No. of Plants	13000	2000	15000
(4.)	Funds Allocated	4000000	200000	4200000

33. **Project Benefits**

S. No.	Type of Project Benefits	Details of Project Benefits
(1.)	Financial	The enhancement in production of oil and gas within the already approved capacity and utilising the infrastructure already available through the operating Ravva Terminal will add to the energy independence of the nation and will reduce the import bills

34. CRZ Specific Details

1.

Project Details:	
(a)CRZ Classification	IB
(b)Location Type	Non-Eroding Coast
(c)Details of Mangroves Land Involved, if Any	Nil
(d)Area of Mangroves Land (hectare)	0
(e)EIA (Terrestrial) Studies	Carried Out
(i)Summary Details of EIA (Terrestrial) Studies	Covered in the EIA Study Report as enclosed
(ii)Uploaded Recommendation made in EIAs	Copy of Recommendation made in EIAs
(iii)Period of Study from (EIA Terrestrial)	01 Jan 2018
(iv)Period of Study To (EIA Terrestrial)	30 Apr 2018
(f)EIA (Marine) Studies	Carried Out
(i)Summary Details of EIA (Marine) Studies	Covered in the EIA Study Report as enclosed
(ii)Uploaded Recommendation made in EIAs	Copy of Recommendation made in EIAs
(iii)Period of Study from (EIA Marine)	01 Jan 2018
(iv)Period of Study to (EIA Marine)	30 Apr 2018
(g)Disaster Management Plan/National Oil Spill Disaster Contigency Plan	The Oil Spill Contingency Plan for PKGM-1 (Ravva)

2.

Description of the Project Under Consideration:	
(a)Type of Project	Others
(i)Agency Name for Preparing CRZ Maps	National Center for Sustainable Coastal Management
(ii)Please Specify with salient features	Drilling of 123 wells. In the onshore drilling of
(iii)Uploaded relevent Document	Copy of relevent Document

3.

Distance of Project (in meters) from ltl/htl to be stated :	
(a)Clause of CRZ Notification Under which the Project is a Permissible/Regulated Activity	IB
(b)Whether CRZ Map Indicating HTL,LTL Demarcation in 1:4000 Scale Prepared?	Yes
(i)Distance of Project (in meters) from HTL to be Stated	100
(ii)Uploaded Maps(Shape File)	Copy of Maps
(iii)Distance of Project(in meters) from LTL to be Stated	250
(iv)Uploaded Maps(Shape File)	Copy of Maps
(c)Whether Project Layout Superimposed on CRZ Map 1:4000 Scale ?	Yes
(i)Uploaded Maps (Shape File)	Copy of Maps
(d)Whether CRZ Map 1:25000 Covering 7 km Radius Around Project Site Prepared ?	Yes
(i)Uploaded Maps (Shape File)	Copy of Maps
(e)Whether CRZ Map Indicating CRZ-I,II,III and IV Including Other Notified ESAs Prepared	Yes
(i)Uploaded Maps (kml File)	Copy of Maps
(f)NOC from State Pollution Control Boards Obtained	Yes

4.	**Recommendation of State Coastal Zone Management Authority:**	
	(a)Copy of CZMA	Copy of CZMA
	(b)State the Conditions Imposed	As enclosed
	(c)Social and Environmental Issues and Mitigations Measures Suggested Including but not Limited to R&R, Water, Air, Hazardous Wastes, Ecological aspects, etc. (Brief Details to be Provided)	As enclosed

35. Sector Specific Details: NOT APPLICABLE

35. Sector Specific Details For Industrial Projects - 2

S. No.	Item	Details
Additional Detail Sought Additional Detail Sought, **3.**		
S. No.	**Item**	**Details**
36.	**Details of Court Cases:**	
	(a)Whether there is any Court Cases pending against the project and/or land in which the project is proposed to be set up ?	No
37.	**Details of Direction Issued under Environment (Protection) Act / Air (Prevention & Control of Pollution)) Act / Water (Prevention & Controlof Pollution) Act:**	
	(a)Whether any Direction issued under EPA Act/Air Act/Water Act ?	No
38.	**Details of EIA Consultant:**	
	(a)Have you hired Consultant for preparing document?	Yes
	(i)Accreditation No.	NABET/EIA/1619/RA 0055
	(ii)Name of the EIA Consultant	ERM India Private Limited
	(iii)Address	Building 10, Tower - A, 4th Floor, DLF Cyber City, Gurgaon
	(iv)Mobile No.	9810112106
	(v)Landline No.	0124417030
	(vi)Email Id	neena.singh@erm.com
	(vii)Category of Accreditation	A
	(viii)Sector of Accreditation	Industrial Projects - 2
	(ix)Validity of Accreditation	31 July 2020
	(x)Uploaded Certificate of Accreditation certified by QCI/NABET	Copy of Certificate of Accreditation
39.	**Documents to be Attached:**	
	(a)Uploaded Copy of EIA/EMP Report	Copy of EIA/EMP (Revised EIA Volume 1 attached) Copy of EIA/EMP(Annexures) (Revised EIA Volume 2 Annexes attached) Copy of EIA/EMP(Plans/Figures) (included in the Reivsed EIA)
	(b)Uploaded Copy of Risk Assessment Report	Copy of Risk Assessment (included in Section 6 of the Revised EIA Volume 1)
	(c)Uploaded Copy of Feasibility Report/ Detailed Project Report (DPR) /Detailed Engineering Report /Detailed Conceptual Plan /Approved Mining Plan	Copy of Feasibility Report/ Detailed Project Report(DPR) /Detailed Engineering Report /Detailed Conceptual Plan /Approved Mining Plan
	(d)Uploaded Copy of Final Layout Plan	Copy of Final Layout Plan
	(e)Uploaded Cover Letter	Copy of Cover Letter
	(f)Uploaded Copy of documents in support of the competence/authority of the person making this application to make application on behalf of the User Agency	Copy of documents in support of the competence/authority of the person making this application to make application on behalf of the User Agency
	(g)Uploaded Additional File	Copy of Additional File

Additional Detail Sought

Sno.	ADS Letter	Remarks	Date of ADS
1.	NA	*The Committee, after deliberations, deferred the proposal for want of following additional information:-* • &	06 Oct 2019
2.	ADS Letter	Submission of the requested information sought during 11th EAC meeting held between 28-29 August 2019 agenda item no. 11.5.3 regarding the EC and CRZ clearances of "Expansion of Offshore and Onshore Oil and Gas Exploration, Development & Production in existing Ravva Field, PKGM-1 Block (of 331.26 km2) located near Surasaniyanam Village (S. Yanam) in Krishna- Godavari Basin, East Godavari District, Andhra Pradesh by M/s Vedanta Limited (Division of Cairn Oil and Gas)- Proposal no. IA/AP/IND2/102271/2013	29 Nov 2019
3	ADS	Submission of ADS raised during 15th meeting of EAC held between 30th Dec 2019 to 01st Jan 2020, agenda item no. 15.5.12	26 May 2020

Undertaking

I hereby give undertaking that the data and information given in the application and enclosures are true to be best of my knowledge and belief. And I am aware that if any part of the data and information found to be false or misleading at any stage, the project will be rejected and clearance given, if any to the project will be revoked at our risk and cost. In addition to above, I hereby give undertaking that no activity/ construction/ expansion has since been taken up.

	Name of Applicant	Dilip Kumar Bera
	Designation	Sr. Manager - Environment
	Name of Company (Applicant Name should not be given here)	M/s Vedanta Limited(Division Cairn Oil & Gas)
	Address	4th Floor, Vipul Plaza, Suncity Sector 54, Gurgaon, Haryana - 122002

Environment Clearance and CRZ Clearance for Expansion of Offshore & Onshore Oil & Gas Exploration, Development & Production in existing Ravva Field, PKGM-1 Block (of 331.26 km^2) located near Surasaniyanam Village (S.Yanam) in Krishna Godavari Basin, East Godavari District, Andhra Pradesh

Vedanta Limited
(Cairn Oil & Gas)

Revised EIA Report – Volume 1 (Main Report)

30 April 2020 (revised from May & Nov 2019): Rev. II

EIA Consultant: ERM India Private Limited, Gurgaon – NABET Accredited as per Certificate No. NABET/EIA/1619/RA0055 Valid up to 31 July 2020

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Vedanta Limited (Cairn Oil & Gas)

Environment Clearance and CRZ Clearance for Expansion of Offshore & Onshore Oil & Gas Exploration, Development & Production in existing Ravva Field, PKGM-1 Block (of 331.26 km^2) located near Surasaniyanam Village (S.Yanam) in Krishna Godavari Basin, East Godavari District, Andhra Pradesh

30 April 2020 (revised from 09 May & 14 Nov 2019): Rev. II

Reference # 0440174

Project Manager	**Dhritiman Ray** *Principal Consultant*	
NABET Approved EIA Co-ordinator for Oil & Gas Sector	**Sushil Kumar Handa** *Technical Director*	

Declaration by Experts contributing to the Environmental Impact Assessment of Expansion of Offshore & Onshore Oil & Gas Exploration, Development & Production in existing Ravva Field, PKGM-1 Block (of 331.26 km²) located near Surasaniyanam Village in Krishna–Godavari Basin, East Godavari District, Andhra Pradesh

EIA Coordinator

I, hereby, certify that I was a part of the EIA team in the following capacity that developed the above EIA.

EIA coordinator : **Sushil Kumar Handa**

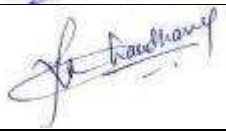
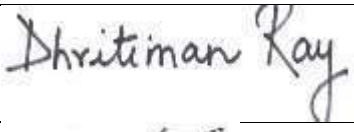
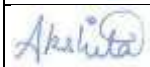
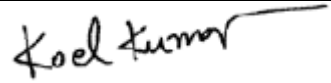
Signature and Date:

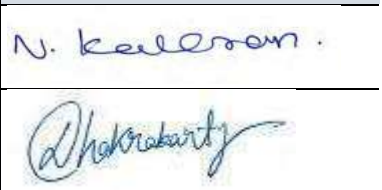
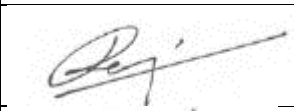
30 April 2020 (revised from 09 May & 14 Nov. 2019): Rev. II

Period of involvement: From December 2017 – Ongoing

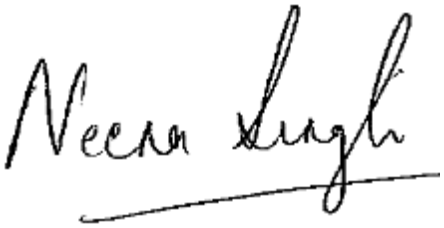
Contact information : ERM India Private Limited, 4th Floor, Tower A, Bldg. 10, DLF Cyber City, Gurgaon.
Tel: 91-124-4170300; Email: Sushil.Handa@erm.com

Functional Area Experts [FAEs]

S.N	Role in the EIA	Name of the Expert	Involvement & Dates	Signatures
1	[**EIA Coordinator** for Offshore and Onshore Oil & Gas Exploration, Development and Production]	Sushil Kumar Handa	Coordination with experts; Impact assessment methodology development; Inputs related to given functional areas related baseline and impact assessment; Formulation of Environment Management Plan; Technical review and QA/QC for all outputs [Dec 2017-Ongoing]:	
2	[**FAE**: Meteorology, Air Quality Modelling & Prediction and Noise and Vibration]	Sushil Kumar Handa & Naval Chaudhary	Undertaking air and noise quality modelling; Inputs for impact assessment and development of EMP. [Jan. - Oct 2018]	 
3	[**FAE**: Air Pollution Monitoring, Prevention and Control and Risk Assessment and Hazard Management]	Dr. Debanjan Bandyopadhyay	Selection of air quality monitoring stations; Discussion with client on various air pollution control aspects; Inputs for impact assessment and development of EMP; Risk assessment and hazard management.[Feb - June 2018]	
4.	[**FAE**: Water Pollution Monitoring, Prevention and Control]	Dhritiman Ray	Selection of water monitoring stations; Interpretation of analysis results; Inputs for impact assessment and development of EMP. [Dec 2017- Ongoing]	
5.	[**FAE**: Ecology and Biodiversity]	Dr. Rahul Srivastava & Dr. Abhishek Roy Goswami	Ecological survey and assessment of flora and fauna; Impact assessment and development of EMP. [February - June 2018]	 
6.	[**FAE**: Socio-economics]	Tufail Khan & Akshita Misra	Support for socio economic baseline, stakeholder consultations and impact assessment. [Feb - June 2018]	 
7.	[**FAE**: Solid & Hazardous Waste Management]	Dr. Koel Kumar	Review of existing SHW management and support for impact assessment, and development of EMP. [Feb - June 2018	

S.N	Role in the EIA	Name of the Expert	Involvement & Dates	Signatures
8.	[**FAE**: Land use]	Dr. K Nagalingam & Dibyendu Chakraborty	Preparation of all maps including LU/LC and impact assessment. [Jan- June 2018]	
9	[**FAE**: Soil Conservation]	Rajesh Mohanan	Baseline soil quality and related impact assessment. [Jan- June 2018]	
10.	[**FAE**: Geology **FAE**: Hydrology, ground water and water conservation]	Samrat Bask	Support for developing geology and hydrogeology related baseline and impact assessment. [Jan – 03 April 2018]	

I, Neena Singh, hereby, confirm that the above mentioned experts prepared the EIA of Expansion of Offshore & Onshore Oil & Gas Exploration, Development and Production in existing Ravva Field, PKGM-1 Block (of 331.26 km^2) located near Surasaniyanam Village in Krishna – Godavari Basin, East Godavari District, Andhra Pradesh. I also confirm that the consultant organization shall be fully accountable for any misleading information mentioned in this statement.

Signature: 

Name: **Neena Singh**
Designation: ***Managing Director***
Name of the EIA consultant organization: **ERM India Private Limited**
Date: 30 April 2020
NABET Certificate No. & Issue Date: **NABET/EIA/1619 /RA 0055 valid up to 31 July 2020**

DOCUMENTS HISTORY

Table 0.1 EIA Documents History

Document Version	Date	Description
EIA (Draft) Vol 1 & 2	25 Jun 2018	EIA was issued for public consultation by APPCB.
EIA Vol 1 & 2	01 Nov 2018	EIA was issued for APCZMA appraisal for CRZ NOC after public consultation by APPCB on 11 October 2018 and incorporation of public consultation proceedings and related response from Vedanta Limited (Cairn Oil & Gas).
EIA Vol 1 & 2	09 May 2019	EIA was issued for Appraisal by MoEFCC after Appraisal of the Project by APCZMA on 19 February 2019 and incorporating CRZ NOC by APCZMA dated 03 April 2019 issued on 06 May 2019.
EIA Vol 1 & 2(Rev. I)	14 Nov 2019	EIA was revised to include additional information required by the Expert Appraisal Committee (EAC - Industry –(2) of MoEFCC as communicated through minutes of 11th meeting held from August 28 to 29, 2019 for the expansion Project in PKGM-1 Block. Following information was included in the EIA (Rev. I): a) Additional information on produced water generation and effluent treatment in Section 2.4.1.11 and in Section 4.6.4; b) Integration of baseline data (from Chapter-3 i.e. 'Description of Environment') in column 4 of Table 9.1 on Environmental Management Plan: Onshore and Offshore Drilling Activities in the EMP Section; and c) Addition of detailed Action Plan with budget on issues raised during public hearing held on 11 October 2018 in Table 9.3 in the EMP Section.
EIA Vol 1 & 2 (Rev. II)	30 April 2020	EIA is revised to include further additional information and clarification required by the Expert Appraisal Committee (EAC - Industry –(2) of MoEFCC as communicated through minutes of 15th meeting held from December 30, 2019 to January 01, 2020 for appraisal of the expansion Project in PKGM-1 during appraisal of the expansion Project in PKGM-1 Block. The changes included in this EIA include the following: a) Revision of Executive Summary after dropping five onshore well pads (WP# 1 to 5) and change in pipeline corridor length from 15 km to 8 km from the project proposal and related changes in impact assessment. b) Revision of Section 2 on Project Description after dropping of five onshore well pads (WP # 1 to 5) that were located outside the PKGM-1 Block. Drilling of onshore wells 33 nos. (11 exploratory + 23 developmental) are now proposed to be drilled only from two onshore well pads [numbered as WP-7 (or RX-8) and WP-8 (or RX-9)] located within the PKGM-1 Block. here is no change in the proposal related to drilling of 90 offshore wells (73 exploratory + 17 developmental wells) from within the block. Thus, total number wells to be drilled will be 123 (33 from onshore + 90 from offshore) within PKGM-1 Block. No drilling will be carried outside the PKGM-1 Block area. Revised Project Proposal is included in Section 2.6. Sections 2.7 describe onshore drilling of wells while Section 2.8 describe offshore drilling of wells. Section 2.12.1 desribes onshore drilling related wastewater - zero liquid discharge in onshore water bodies during onshore drilling of onshore wells. Revision of Section 2.12.5 wherein wastes generated from onshore and offshore drilling of wells are separately described

		c) Revision of Section 4.4 on impacts due to onshore drilling and associated activities after dropping of five onshore well pads (WP # 1 to 5). Section also include revision of air impact assessment after dropping of five well pads. d) Revision of Section 5 on Analysis of Alternatives after dropping of five onshore well pads (WP # 1 to 5) e) Revision of Section 9 on Environmental Management Plan after dropping of five well pads. In the section, Table 9.3 on actions required Public Hearing is revised. Added Table 9.4 on actions in compliance of conditions of NOC issued by APCZMA and Table 9.5 on action items committed by Vedanta Limited (Cairn Oil & Gas) on Corporate Environment Responsibility (CER) f) Revision of Section 10 on Summry and Conclusion after dropping of five onshore well pads (WP # 1 to 5) g) Addition of Annex 23 on copy of NOC issued by APCZMA in EIA Report Volume 2 h) Addition of Annex 24 on copy agreement between Vedanta Limited (Cairn Oil & Gas) and International Oil Spill Response Service Provider in EIA Report Volume 2.

COMPLIANCE OF APPROVED TERMS OF REFERENCE (TOR) FOR THE EIA STUDY

The terms of reference (ToR) for conduct of EIA study as approved by EAC of MoEFCC are included in ***Section 13***. The ToR requirements and their inclusion in the EIA study have been described in **Table 0.2.**

Table 0.2 Requirements & Compliance of Approved Terms of Reference for the EIA

SN	ToR Requirement	ToR Compliance – Reference Section/Page#	Remarks
1.	Executive summary of the project	▪ ***Section 0***	Covered as part of this EIA Report
2.	No. of exploratory wells for which environmental clearance is accorded and No. of new wells proposed during expansion. Status and No. of the wells, which are completed and closed.	▪ ***Sections 1.2, Tables 1.4, & 1.5,*** ▪ ***Sections 1.3 & 2.6, 2.7 & 2.8***	***Table 1.5*** covers Environmental Clearances issued for exploratory wells drilling in PKGM-1 Block. ***Section 1.3 & 2.6*** covers revised project proposal ***Sections 2.7 & 2.8*** covers project proposal of onshore and offshore respectively. ***Table 1.4*** covers number of developmental wells drilled & their status
3.	Project Description and Project Benefits.	▪ ***Section 2*** ▪ ***Section 8***	***Section 2*** covers detailed Project Description and ***Section 8*** covers Project Benefits
4.	Cost of project and period of completion.	▪ ***Section 1.6***	***Section 1.6*** describes cost of the project. The tentative schedule for drilling of all 123 wells in the PKGM-1 Block is over the next 10 years. Drilling of a well together with mobilization and demobilization takes ~90 days. Drilling activities of a developmental well takes average ~45 days and of an exploratory well takes average ~55 days.
5.	Employment to be generated.	▪ ***Section 1.5***	The proposed exploration and development drilling project does not anticipate increase in the operations crew. There would however be employment opportunities during site development of two onshore well pad sites, drilling and laying of onshore pipelines. Wherever possible, engagement of local contractors and workers during the project phase will be preferred.
6.	Distance from coast line.	▪ ***Tables 1.2 & 1.3 of Section 1.2*** ▪ ***Section 2.2.3***	***Table 1.2*** covers distances of apex points of PKGM-1 Block from coastline. ***Table 1.3*** covers distances of existing offshore platforms from coastline. ***Section 2.2.3*** covers environmental setting of proposed onshore and offshore wells.
7.	Details of sensitive areas such as coral reef, marine water park, sanctuary and any other eco-sensitive area.	▪ ***Section 2.2.3*** ▪ ***Sections 3.14.3 to 3.14.9*** ▪ ***Table 3.37***	Referred sections and tables covers location of sensitive areas. ***Table 3.37*** describes Coringa Wildlife Sanctuary located 25 km from nearest E-11 proposed well and beyond 18 km north of apex point D of PKGM-1 Block.
8.	Recommendation of SCZMA / CRZ clearance as per CRZ Notification dated 6th January, 2011 (if applicable).	▪ ***Section 1.7.6*** ▪ ***Section 10.1.2*** ▪ ***Annex 23 of EIA Volume 2)***	CRZ clearance is applicable to this oil & gas development program. Accordingly, National Centre for Sustainable Coastal Management (NCSCM), Chennai (a MoEFCC authorised agency) has done CRZ Mapping of the proposed Project in the PKGM-1 block. NOC dated 3 April 2019 from APCZMA in this regard has been received.
9.	Details on support infrastructure and vessel in the study area.	***Section 3.15.6***	Physical and social infrastructure and amenities in the study area is indicated under Section 3.15.6

SN	ToR Requirement	ToR Compliance – Reference Section/Page#	Remarks
10.	Climatology and meteorology including wind speed, wave and currents, rainfall etc.	▪ ***Section 3.6*** ▪ ***Section 3.12***	***Section 3.6*** covers climatology & meteorology. ***Section 3.12*** covers oceanographic information.
11.	Details on establishment of baseline on the air quality of the areas immediately affected by the exploratory drilling and also particularly with reference to hydrogen sulphide, sulphur dioxide, NOx and background levels of hydrocarbons and VOCs.	▪ ***Section 3.7***	***Section 3.7*** covers details of ambient air quality monitored at 8 locations for background levels of $PM_{2.5}$, PM_{10}, SO_2, NOx, H_2S , CO, VOCs, Methane and Non-Methane HC, NH_3, Benzene, BAP, O_3, Pb, As and Ni.
12.	Details on estimation and computation of air emissions (such as nitrogen oxides*, sulphur oxides*, carbon monoxide*, hydrocarbons*, VOCs*, etc.) resulting from flaring, DG sets, combustion, etc. during all project phases	▪ ***Section 4.4.4*** ▪ ***Section 4.5.1***	***Sections 4.4.4 & 4.5.1*** covers predictions of air emissions from different sources during drilling and testing (e.g. DG sets, flaring, etc.) using air quality modelling software and outputs presented thereof for onshore and offshore drilling locations respectively.
13.	Base line data collection for surface water for one season leaving the monsoon season within 1 km for each exploratory wells, particularly in respect of oil content in the water sample and sediments sample.	▪ ***Section 3.10*** ▪ ***Section 3.13***	***Section 3.10*** covers onshore baseline studies on surface water quality. ***Section 3.13*** covers offshore baseline studies on marine water quality.
14.	Fisheries study w.r.t. benthos and marine organic material and coastal fisheries.	▪ ***Sections 3.13.2, 3.13.3, 3.14.6*** ▪ ***Section 3.15.5***	Referred section include details on inland and marine fishes and marine fauna. ***Section 3.15.5*** covers study of the fishermen settlements with details on captive and culture fishing practices in the study area.
15.	Source of fresh water. Detailed water balance, waste water generation and discharge.	▪ ***Section 2.9*** ▪ ***Section 2.12.1 &2.12.2*** ▪ ***Section 2.4.1.11***	***Section 2.9*** covers water consumption for drilling of offshore and onshore wells. ***Sections 2.12.1 & 2.12.2*** covers wastewater generation, treatment and disposal for onshore and offshore drilling of wells. ***Section 2.4.1.11*** covers produced water generation for different water cut with the enhancement of the production at onshore Ravva Terminal. ***Figure 2.10*** describes indicative water balance at onshore Ravva Terminal post enhacement of declined production to already approved capacity.
16.	Noise abatement measures and measures to minimize disturbance due to light and visual intrusions in case of project site closed to the coast.	▪ ***Sections 4.4.5, 4.4.12 & 4.5.2***	Section 4.4.5 covers impacts and mitigations for onshore drilling of a well. ***Section 4.4.12*** covers impacts and mitigation for light & visual quality. ***Section 4.5.2*** covers impacts and mitigations for offshore drilling of a well.
17.	Procedure for handling oily water discharges from deck washing, drainage systems, bilges etc.	▪ ***Section 4.5.5***	Mitigation measures cover the requirement and considers prior treatment in form of oily water separators and test of oil and grease content prior to disposal as per applicable Indian discharge standards and MARPOL requirements.
18.	Procedure for preventing spills and spill contingency plans.	▪ ***Section 7.3*** ▪ ***Annex 6 of EIA Volume 2***	Details on Oil spill Risk Assessment and control are included in ***Section 7.3***; relevants excerpts from Vedanta Ltd (Cairn Oil & Gas)'s Oil Spill Contingency Plan (OSCP) are presented in ***Annex 6*** of EIA Volume 2.

SN	ToR Requirement	ToR Compliance – Reference Section/Page#	Remarks
19.	Procedure for treatment and disposal of produced water.	▪ ***Figures 2.8 & 2.9 of Section 2.4.1*** ▪ ***Section 2.4.1.11***	Produced Water Injection System has been installed at the onshore Ravva Terminal for produced water treatment and its disposal through re-injection thus to maintain reservoir pressure as presented in ***Section 2.4.1.11***
20.	Procedure for sewage treatment and disposal and also for kitchen waste disposal.	▪ ***Sections 2.4.1.12, 2.12.1 & 2.12.2 & 2.12.5*** ▪ ***Sections 4.4.7 & 4.5.5***	Referred sections cover sewage treatment at onshore well pad sites, onshore sewage treatment in STP at Ravva Terminal and on-board sewage treatment for offshore rigs and also kitchen waste treatment and disposal. ***Sections 4.4.7 & 4.5.5*** cover impacts and mitigations for onshore surface water quality and offshore marine water quality drilling of a well respectively.
21.	Details on solid waste management for drill cuttings, drilling mud and oil sludge, produced sand, radioactive materials, other hazardous materials, etc. including its handling and disposal options during all project phases.	▪ ***Section 2.12.5*** ▪ ***Sections 4.4.3, 4.5.4 & 4.5.5*** ▪ ***Annex 5 of EIA Volume 2***	Covers solid and hazardous waste generation and disposal arrangements.
22.	Storage of chemicals on site.	▪ ***Section 2.7.8 5), Tables 2.13, 2.14,*** ▪ ***Section 4.4.3*** ▪ ***Annex 8 of EIA Volume 2***	Chemicals and diesel will also be stored at paved and bunded areas within the onshore well pad sites. Drilling mud and mud additives will be stored on-board the rig. ***Annex 8*** of EIA Volume 2 Covers Occupational Health Hazards and Control Measures due to storage of chemicals.
23.	Commitment for the use of water based mud (WBM) and synthetic oil based mud in special case.	▪ ***Section 4.4.3*** ▪ ***Section 4.5.4***	Vedanta Ltd (Cairn Oil & Gas) is proposing use of Water Based Mud (WBM) for upper depths of drilling while for deeper sections Synthetic Based Mud (SBM) will be used. There will be reuse of all SBM left over after drilling for next drilling and SBM will not be discharged offshore. Only residual WBM of low toxicity will be disposed offshore complying with all the required mitigation measures for disposal of drill cuttings and drilling mud as specified in ***Section 4.5.4***. ***Section 4.4.3*** describes onshore wells the project design considers construction of a HDPE lined impervious pits for storage of drill cuttings, drilling mud and drilling fluid respectively. SBM, if used will be collected for re-use in next drilling operation, while WBM will be disposed within the well pad sites in a HDPE lined pit in accordance with "CPCB Oil & Extraction Industry Standard – Guidelines for Disposal of Solid Wastes".
24.	Details of blowout preventer Installation.	▪ ***Section 2.7.8, Box 2.2, Figure 2.16***	Details on blow out preventer installation are included in ***Box 2.2*** as shown in ***Figure 2.16***.

SN	ToR Requirement	ToR Compliance – Reference Section/Page#	Remarks
25.	Risk assessment and mitigation measures including whether any independent reviews of well design, construction and proper cementing and casing practices will be followed.	▪ ***Section 7.2***	Covers Risk Assessment & Risk Mitigation Measures
26.	Handling of spent oils and oil from well test operations.	▪ ***Section 2.12.5, Tables 2.13 & 2.14*** ▪ ***Section 2.7.8 3)***	Sections cover handling of spent oil and oil from well testing procedure.
27.	H_2S emissions control plans, if required.	▪ ***Section 4.4.4***	Crude produced from Ravva is sweet and light (API 35 degree) and no H_2S is not expected to be encountered. However, in the event of any H_2S encountered during drilling, controls have been included in ***Section 4.4.4***.
28.	Details of all environment and safety related documentation within the company in the form of guidelines, manuals, monitoring programmes including Occupational Health Surveillance Programme etc.	▪ ***Annexes 6, 7 & 8 of EIA Volume 2***	***Annex 6*** covers Oil Spill Contingency Plan; ***Annex 7*** covers Emergency Response Plan; & ***Annex 8*** covers Occupational Health & Hygiene Procedures including a) Health Hazard Identification and Evaluation; and b) Health Hazard and Control Measures.
29.	Restoration plans and measures to be taken for decommissioning of the rig and restoration of onshore support facilities on land.	▪ ***Section 4.7.*** ▪ ***Section 9 Table 9.1***	At the end of the operational life of Ravva Field, Ravva JV will declare decommissioning phase and ensure proper planning to minimize and avoid adverse impacts and associated risks. A detailed decommissioning management plan will be developed prior to the culmination of the life of Ravva Field in accordance with the applicable legislations and requirements of the PSC prevailing at the time of decommissioning with necessary approvals from agencies (MoEFCC, DGH and OISD etc.) involved. Ravva JV will abide by the requirements under Clause 14.9 of the PSC.
30.	Documentary proof for membership of common disposal facilities, if required.	▪ ***Annex 13 of EIA Volume 2***	Membership Certificate of Cairn with Coastal Waste Management Project (TSDF), Vishakhapatnam is included as ***Annex 13*** of EIA Volume 2.
31.	Any litigation pending against the project or any directions / order passed by any Court of Law against the project. If so, details thereof.	-	None reported.
32.	Total capital and recurring cost for environmental pollution control measures.	▪ ***Section 9.4*** ▪ ***Tables 9.2, 9.3 & 9.5***	The capital and recurring costs are presented in Section 9.4. Table 9.3 includes an action plan with budget on issues raised during public hearing held on 11 October 2019.

CONTENTS

EXECUTIVE SUMMARY		*1*
1	*INTRODUCTION*	*1*
1.1	*BACKGROUND*	*1*
1.2	*OVERVIEW OF THE PROJECT*	*1*
1.2.1	*Block Location*	*1*
1.2.2	*Brief Status of Activities in Ravva Field*	*3*
1.3	*PROJECT PROPOSAL*	*5*
1.4	*NEED OF THE PROJECT (PROJECT JUSTIFICATION) & ITS IMPORTANCE TO THE COUNTRY*	*7*
1.5	*EMPLOYMENT GENERATION*	*7*
1.6	*PROJECT SCHEDULE & COST ESTIMATE*	*7*
1.7	*APPROACH & METHODOLOGY FOR THE EIA STUDY*	*7*
1.7.1	*Step I: Screening*	*7*
1.7.2	*Step II: Scoping Exercise involving submission of Application for Terms of Reference & Appraisal by EAC for Scoping for the EIA study*	*8*
1.7.3	*Step III: Project Description*	*8*
1.7.4	*Step IV: Environmental Baseline Data Compilation*	*8*
1.7.5	*Step V: Impact Assessment & Analysis of Alternatives*	*9*
1.7.6	*Step VI: CRZ Mapping by MoEFCC Authorised Agency*	*9*
1.7.7	*Step VII: Environmental Management and Monitoring Plan*	*10*
1.7.8	*Step VIII: Statutory Public Consultation*	*10*
1.7.9	*Step IX: Project Approvals*	*10*
1.8	*SCOPE OF THE EIA STUDY*	*10*
1.9	*LIMITATIONS*	*11*
1.10	*CONTENTS OF THE EIA REPORT*	*11*
2	*PROJECT DESCRIPTION*	*14*
2.1	*INTRODUCTION*	*14*
2.2	*BLOCK LOCATION, ACCESSIBILITY AND ENVIRONMENTAL SETTINGS*	*14*
2.2.1	*Location of Block*	*14*
2.2.2	*Accessibility*	*14*
2.2.3	*Environmental Settings*	*17*
2.3	*DESCRIPTION OF PKGM-1 BLOCK - EXISTING & PROPOSED FACILITIES*	*19*
2.3.1	*Description of Existing Facilities - Oil & Gas Production*	*19*
2.4	*EXISTING PROJECT WITH PROCESS DETAILS*	*23*
2.4.1	*Existing Setup at Onshore Ravva Terminal*	*23*
2.5	*HYDROCARBONS POOLS/PROSPECTS IN PKGM-1 BLOCK*	*37*
2.6	*PROPOSED DEVELOPMENT*	*39*
2.6.1	*Exploratory Wells*	*39*
2.6.2	*Development Wells*	*39*
2.7	*DRILLING OF ONSHORE WELLS IN PKGM-1 BLOCK*	*42*
2.7.1	*Site Selection*	*42*
2.7.2	*Land Requirement for Onshore Well Pads and Pipelines*	*42*
2.7.3	*Access Road & OHL for Power Supply to Well Pads*	*42*
2.7.4	*Method of Land Procurement/Lease*	*42*

2.7.5	Construction of Well Pads	43
2.7.6	Transportation of Rig and Associated Machineries	44
2.7.7	Rig Mobilization and Rigging up	44
2.7.8	Drilling Operation	46
2.8	DRILLING OF OFFSHORE WELLS IN PKGM-1 BLOCK	50
2.8.1	Drilling Process	50
2.8.2	Drilling Mud System	51
2.8.3	Drill Cuttings Disposal	52
2.9	WATER CONSUMPTION	53
2.9.1	Offshore Drilling Activity	53
2.9.2	Onshore Drilling Activity	53
2.10	POWER AND FUEL CONSUMPTION	53
2.10.1	Offshore Drilling Activity	53
2.10.2	Onshore Drilling Activity	53
2.11	MANPOWER	54
2.12	WASTEWATER, EMISSIONS & WASTES	54
2.12.1	Onshore Drilling of Wells related Wastewater Generation, Treatment & Disposal	54
2.12.2	Offshore Drilling of Wells Related Wastewater Generation, Treatment & Disposal	56
2.12.3	Air Emission	57
2.12.4	Noise Generation	60
2.12.5	Solid & Hazardous Waste	60
2.13	CHANGES IN PRODUCTION PROFILE AND ADEQUACY ASSESSMENT OF EXISTING INFRASTRUCTURE AT RAVVA TERMINAL	63
3	DESCRIPTION OF THE ENVIRONMENT	65
3.1	INTRODUCTION	65
3.2	STUDY AREA	65
3.3	GEOGRAPHY & GEOMORPHOLOGY	67
3.3.1	Godavari Delta	67
3.4	GEOLOGY	69
3.5	HYDROGEOLOGY	70
3.5.1	Land Subsidence	71
3.6	CLIMATE & METEOROLOGY	72
3.6.1	Regional Meteorological Conditions	73
3.6.2	Micro-meteorological Data Recorded at Surasaniyanam Village	75
3.7	AMBIENT AIR QUALITY	79
3.8	AMBIENT NOISE QUALITY	87
3.9	ROAD TRAFFIC SURVEY	89
3.10	GROUND & SURFACE WATER RESOURCE & QUALITY	90
3.10.1	Groundwater Quality	90
3.10.2	Surface Water Quality	94
3.11	SOIL QUALITY	96
3.12	OCEANOGRAPHY DETAILS	99
3.12.1	Bathymetry	99
3.12.2	Tides	99
3.12.3	Currents	100
3.12.4	Waves & Winds	101
3.13	OFFSHORE ENVIRONMENTAL BASELINE STUDIES	102

3.13.1	*Marine Water Quality*	*102*
3.13.2	*Sediment Quality*	*118*
3.13.3	*Marine Biological Parameters*	*123*
3.14	*BIOLOGICAL ENVIRONMENT*	*132*
3.14.1	*Approach and Methodology of the Ecological Assessment*	*133*
3.14.2	*Study Area*	*138*
3.14.3	*Terrestrial Floral species*	*140*
3.14.4	*Terrestrial Faunal Species*	*148*
3.14.5	*Secondary Information on Marine Flora*	*152*
3.14.6	*Secondary Informattion on Marine Fauna*	*153*
3.14.7	*Coastal Survey*	*157*
3.14.8	*Habitats*	*158*
3.14.9	*Olive Ridley Turtle Breeding , Nesting & Spawning Sites*	*162*
3.14.10	*Old Structures*	*167*
3.14.11	*Wetlands*	*167*
3.15	*SOCIOECONOMIC ENVIRONMENT*	*169*
3.15.1	*Approach and Methodology*	*169*
3.15.2	*Project Area for Socio-Economic Baseline*	*170*
3.15.3	*Demographic Profile of Study Area*	*171*
3.15.4	*Land Use Profile*	*174*
3.15.5	*Occupation and Livelihoods*	*176*
3.15.6	*Physical and Social Infrastructure and Amenities*	*186*
4	*IMPACT ASSESSMENT AND MITIGATION MEASURES*	*190*
4.1	*INTRODUCTION*	*190*
4.2	*IMPACT ASSESSMENT METHODOLOGY*	*190*
4.2.1	*Prediction of Impacts*	*191*
4.2.2	*Evaluation of Impacts*	*191*
4.2.3	*Identification of Mitigation and Enhancement Measures*	*194*
4.2.4	*Residual Impact Evaluation*	*195*
4.3	*IDENTIFICATION OF POTENTIAL IMPACTS*	*195*
4.4	*IMPACT ASSESSMENT OF ONSHORE DRILLING & ASSOCIATED ACTIVITIES*	*200*
4.4.1	*Impact on Landuse*	*200*
4.4.2	*Impact on Physiography & Drainage*	*201*
4.4.3	*Impact on Soil and Sediment Quality*	*202*
4.4.4	*Impact on Air Quality*	*205*
4.4.5	*Impact on Noise Quality*	*216*
4.4.6	*Impact on Road & Traffic*	*219*
4.4.7	*Impact on Surface Water Quality*	*221*
4.4.8	*Impact on Ground Water Resources*	*223*
4.4.9	*Impact on Ground Water Quality*	*226*
4.4.10	*Impacts on Ecology*	*228*
4.4.11	*Impact on Socio-economic Environment*	*231*
4.4.12	*Impact on Visual Quality*	*236*
4.5	*IMPACT ASSESSMENT OF OFFSHORE DRILLING & ASSOCIATED ACTIVITIES*	*237*
4.5.1	*Impact on Air Quality*	*237*
4.5.2	*Impact on Noise Quality*	*243*
4.5.3	*Ambient Noise Quality*	*246*
4.5.4	*Impact on Seabed and Sediment Quality*	*248*
4.5.5	*Impact on Marine Water Quality*	*251*

4.5.6	Impacts on Ecology	256
4.5.7	Impacts on Community Health and Safety	259
4.6	POTENTIAL IMPACTS DUE TO OPERATIONAL ACTIVITIES	261
4.6.1	Impact on Air Quality	261
4.6.2	Impact on Ground Water Resources	261
4.6.3	Impact on Ground Water Quality	261
4.6.4	Impact on Surface Water Quality & Aquatic Ecosystem	263
4.7	IMPACT ASSESSMENT OF SITE DECOMMISSIONING	267
4.7.1	Impact on Air Quality	268
4.7.2	Impact on Noise Quality	269
4.7.3	Impact on Benthos & Benthic Habitat	270
4.7.4	Impact on Marine Water Quality & Marine Ecosystem	271
4.7.5	Impacts on Soil & Sediment Quality	273
4.7.6	Socio-economic Impacts	274
4.8	CUMULATIVE IMPACTS	275
5	ANALYSIS OF ALTERNATIVES	276
5.1	BACKGROUND	276
5.2	ALTERNATIVE LOCATIONS	276
5.2.1	Locations of Proposed Offshore Exploratory/Appraisal & Development Wells	276
5.2.2	Location of Proposed Onshore Exploratory/Appraisal & Development Wells	276
5.2.3	New Pipelines	277
5.2.4	Options on Methodologies available for Pipeline Installation	277
5.2.5	Pipeline Route Alternatives	278
5.3	OPTIONS FOR USE OF DRILLING MUD	279
5.4	SAFETY CONSIDERATIONS	279
5.5	NO PROJECT SCENARIO	280
6	ENVIRONMENTAL MONITORING PROGRAM	281
7	ADDITIONAL STUDIES	289
7.1	PUBLIC CONSULTATION	289
7.1.1	Queries Raised, Views & Suggestions expressed by attendees during Public Consultation	289
7.1.2	Views & Suggestions expressed by Joint Collector & Addl. District Magistrate, East Godavari District during Public Consultation	294
7.1.3	Responses provided by the Project Proponent during Public Consultation	295
7.1.4	Summary of Key Issues raised during Pubic Consultation and Responses by Project Proponent	296
7.2	ADDITIONAL STUDIES - RISK ASSESSMENT	299
7.2.1	Risk Assessment for Onshore Activity	299
7.2.2	Risk Assessment for Offshore Activity	341
7.2.3	Emergency Response Plan for Ravva Field	366
7.3	ADDITIONAL STUDIES – OIL SPILL RISK ASSESSMENT & CONTROL	378
7.3.1	Purpose, Scope & Structure of the Plan	378
7.3.2	Alignment with Statutory Contingency Plans	379
7.3.3	Authorities, Responsibilities & Coordination	380

7.3.4	*Regional Cooperation Agreements*	*380*
7.3.5	*Agreements with External Agencies*	*381*
7.3.6	*Strategy Plan*	*381*
7.3.7	*Oil Spill Modelling*	*388*
7.3.8	*Response Strategy*	*392*
7.3.9	*Emergency Response*	*405*
7.3.10	*Emergency Management Structure of Cairn*	*405*
7.3.11	*Oil Spill Response Equipment*	*411*
7.3.12	*Support from other Operators under Mutual Cooperation agreement*	*411*
7.3.13	*Activation of OSRL Singapore*	*411*
7.4	*ADDITIONAL STUDIES: OFFSHORE DISPERSAL OF DRILL CUTTINGS & DRILLING MUD*	*412*
7.4.1	*Drill Cutting & Spent Mud Generation & Disposal*	*412*
7.4.2	*Dispersion of Drill Cuttings*	*413*
7.4.3	*Control Measures*	*416*
8	*PROJECT BENEFITS*	*418*
8.1	*FINANCIAL BENEFITS*	*418*
8.2	*SOCIAL BENEFITS*	*418*
8.3	*CSR ACTIVITIES*	*418*
8.4	*CER INITIATIVES*	*419*
9	*ENVIRONMENTAL MANAGEMENT PLAN*	*420*
9.1	*INTRODUCTION*	*420*
9.2	*ELEMENTS OF EMP*	*420*
9.2.1	*Planning*	*420*
9.2.2	*Implementation*	*427*
9.2.3	*Checking*	*427*
9.2.4	*Management Review*	*428*
9.3	*MANAGEMENT ACTIONS*	*429*
9.4	*BUDGET ALLOCATION FOR THE ENVIRONMENTAL MANAGEMENT PLAN*	*430*
10	*SUMMARY AND CONCLUSION*	*490*
10.1	*PROJECT DESCRIPTION*	*490*
10.2	*DESCRIPTION OF THE ENVIRONMENT*	*490*
10.3	*ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES*	*492*
10.4	*ENVIRONMENTAL MONITORING PROGRAMME*	*494*
10.5	*ADDITIONAL STUDIES*	*494*
10.6	*PROJECT BENEFITS*	*495*
10.7	*ENVIRONMENTAL MANAGEMENT PLAN*	*495*
10.8	*CONCLUSION*	*495*
11	*DISCLOSURE OF CONSULTANTS*	*497*
11.1	*ERM'S ACCREDITATION AS EIA CONSULTANT*	*497*
TERMS OF REFERENCE		*499*

LIST OF TABLES

Table 0.1 EIA Documents History I
Table 0.2 Requirements & Compliance of Approved Terms of Reference for the EIA III
Table 1.1 Ravva JV Parties & their Participation Interest in PKGM-1 Block 1
Table 1.2 Coordinates of Apex Points of PKGM-1 Block 2
Table 1.3 Coordinates of Existing Offshore Facilities within PKGM-1 Block 3
Table 1.4 Number of Development Wells Drilled in PKGM-1 Block (as on 31 Dec 2019) 3
Table 1.5 Chronology of Developments within Ravva Field in PKGM-1 Block 4
Table 1.6 Project Proposal 5
Table 1.7 Contents of the EIA Report 11
Table 2.1 Crude Oil Storage Tanks at the Ravva Terminal 27
Table 2.2 Indicative Produced Water & related Effluent Generation 31
Table 2.3 Wastewater Generation from Reverse Osmosis Plants 32
Table 2.4 Wastewater to ETP Inlet (for Peak Scenario Produced Water: Crude Oil Ratio of 10:1) 32
Table 2.5 Quality of Treated Effluent from ETP at Ravva Terminal 33
Table 2.6 Fire Water Storage and Pumps Capacities 36
Table 2.7 Locations of Proposed Exploratory & Developmental Wells 40
Table 2.8 Water Requirement for Drilling of an Onshore Well 53
Table 2.9 Details of Diesel Generators for Onshore Drilling Activity 54
Table 2.10 Expected Quality of Effluent from Skid Mounted Mobile ETP 56
Table 2.11 Typical Quality of Treated Sewage & Bilge Water from an Offshore Rig 56
Table 2.12 Air Emissions Sources (Point & Flare) from Ravva Terminal 58
Table 2.13 Waste Generation from Onshore Well Drilling 60
Table 2.14 Waste Generation from Offshore Well Drilling 62
Table 2.15 Adequacy Analysis of Ravva Field vis-à-vis Proposed Ravva Dev. Program 63
Table 3.1 Cyclones observed over Bay of Bengal in last 110 years (1900 to 2009) 74
Table 3.2 Summary of Meteorological Observations 79
Table 3.3 Sampling Frequency, Detection Limits & Analytical Method 79
Table 3.4 Details of Ambient Air Monitoring Stations 80
Table 3.5 Ambient Air Quality 81
Table 3.6 Description of Noise Sampling Locations 87
Table 3.7 Noise Level in the Study Area 89
Table 3.8 Observed Traffic Density 89
Table 3.9 Details of Ground and Surface Water Sampling Locations 90
Table 3.10 Ground Water Quality during the Study Period 93
Table 3.11 Surface Water Quality during the Study Period 95
Table 3.12 Soil Sampling Locations 96
Table 3.13 Soil Analysis Results 97
Table 3.14 Soil Remediation Intervention Values as per Dutch Standards 99
Table 3.15 Observed Coastal Tidal Constituents (for Kakinada Station) 100
Table 3.16 Tidal Levels & Amplitude reported in Bay of Bengal 100
Table 3.17 Current Conditions 100
Table 3.18 Marine Water & Sediment Sampling Locations 102
Table 3.19 Marine Water Quality Sampling and Analysis Procedures 103
Table 3.20 Marine Water Quality during the Study Period 106
Table 3.21 Co-ordinates of Seawater/Sediment/Biological Sample Collection Stations 113
Table 3.22 Summary of Physiochemical Properties of Marine Water 117

Table 3.23	Marine Sediment Quality Sampling and Analysis Procedures	118
Table 3.24	Marine Sediment Quality	119
Table 3.25	Summary of Sediment Quality Analyses, Andhra University, 2017	122
Table 3.26	Chlorophyll-a Diversity in Ravva Offshore Sampling Locations	124
Table 3.27	Phytoplankton Diversity at the Ravva Offshore Sampling Locations	125
Table 3.28	Zooplankton Diversity at the Ravva Offshore Sampling Locations	127
Table 3.29	Diversity of Benthic Communities in Sampling Stations	128
Table 3.30	Distribution of Quadrates Habitats wise	135
Table 3.31	Reserve Forest in Study area	143
Table 3.32	Major Mangrove species in the Godavari Region	145
Table 3.33	Species Richness and Diversity in Various Habitats	147
Table 3.34	Marine Fish Production Reported for the East Godavari District	153
Table 3.35	Marine Mammals Reported from the Region	155
Table 3.36	Forest Areas on the Coastline	159
Table 3.37	Location details of Coringa Wildlife Sanctuary	162
Table 3.38	Details of Turtle Nesting Ground in Study Area	163
Table 3.39	Stakeholder Consultations Undertaken for the EIA	170
Table 3.40	Villages within Study Area	171
Table 3.41	Demographic Profile of State, District and Mandals	171
Table 3.42	Demographic Profile of Villages in Study Area	172
Table 3.43	Key Land Use Categories in Study Area	174
Table 3.44	Land Use in Study Area (as per Satellite Imagery)	175
Table 3.45	Worker Participation Ratio in Study Area	178
Table 3.46	Area, Production and Yield per Hectare of Key Crops	179
Table 3.47	Net Area Irrigated in the year 2014-2015	179
Table 3.48	Coordinates of Habitation along the coastline and Mangrove Vegetation	180
Table 3.49	Number of Active Fishermen and Crafts in the Study Area	184
Table 3.50	Number of Registered Factories & Employment in Mandals in Study Area	185
Table 3.51	Educational Facilities in Study Area	186
Table 3.52	Rural Health Infrastructure in Study area	187
Table 3.53	Water Supply in Study Area	188
Table 3.54	Drainage Facilities in Study Area	189
Table 4.1	Impact Prediction Criteria	192
Table 4.2	Assessing Magnitude of Impact	192
Table 4.3	Sensitivity/Importance/ Vulnerability Criteria	193
Table 4.4	Impact Identification Matrix for Proposed Oil & Gas Activities	196
Table 4.5	Emissions Characteristics from Onshore Well Drilling & Flaring	207
Table 4.6	Inputs for the Air Dispersion Modelling for Onshore Sources	208
Table 4.7	Predicted 24 Hourly Incremental & Resultant GLCs at Receptors - PM_{10} (for emissions from onshore Well Pads)	209
Table 4.8	Predicted 24 Hourly Incremental & Resultant GLC at Receptors – NOx (for emissions from onshore Well Pads)	209
Table 4.9	Predicted 8 Hourly Incremental & Resultant GLC at Receptors – CO (for emissions from onshore Well Pads)	210
Table 4.10	Predicted 24 hourly Incremental & Overall GLC at Receptors - SO_2 (for emissions from onshore Well Pads)	210
Table 4.11	Noise Sources – Onshore Drilling	217
Table 4.12	Noise Levels Predicted at Receptor Locations due to Onshore Drilling from WP-7 & WP-8	218
Table 4.13	Emissions Characteristics during Offshore Well Drilling	238

Table 4.14	Inputs for the Air Dispersion Modelling for Offshore Sources	239
Table 4.15	Outputs for Air Dispersion Modelling for Offshore Sources for PM_{10}	239
Table 4.16	Outputs for Air Dispersion Modelling for Offshore Sources for NOx	240
Table 4.17	Outputs for Air Dispersion Modelling for Offshore Sources for SO_2	240
Table 4.18	Outputs for Air Dispersion Modelling for Offshore Sources for CO	240
Table 4.19	Indicative Sound level likely to be Produced during Well Drilling	244
Table 4.20	Estimated Distances to achieve Target Noise Level from Noise Sources	245
Table 4.21	Noise Generation Sources on-board Rig during Well Drilling in Offshore PKGM-1 Block	246
Table 4.22	Predicted Incremental & Resultant Noise Levels at Receptor Villages	247
Table 4.23	Potential Impacts of Underwater Noise on Marine Fauna	257
Table 4.24	Resultant Values for Effluent Discharge from Marine Outfall	265
Table 6.1	Proposed Monitoring Program	282
Table 7.1	Frequency Categories and Criteria	303
Table 7.2	Severity Categories and Criteria	304
Table 7.3	Risk Matrix	305
Table 7.4	Risk Criteria and Action Requirements	305
Table 7.5	Blow Out Cause Distribution for Failures during Drilling Operations	306
Table 7.6	Blow Out Frequencies Recommended per Drilled Well	307
Table 7.7	Pool Fire Modelling Scenario	310
Table 7.8	Pool Fire Diameter & Steady State Burning Scenario	310
Table 7.9	Thermal Radiation Intensity Threshold Values Impact Criterion	310
Table 7.10	Distance to Thermal Radiation Threshold Levels	311
Table 7.11	Natural Gas Release Modelling Scenario	312
Table 7.12	Zone of Flammable Vapour Cloud-Natural Gas Release Scenarion	315
Table 7.13	Thermal Radiation Zone for Natural Gas Release Scenario during Well Testing	319
Table 7.14	Primary Gas Pipeline Failure Frequency	321
Table 7.15	Primary Failure Frequency based on Diameter Class (1970-2013)	322
Table 7.16	Interconnecting Gas Pipeline - Failure Frequency	322
Table 7.17	Interconnecting Pipeline – Ignition & Jet Fire Probability	323
Table 7.18	Interconnecting Pipeline Risk Modelling Scenarios	324
Table 7.19	Road Tanker Loading Facility Details	331
Table 7.20	Road Tanker Failure - Potential Hazards	332
Table 7.21	Failure Frequencies for Road Tanker Loading Hoses	332
Table 7.22	Frequencies for Road Tanker Incidents	332
Table 7.23	Road Tanker Failure Scenarios	332
Table 7.24	Individual Risk – Blow Out & Loss of Containment	340
Table 7.25	Factors of Safety Considered for the Structure Design Criteria	350
Table 7.26	Fluid properties for different streams	350
Table 7.27	Isolatable Sections & Inventories	351
Table 7.28	Meteorological data	352
Table 7.29	Manning Distribution & Helicopter Operation at the Platform	352
Table 7.30	Process Release Frequencies- Extract from HCR Database	353
Table 7.31	Riser & Pipeline Frequencies	354
Table 7.32	Hole Size distribution for Risers & Pipelines	354
Table 7.33	Release Location Distribution for Risers	354
Table 7.34	Riser Failure Frequency	355
Table 7.35	Jet Fire Radiation Results (in meters) for all weather conditions	357
Table 7.36	Pool Fire Radiation Results (in meters) for 1F weather condition	359

Table 7.37	Flash Fire distances (in meters) for all weather conditions	360
Table 7.38	Fatality Rates	362
Table 7.39	Explosion Overpressure for structural failure	362
Table 7.40	Overall PLL for the Platform	362
Table 7.41	Platform Hydrocarbon Risk Breakdown by Fatalities Phases	363
Table 7.42	Individual Risk Per Annum for different hazard categories on the Platform	364
Table 7.43	Emergency Calssification	368
Table 7.44	Communication Protocol during Emergencies	369
Table 7.45	Emergency Events & Procedures	373
Table 7.46	Numerical Factors for Likelihood of Exposure/Impact	383
Table 7.47	Consequence of Exposure/Impact	383
Table 7.48	List of identified maximum oil spill risks in the Ravva operations	385
Table 7.49	Characteristics of Ravva Crude and Natural Gas	386
Table 7.50	Effects of oil on Marine Populations and Communities	388
Table 7.51	Atmospheric Temperature Details - 2016	391
Table 7.52	Scenarios Considered for Oil Spill Modelling	391
Table 7.53	Tiered Oil Spill – Resource Details	393
Table 7.54	Oil Spill Strategies in Open Sea	399
Table 7.55	Response Strategies for Shore Line Clean Up	403
Table 7.56	Bottom Orbital Velocity (Urms m/sec) Calculator	415
Table 7.57	Composition Analysis of Drilling Mud & Drill Cuttings	415
Table 7.58	Bio Assay of Drill Cuttings and Drilling Mud Samples	416
Table 9.1	Environmental Management Plan: Onshore & Offshore Drilling Activity	431
Table 9.2	Budget for Environmental Actions	458
Table 9.3	Action Plan on Issues Raised during Public Hearing held on 11 Oct 2018	462
Table 9.4	Action Plan on Conditions Imposed by APCZMA in NOC dated 3 April 2019	487
Table 9.5	Action Items on Corporate Environment Responsibility (CER) Fund of INR 20 Crores to be spent over next 10 years	489
Table 10.1	Summary of Baseline Environment in the Study Area	490
Table 10.2	Summary of Anticipated Environmental Impacts and Mitigation Measures	492

LIST OF FIGURES

Figure 1.1	Locations of PKGM-1 Block & Onshore Terminal	2
Figure 1.2	PKGM-1 Block & Drilling Locations of Proposed Wells	6
Figure 2.1	PKGM-1 Block with Revised Proposed Drilling Locations on SOI Toposheet	15
Figure 2.2	PKGM-1 Block with Proposed Drilling Locations on Satellite Imagery	16
Figure 2.3	Accessibility Map of the PKGM-1 Block	18
Figure 2.4	Environmental Setting Map of the PKGM-1 Block	20
Figure 2.5	Layout of Existing Offshore & Onshore Facilities in PKGM-1 Block	21
Figure 2.6	Schematic of Existing Platforms and Pipelines in Ravva Field	22
Figure 2.7	Layout Plan of the Ravva Terminal	25
Figure 2.8	Schematic of Hydrocarbon Stabilization & Produced Water Injection System	26
Figure 2.9	Existing PWRI System at Ravva Terminal	30
Figure 2.10	Indicative Water Balance at Ravva Terminal (for the Expansion Project)	33
Figure 2.11	Layout Plan of Effluent Treatment Plant at Ravva Terminal	34
Figure 2.12	Schematic Flow Diagram of Operating STP at Ravva Terminal	36
Figure 2.13	Hydrocarbon Resource Pools Available in Ravva Field	38

Figure 2.14	Hydrocarbon Resource Pools Expected in the PKGM-1 Block	38
Figure 2.15	Layout of Typical Onshore Well Pad Site of Vedanta Ltd (Cairn Oil & Gas)	45
Figure 2.16	A Typical View of Blow Out Preventer	48
Figure 2.17	A Typical View of Jack-up Rig	50
Figure 2.18	A Typical View of Drill Cutting Separation & Treatment System	52
Figure 2.19	A Typical skid mounted Mobile Effluent Treatment Plant	55
Figure 2.20	Waste Disposal Plan – Offshore –weight	62
Figure 3.1	Study Area Map	66
Figure 3.2	Drainage Patter in the Study Area	68
Figure 3.3	Ground Water Level Countours (m bgl) in Study Area	71
Figure 3.4	Wind and Cyclone Hazard Map	74
Figure 3.5	Tracks of Storms/Depressions in Bay of Bengal – 2014, 2015 and 2016	75
Figure 3.6	Wind rose of Jan-Mar 2018	75
Figure 3.7	Ambient Air Quality & Micro Meteorological Monitoring Stations	76
Figure 3.8	Wind roses for January – December 2016	77
Figure 3.9	Photographs of Ambient Air Quality Monitoring	80
Figure 3.10	$PM_{2.5}$ Concentrations in Study Area	83
Figure 3.11	PM_{10} Concentrations in Study Area	84
Figure 3.12	SO_2 Concentrations in Study Area	84
Figure 3.13	Oxides of Nitrogen Concentrations in Study Area	85
Figure 3.14	Carbon Monoxide Concentrations in the Study Area	85
Figure 3.15	Ozone Concentrations in Study Area	86
Figure 3.16	Ambient Noise Monitoring and Traffic Survey Locations	88
Figure 3.17	Photographs of Surface and Ground Water Quality Monitoring	90
Figure 3.18	Water and Soil Sampling Locations	92
Figure 3.19	Photographs of Soil Sampling	97
Figure 3.20	Monthly Current Roses (Currents Flowing Towards) (PKGM-1 Block)	101
Figure 3.21	Marine Water and Sediment Sampling Locations	104
Figure 3.22	Photographs of Marine Water Sampling	105
Figure 3.23	Temperature of the Surface Water Samples	107
Figure 3.24	Distribution of Salinity in the Marine Water Samples	107
Figure 3.25	Distribution of Suspended Particulate Matter in the Marine Water Samples	108
Figure 3.26	Distribution of pH in the Marine Water Samples	108
Figure 3.27	Distribution of Conductivity in the Marine Water Samples	109
Figure 3.28	Distribution of Dissolved Oxygen in the Marine Water Samples	109
Figure 3.29	Distribution of Total Nitrogen in the Marine Water Samples	110
Figure 3.30	Distribution of Total Phosphorous in the Marine Water Samples	110
Figure 3.31	Distribution of Silicate in the Marine Water Samples	111
Figure 3.32	Monitoring Locations around Offshore Installations in PKGM-1 Block	112
Figure 3.33	Distribution of Transparency & Salinity at Selected Stations	114
Figure 3.34	Distribution of pH, SS & DO at Selected Stations	115
Figure 3.35	Distribution of Nitrate at the Selected Stations	115
Figure 3.35	Distribution of Total Nitrogen & Ammonia at Selected Stations	116
Figure 3.37	Distribution of Phosphate, Total Phosphorous & Silicates at Selected Stations	116
Figure 3.38	Photographs of Marine Sediment Sampling	119
Figure 3.39	Sediment Texture at the Monitored Stations	120
Figure 3.40	Organic Matter Concentration at the Monitored Stations	120
Figure 3.41	TPH Concentration at the Monitored Stations	121
Figure 3.42	Sediment Texture	123

Figure 3.43 Distribution of Chlorophyll-a & Phytoplanktons Composition at the monitoring stations 124
Figure 3.44 Distribution of Chlorophyll-a & Phytoplanktons Composition at the monitoring stations 125
Figure 3.45 Phytoplankton Diversity Index (H') and Species Richness 126
Figure 3.46 Distribution of Zooplankton Biomass and Abundance 127
Figure 3.47 Zooplankton Diversity Index (H') and Richness 127
Figure 3.48 Distribution of Benthos Biomass and Abundance 129
Figure 3.49 Benthic Community Diversity Index (H') 130
Figure 3.50 Ecological Survey in the PKGM-1 Block 137
Figure 3.51 Map of the Study Area with Ecological Sampling Locations 139
Figure 3.52 Beach Vegetation 140
Figure 3.53 Shelter Belt Vegetation 141
Figure 3.54 Back water Vegetation 142
Figure 3.55 Mangrove Habitats 144
Figure 3.56 Vegetation at Aqua culture ponds 146
Figure 3.57 Vegetation at Agriculture Fields 147
Figure 3.58 Ichthyofauna species in the Study Area 148
Figure 3.59 Herpetofauna species recorded in the study area 149
Figure 3.60 Avifaunal Species in the Study Area 150
Figure 3.61 Distribution Map of Cetaceans in Indian EEZ 156
Figure 3.62 Coral Reefs along Bay of Bengal 157
Figure 3.63 Coastline Map in Study Area 158
Figure 3.64 Plantation along the Coastline 159
Figure 3.65 Mangrove Vegetation in Study Area 160
Figure 3.66 Fauna Recorded in the Mangrove of Study Area 161
Figure 3.67 Turtle Nesting Site within Study Area 164
Figure 3.68 Olive Ridley Turtle Egg Conservation Sites 164
Figure 3.69 Recorded Olive Ridley Carcass 165
Figure 3.70 Olive Ridley Turtle Movement Map based on Satellite tracking study 166
Figure 3.71 Wetland Map of East Godavari District 168
Figure 3.72 Consultation with the Community in Project study area 170
Figure 3.73 Landuse and Land cover Map 177
Figure 3.74 Division of Work Force in Study Area 178
Figure 3.75 Maps Showcasing Villages Engaged in Captive and Culture Fishing 182
Figure 3.76 Fish & Prawn Culture and Agriculture Activities within nearby study area 183
Figure 3.77 Capture Fishing in Study Area 184
Figure 4.1 Impact Assessment Process 191
Figure 4.2 Assessing Significance of Impact due to Proposed Project Related Activities 194
Figure 4.3 Incremental GLCs of PM_{10} Isopleths - Scenarios 1 to 3 for WP-7 & WP-8 211
Figure 4.3 Incremental GLCs of NOx Isopleths - Scenarios 1 to 3 for WP-7 & WP-8 212
Figure 4.3 Incremental GLCs of SO_2 Isopleths - Scenarios 1 to 3 for WP-7 & WP-8 213
Figure 4.3 Incremental GLCs of CO Isopleths - Scenarios 1 to 3 for WP-7 & WP-8 214
Figure 4.7 Incremental Noise Levels during Onshore Drilling 218
Figure 4.8 Current Status of Proposed Onshore Wellpads Location 229
Figure 4.9 Incremental GLCs of PM_{10} Isopleths: Scenarios 4 to 5 for Offshore Drilling & Well Testing 241
Figure 4.10 Incremental GLCs of NOx Isopleths: Scenarios 4 to 5 for Offshore Drilling & Well Testing 241

Figure 4.11	Incremental GLCs of SO_2 Isopleths: Scenarios 4 to 5 for Offshore Drilling & Well Testing	242
Figure 4.12	Incremental GLCs of CO Isopleths: Scenarios 4 to 5 for Offshore Drilling & Well Testing	242
Figure 4.13	Isopleths of Incremental Noise Levels during Offshore Drilling	247
Figure 7.1	Risk Assessment Methodology	301
Figure 7.2	Ignition Probability Vs Release Rate	308
Figure 7.3	Scenario I: Risk Contour Map	313
Figure 7.4	Scenario II: Risk Contour Map	314
Figure 7.5	Scenario III: Risk Contour Map	315
Figure 7.6	Scenario III (Worst Case) – Overpressure Risk Modeling	316
Figure 7.7	Overpressure Risk Modeling – Well Releases during drilling	317
Figure 7.8	Thermal Radiation Distances of Jet Flame due to Leak of 25 mm size	318
Figure 7.9	Thermal Radiation Distances of Jet Flame due to Leak of 50 mm size	319
Figure 7.10	Gas Pipeline Failure – Distribution of Incident & Causes	321
Figure 7.11	Natural Gas Release – Potential Consequences	324
Figure 7.12	Threat Zone Plot – Gas Pipeline Leak (25mm dia)	325
Figure 7.13	Threat Zone Plot – Gas Pipeline Leak (50mm dia)	326
Figure 7.14	Threat Zone Plot – Gas pipeline rupture	327
Figure 7.15	Threat Zone Plot –Oil Pipeline Leak (25mm dia)	328
Figure 7.16	Threat Zone Plot – Oil Pipeline Leak (50mm dia)	329
Figure 7.17	Threat Zone Plot –Oil Pipeline Rupture	330
Figure 7.18	Threat Zone Plot – Road Tanker Loading Hose Leak (20mm dia)	334
Figure 7.19	Threat Zone Plot – Road Tanker Loading Hose Rupture	335
Figure 7.20	Threat Zone Plot – Road Tanker Leak (50mm dia)	336
Figure 7.21	Threat Zone Plot – Road Tanker Leak (100mm dia)	337
Figure 7.22	Threat Zone Plot – Road Tanker Catastrophic Failure	338
Figure 7.23	Tolerance Criteria for Individual Risks	340
Figure 7.24	Intensity Radii of Jet Fire Scenarios	358
Figure 7.25	Intensity Radii of Pool Fire Scenarios	359
Figure 7.26	Intensity Radii of Flash Fire Envelop Scenarios	361
Figure 7.27	PLL Breakdown by Different Hazard Categories	363
Figure 7.28	PLL Breakdown by Fatalities Phases due to Hydrocarbon Events	364
Figure 7.29	Individual Risk Per Annum for different hazard categories on the Platform	365
Figure 7.30	Emergency Classification Chart	368
Figure 7.31	Emergency Management Team – Vedanta Ltd (Cairn Oil & Gas) Corporate	370
Figure 7.32	Emergency Management Team – Flow Chart	370
Figure 7.33	Crisis Management Team – Flow Chart	370
Figure 7.34	Emergency Management Organisation Relationship	371
Figure 7.35	Emergency Management Organisation – Structure and Linkages	372
Figure 7.36	Oil Spill Risk Assessment Methodology	382
Figure 7.37	Oil Spill Risk Assessment Matrix	384
Figure 7.38	Computational study domain showing existing Ravva Facilities	390
Figure 7.39	Spill Response Decision Matrix	395
Figure 7.40	General Strategy of Deployment of Resources for Various Spill Types	396
Figure 7.41	Emergency Levels for Various Categories of Incident	406
Figure 7.42	Emergency Response Structure for Ravva Operations	406
Figure 7.43	Emergency Response Mechanism – Roles & Responsibilities	410
Figure 9.1	Vedanta Ltd (Cairn Oil & Gas)'s HSE and Corporate Sustainability Policies	421
Figure 9.2	Vedanta Ltd (Cairn Oil & Gas)'s Aviation & Marine Operations Policies	422

Figure 9.3 Vedanta Ltd (Cairn Oil & Gas)'s Biodiversity and Water Management Policies 423
Figure 9.4 Vedanta Ltd (Cairn Oil & Gas)'s Social Policy 424
Figure 9.5 Vedanta Ltd (Cairn Oil & Gas)'s HSE Organization Chart for Well Drilling 425
Figure 9.6 Vedanta Ltd (Cairn Oil&Gas)'s HSE Organization Chart for Ravva Operations 425
Figure 12.1 ERM's Accreditation from NABET 498

LIST OF BOXES

Box 2.1 SOP for Direct Purchase and / or Lease of Land 43
Box 2.2 Blowout Preventer Installation 47
Box 3.1 Fisheries in East Godavari District 180
Box 3.2 List of Colleges and Technical Institutions at Amalapuram 187
Box 4.1 Nature & Types of Impacts Considered for Impact Assessment 191
Box 4.2 Context of Impact Significance 194
Box 7.1 Primary Causes of Blow Outs 306

Abbreviations Used

AGC	Associated Gas Compressor
AMSL	Above Mean Sea Level
APCZMA	Andhra Pradesh Coastal Zone Management Authority
API	American Petroleum Institute
APPCB	Andhra Pradesh Pollution Control Board
APWALTA	Andhra Pradesh State Water, Land and Tree Authority
BOD	Biochemical Oxygen Demand
BOP	Blowout Preventer
BOPD	Barrels of oil per day (1 barrel = 0.159 m^3)
CER	Corporate Environment Responsibility
CGWB	Central Ground Water Board
CO	Carbon mono-oxide
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CRZ	Coastal Regulation Zone
CSR	Corporate Social Responsibility
CSU	Crude Oil Stabilization Units
dB(A)	A-weighted decibels
DG	Diesel Generator
DO	Dissolved Oxygen
EAC	Expert Appraisal Committee
EC	Environmental Clearance
EIA	Environmental Impact Assessment
EMP	Environment Management Plan
EMS	Environment Management System
ERM	Environmental Resources Management
ERT	Electrical Resistivity Tomography
ETP	Effluent Treatment Plant
FWKOD	Free Water Knock Out Drum
GAIL	Gas Authority of India Limited
GLBC	Gas lift booster compressor
HC	Hydro-carbon
HDPE	High-density polyethylene
HP	High Pressure
HSE	Health Safety and Environment
IGF	Induced Gas Floatation
IMD	India Meteorological Department
IUCN	International Union for Conservation of Nature
JV	Joint Venture
KG	Krishna - Godavari
KLD	Kilo Liter per Day
KVA	Kilo-volt-ampere
KW	Kilo watt

LLM	Lower Late Miocene
LQ	Living Quarters
MARPOL	Marine Pollution
MEG	Mono Ethylene Glycol
MM	Middle Miocene
MMSCFD	Million Standard Cubic Feet per Day
MMSCMD	Million Standard Cubic Meter per Day
MoEFCC	Ministry of Environment, Forest and Climate Change
MoPNG	Ministry of Petroleum and Natural Gas
MP	Medium Pressure
MSDS	Material Safety Data Sheet
MSL	Mean Sea Level
NAAQS	National Ambient Air Quality Standards
NABET	National Accreditation Board for Education and Training
NABL	National Accreditation Board for Testing and Calibration Laboratories
NCSCM	National Centre for Sustainable Coastal Management
NGO	Non Governmental Organisation
NGRI	National Geophysical Research Institute
NH	National Highway
NOx	Oxides of Nitrogen
OISD	Oil Industry Safety Directorate
OIW	Oil in water
ONGC	Oil & Natural Gas Corporation Limited
OSCRP	Oil Spill Contingency Response Plan
OSRL	Oil Spill Response Ltd
PCU	Passenger Car Unit
PCV	Pressure Control Valve
PM	Particulate Matter
PPE	Personnel Protective Equipment
PSC	Production Sharing Contract
PUC	Pollution Under Control
PWRI	Produced Water Re-injection System
QCI	Quality Council of India
RCC	Reinforced Cement Concrete
RF	Reserved Forest
ROS	Ravva Oil Singapore Pty. Ltd.
ROU	Right of Use
RSGDP	Ravva Satellite Gas Development Well and Platform
SBM	Synthetic Based Mud
SCADA	Supervisory Control and Data Acquisition
SO_2	Sulphur Dioxide
SOI	Survey of India
SOP	Standard Operating Procedure
SPM	Single Point Mooring
STP	Sewage Treatment Plant
TDS	Total Dissolved Solids
TEG	Tri-ethylene Glycol
ToR	Terms of Reference
TSGR	Third Stage Gas Recovery
TSS	Total Suspended Solids
VOC	Volatile Organic Carbons
WBM	Water Based Mud
ZLD	Zero Liquid Discharge

EXECUTIVE SUMMARY

1.0 INTRODUCTION

1. Vedanta Limited (Cairn Oil & Gas) (hereinafter also referred to as Cairn Oil & Gas or Cairn) is one of the largest independent oil and gas exploration and production companies in India. On behalf of Ravva Joint Venture, Vedanta Limited (Cairn Oil & Gas) (erstwhile Cairn India Limited or Cairn Energy India Pty Limited) has been carrying out oil and gas operations in PKGM-1 Block (also referred to as Ravva Field or Ravva Block) since 1997. The PKGM-1 Block is located in Krishna-Godavari Basin near Surasaniyanam Village, Uppalaguptam Mandal, East Godavari District, Andhra Pradesh.

2. Vedanta Ltd (Cairn Oil & Gas) is the Operator of Ravva Joint Venture comprising of Oil & Natural Gas Corporation Limited (ONGC), Vedanta Ltd (Cairn Oil and Gas), Videocon Industries Ltd. and Ravva Oil Singapore Pty. Ltd. under the Production Sharing Contract (PSC) signed for PKGM-1 Block with the Ministry of Petroleum and Natural Gas (MoPNG) through Directorate General of Hydrocarbons (DGH), Government of India. The PKGM-1 Block has an area of 331.26 sq.km (km^2).

3. Initially, ONGC discovered the oil & gas in the field in 1988. On October 28, 1994 when a PSC was signed by Ravva Joint Venture, the offshore facilities included four wells, two platforms and two pipelines for production of 3,000 barrels of oil per day (BOPD) with an onshore processing capacity of 8,600 BOPD. The Ravva JV commenced operations in 1995 and over the years increased production capacity and upgraded facilities. The operatorship of the field was transferred in 1995 to Command Petroleum (India) Pty Ltd which subsequently in 1997 was transferred to the erstwhile company of Vedanta Ltd i.e. Cairn Energy India Pty Limited (CEIL).

2.0 EXISTING OPERATIONS IN THE BLOCK

4. Within PKGM-1 Block, there exists eight (8) oil and gas unmanned platforms (six for crude oil and two for natural gas production), connecting pipelines, and Ravva Terminal near Surasaniyanam Village ~1 km from shore (with oil, gas and water separation and water injection facilities). Well fluid from offshore wells is routed through existing subsea pipelines to onshore Ravva terminal for oil, gas and water separation. The separated crude is transferred through offshore pipelines to Single Point Mooring (SPM) from where it is transported through Shuttle Tankers. The separated natural gas is compressed and treated before it flows to the Gas Authority of India Limited (GAIL). The produced water generated is treated and recycled for re-injection into hydrocarbon reservoirs after comingling with the saline ground water.

5. The existing operations of Ravva Field in PKGM-1 Block are governed by following Environmental and CRZ Clearances obtained from Ministry of Environment, Forest and Climate Change (MoEFCC):

   i. EC no. J-11011/11/90-IA dated 30 July 1990 (Phase -I)
   ii. EC no. J-11011/6/91-IA (Phase -I) dated 19 December 1991
   iii. EC no. J-11012/59/95-1A-II (I), dated 03 July 1996 (Phase II)
   iv. EC no. J-11011/84/2000-IA – II dated 30 January 2001 (for Ravva Satellite Gas Development)
   v. EC no. J-11011/50/2001-IA II dated 11 Sep 2001 (for exploratory drilling of 8 wells)
   vi. EC no. J - 11011/207/2004-IA(II)I dated 4 August 2005 (for drilling of 15 infill wells);
   vii. EC & CRZ no. 10-28/2004-IA-IIIdated 31 March 2006 for exploratory drilling of two onshore wells;
   viii. EC No. J-11011/81/2013-IA-II dated 23 Feb 2015 & CRZ Clearance No. 11-20/2015-IA III dated 25 May 2017 (for setting up of new offshore RI Platform, drilling of 20 development & 6 exploratory offshore wells & laying of connecting pipelines).

3.0 PROJECT PROPOSAL

6. Over the years due to ageing of the reservoir, production of oil and gas has declined. In order to maintain hydrocarbon production at already approved production capacities, Vedanta Limited (Cairn Oil & Gas) is proposing drilling of exploratory, developmental and production wells in the PKGM-1 Block.

7. The project was appraised by the Expert Appraisal Committee (EAC - Industry-2) of MoEFCC during its 15th meeting held from 30th Dec 2019 to 1st Jan 2020 of the agenda item no. 15.5.12 and 11th meeting held from August 28 to 29, 2019 of the agenda item no. 11.5.3 for Environmental & CRZ Clearance of the Project. During the meetings, additional information was sought and Vedanta Ltd (Cairn Oil & Gas) agreed to drop five well pads that were proposed to be located outside the block. Hence, this EIA is revised to cover following revised project proposal:

   i. Drilling of a total of 123 exploratory and development wells covering 83 nos. exploratory wells and 40 nos. development (production) wells. Of the 83 exploratory wells, 59 are proposed to be drilled from standalone offshore locations, 14 nos. from existing offshore platforms and 10 nos. from two onshore well pads to assess presence of hydrocarbons in prospects identified. Of the 40 development (production) wells, 17 will be drilled from the existing offshore platforms and 23 nos. from onshore well pads][2]
   ii. Establishing of two onshore well pads numbered as WP-7 (RX-8 or WP-A) and WP-8 (RX-9 or WP-B)[1]; and
   iii. Laying of ~8 km of pipeline corridor (for three pipelines) connecting onshore well pads with the existing onshore oil & gas processing Ravva Terminal[3].

Note:

1) Earlier proposal comprised of establishment of eight well pads including five well pads (wellpads # 1 to 5) located outside the PKGM-1 Block (to tap hydrocarbons resource from within the block through inclined drilling). As the process of obtaining approval of DGH for development of well pads outside the PKGM-1 Block is taking time, therefore, Vedanta Limited (Cairn Oil & Gas) on behalf of the Ravva JV has decided to drop development of five onshore well pads (Well Pads # 1 to 5) that were earlier proposed to be located outside the

PKGM-1 Block. No drilling of wells will be carried outside the PKGM-1 Block area. The development of five well pads that were located outside in the ONGC Block area proposed as part of the EIA study will not carried out further. Wellpad #6 will not be developed to minimise environmental impacts.

2) There is no change in the proposal related to drilling of number of wells.In all 123 wells are proposed to be drilled comprising of a) onshore wells 33 nos. (10 exploratory + 23 developmental) to be drilled from two onshore well pads numbered as WP-7 (RX-8 or WP-A) and WP-8 (RX-9 or WP-B). These two well pads located within the PKGM-1 Block were developed in the year 2006-2007; and b) offshore wells 90 nos. (73 exploratory + 17 developmental wells) from within the offshore component of the block.
3) Earlier proposal comprised of laying of 15 km long onshore pipelines corridor which has been reduced to 8 km after withdrawal of development of onshore well pads WP 1 to WP-5 that were proposed to be located outside the PKGM-1 Block.

8. There will be no major modifications/ alterations at the onshore Ravva Terminal as the processing facilities and utilities have adequate capacity to handle the already approved production capacity of 50,000 BOPD of crude and 2.32 MMSCMD (million standard cubic meter per day) of natural gas. The present production is approximately 15,000 BOPD of crude and 1.40 MMSCMD of natural gas.

4.0 REQUIREMENT OF ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDY

9. The activities proposed (as per paragraph 7 above) requires prior Environmental Clearance from Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India under the EIA Notification 2006 and CRZ Clearance under the CRZ Notification, 2011 as the above proposed activities fall in coastal regulation zone. The above approvals are to be appraised based on this EIA study conducted as per the terms of reference issued by MoEFCC on 24 March 2018. The Project is also considered for CRZ mapping of the activities proposed in the block by engaging National Centre for Sustainable Coastal Management (NCSCM), Chennai (a MoEFCC authorized agency). The CRZ maps prepared for the proposed oil and gas exploration, development and production are annexed in a standalone report prepared by NCSCM, Chennai (MoEFCC authorized agency) [included with CRZ NOC by APCZMA in Annex 23 of EIA Volume 2].

10. Based on the draft EIA study, public consultation was duly conducted by Andhra Pradesh Pollution Control Board (APPCB) on 11 October 2018. The environmental concerns expressed during the consultation have been duly incorporated in this final EIA Report. This EIA Report, together with CRZ Maps, approval by APCZMA and other submittals/commitments by Vedanta Limited (Cairn Oil & Gas) will become the basis for the Project appraisal by MoEFCC.

5.0 PROJECT DESCRIPTION

5.1 Existing Activities in the Ravva Block

11. Within PKGM-1 Block, 55 exploratory/appraisal/infill and production wells have been drilled to date. Of the 55 wells, currently there are 21 producing wells and eight injector wellseight. There are eight (8) unmanned fixed well-head offshore platforms. Of the eight platforms, six platforms (RA, RB, RC, RD, RE & RF) are meant for crude oil production while remaining two (RG & RH) for gas production. RA and RC Platforms have an interconnecting bridge. No oil and gas separation processing facility exists at the offshore platforms except water separation units at platform RC. Well fluid from the platforms is transferred through subsea pipelines to onshore Ravva Terminal at Surasaniyanam for oil, gas and water separation process and water injection facilities. A Single Point Mooring (SPM) facility exists offshore, which is connected to the onshore Ravva Terminal through sub-sea pipeline, from where crude is transported to Shuttle Tankers.

12. The treated effluent (treated produced water) and lift gas from onshore Ravva Terminal is transferred to platforms through subsea pipelines. In addition, there are subsea pipelines between the platforms for distributing water for injection and lift gas. The associated systems available at the platforms include: a) wellheads; b) production/test manifold with knockout provision; c) flow pipelines (with pig launchers/receivers); d) test separator / flow meters; e) water injection system; f) gas lift system; g) instrumentation control panel & telemetry PLC system; and h) utility system comprising of electrical system, instrumentation gas system, chemical injection system, drain system, vent system and fresh water storage and distribution system.

5.2 The Onshore Ravva Processing Terminal

13. Wells' fluid (containing mixture of oil, water and gas) from offshore platforms is conveyed to onshore Ravva Terminal located at Sursaniyanam through four pipelines which join a common header leading to three crude stabilization trains containing Free Water Knock Out Drum (FWKOD), Flow Splitter and Crude Oil Stabilization Units (CSU). The separated oil and gas are further treated for phase separation while separated produced water is treated in Produced Water Re-injection System (PWRI).

14. The separated produced water is treated to separate oil from water degassing in the degasser vessel and oil-water separation in surge tank. Separated produced water is treated in Induced Gas Floatation (IGF) unit of PWRI System. Produced water up to 90,000 barrels per day (14,310 m^3/day) is comingled with ~9,170 m^3/day of saline groundwater withdrawn from deep aquifers of existing deep bore wells at the Ravva Terminal. Comingled produced water is filtered to remove oil and suspended solids and chemically treated to prevent from scaling, corrosion and to avoid sulphur reducing bacterial (SRB) growth before it is sent to all platforms for re-injection into confined hydrocarbon reservoirs.

15. Oil skimmed from the IGF's discharge is pumped into an oil recovery sump from where it is pumped to the Crude Oil Wash Tank. The produced water from the process units that is not routed through PWRI system is routed to the API

separator, where oil in water and inert sediments are separated. Treated produced water from the API separator is pumped to the Effluent Treatment Plant (ETP) for further treatment.

16. The crude oil is sent for storage in one of the floating roof storage tanks T-401, T-402, T-403 each of 45,243 m^3 capacity and T-405 of 45,932 m^3 capacity. One storage tank T-404 of 2,940 m^3 capacity has been provided to receive crude from nearby ONGC facility for storage and final evacuation. The crude from storage tanks is pumped through two parallel 20 inches subsea pipelines to the SPM, for transportation through shuttle tankers to nearby refineries within the country.

17. Separated natural gas is compressed in associated gas compressors and Third Stage Gas Recovery (TSGR) compressors. The compressed gas is further treated with glycol and cooled to 0 ^oC. Treated gas from the gas/gas exchanger flows into pipeline network of GAIL. Glycol is recycled.

5.3 Existing Utilities at the Onshore Ravva Terminal

18. The existing utilities available at the onshore Ravva Terminal include the following:

- An ETP of 3,000 m^3/day capacity consisting of primary, secondary and tertiary treatment system. The treated wastewater is discharged into the sea through a submerged sub-sea pipeline leading to a pipe diffuser system at marine outfall located at 540 m from the shore at approximately 5 m water depth;
- High Pressure (HP) and Low Pressure (LP) Flares have been operating to relieve any pressure of vessel and piping works during abnormal conditions. Ravva Terminal is equipped for minimum flaring under normal conditions. A closed loop hot oil heater has been provided to heat various exchangers;
- Captive power of 10 MW capacity is operating through four gas turbine driven generators (2.5 MW each). An emergency power diesel generator of 1,000 KVA (800 kW) is also available to cater to emergency power needs.
- There are nine firewater pumps along with firewater storage capacity of 15,765 m^3. Firewater is sourced from from rain water harvesting ponds and RO plant;
- Saline groundwater of ~ 9,570 m^3/day is withdrawn from deep tube wells. Of this, 9170 m^3/day is comingled with produced water for reinjection in hydrocarbon reservoir and 400 m^3/day is treated in reverse osmosis units for domestic and fire water make up needs; the present approved capacity is 10,413 m^3/day while additional requirement of ~7,872 m^3/day is anticipated for which permission will be obtained from Government of Andhra Pradesh Commissioner, Rural Developmnet & Administrator, APWALTA.
- Living quarters (LQ) exist accomodating 90 rooms with single and double occupancy near onshore Ravva Terminal.
- Sewage from Living quarters and Ravva Terminal is treated in the Sewage Treatment plant (STP) of 175 m^3/day capacity and treated sewage is used in watering the plantation and green belt within the Ravva Terminal;
- A helipad has been provided at the Living Quarters with approval of Directorate General of Civil Aviation for taking up sorties to unmanned platforms within the Ravva Field;
- Vedanta Limited (Cairn Oil & Gas) has deployed one vessel exclusively for surveillance of existing offshore installations. This vessel is also equipped with firefighting capabilities and oil spill response equipment. The offshore operation activities are supported by one vessel and a line boat is available for for SPM surveillance, maintenance and support in tanker loading. Additionally, one Tug is deployed for assisting shuttle tanker loading operation. All vessels are operated as per the approval of Directorate General of Shipping and Naval authorities.

5.4 Proposed Activities in the Ravva Field

19. As discussed in paragraph 6 above, the proposed project is to maximize production of hydrocarbons resources available in the PKGM-1 Block by optimally utilizing existing infrastructure and facilities. Following subsections briefly cover the additional onshore and offshore activities proposed in response to the declining production from existing wells.

5.4.1 Proposed Onshore Activities

20. As described in paragraph 7 above, it is proposed to have two (2) well pads (as against 8 well pads proposed at ToR stage) for drilling of 10 exploration wells and 23 developmental wells at the onshore as a part of the development project. Overall, the onshore activities will include:

a) **Onshore Well Pads Site Development**:

21. The tentative plot plan for a well pad will cover area of approximately 3.83 ha (225m x 170m). As per the revised proposal, only two previously developed onshore well pads WP-7 (also numbered as RX-8 or WP-A) and WP-8 (also numbered as RX-9 or WP-B) located within the PKGM-1 Block area will be utilised for drilling of onshore wells. Site preparation will involve leveling, filling and consolidation of the well pad sites for staging equipment and machinery above HFL. Individual sites will be duly fenced to a height of about 2 m from surace using wired fencing. HDPE lined pits will be constructed for temporary storage of drill cuttings, drilling wash waters and waste mud. [Note: The sites selected earlier for onshore well pads located outside the PKGM-1 Block will not be developed]

22. Site development will also involve upgradation/ strengthening of site approach roads and laying of onshore pipelines. The two onshore well pads are connected with existing all weathered access road from Ravva onshore processing facility. The existing road will be upgraded and strengthened for the rig movement.

23. The development of pipeline will be taken up only after commercially viable discovery of hydrocarbon resources. There will be setting up of ~8 km of pipeline corridor comprising of three subsurface pipelines (i.e. 3 nos. of pipelines in 8 km

corridor) connecting onshore well pads with the existing Ravva Terminal. These subsurface pipelines include: i) pipeline of 8 inches diameter connecting well fluids from each well pads to Ravva Terminal; ii) pipeline of 6 inches diameter gas lift to Ravva Terminal; iii) pipeline of 14 inches diameter for carrying injection water from Ravva Terminal to the onshore well pads to maintain reservoir pressure. In case of commercially viable discovery is made, initially up to two years, Vedanta Limited (Cairn Oil & Gas) is proposing to transfer well fluids through road tankers from onshore well pads.

b) Onshore Wells Drilling and Testing:

24. Onshore wells 33 nos. (10 exploratory + 23 developmental) to be drilled from two onshore well pads. After completion of construction of onshore well pads and provision of basic facilities, a drill rig will be transported to the well pad site. The drill equipment are designed as modular/skid mounted type, which facilitates quick mobilization and demobilization. The rig will have various allied equipment like mud tanks, mud pumps, compressors, fuel tank and diesel generators etc. Water based mud will be used for shallower sections and synthetic based mud will be used for deeper sections of a well. Drill cuttings generated will be collected and separated using a solid control system and temporarily stored on-site in impervious HDPE lined pits. Drilling and wash wastewater generated will also be temporarily stored onsite in impervious HDPE lined pits. The wash wastewater will be adequately treated in a mobile ETP and conveyed to existing ETP at Ravva Terminal to ensure conformance to applicable regulatory norms of APPCB before its final disposal through marine outfall in offshore. Well control equipment in form of Blowout Preventers (BOP) will be installed over the wellhead to forestall the possibility of any potential blowout, and regain control of the wellbore.

25. Towards the end of the drilling cycle, well testing will be initiated to establish the characteristics of the reservoir and the viability of commercially exploiting the reserve. The controlled flow of hydrocarbons from a drilled well will be tested, recovered and or ground flared for a maximum of 2 days.

c) Onshore Site Closure and Decommissioning:

26. After completion of an exploratory drilling, if no commercial reserves are established, the well pad site(s) will be properly reclaimed and rehabilitated. This process will involve capping of the well(s), decommissioning of the rig and all machineries above ground, ensuring removal of drilling waste from captive waste pit as per CPCB guidelines, disposal or reuse of fill materials, restoration of top soil within well pad site and transfer of leased land back to the landowner.

5.4.2 Proposed Offshore Activities

27. In the offshore part of the block, there will be 14 exploratory and appraisal wells drilling from existing offshore platforms 2 nos. from RB, 1 no. from RC, 2 nos. from RD, 4 nos. from RE, 2 nos. from RF, 1 no. from RG and 2 nos. from RH and 59 exploratory / appraisal wells drilling from standalone offshore locations.

28. There will be 17 developmental wells drilling from the existing well-head platforms i.e. 4 nos. from RB, 3 nos. from RC, 4 nos. from RD, 1 no. from RE, 2 nos. from RF and 3 nos. from RH Platforms. Existing platforms will be extended to facilitate installation of new wells slots and ancillary items. Each new well will be connected to the manifold through the flow-arms and will have all the relevant instrumentation and control philosophy applicable for the particular platform.

29. In offshore part of the block, drilling process for developmental (infill production) and exploration and appraisal wells is similar. Jack up rig will be used in both cases - mat supported jack up or independent leg jack-up may be deployed. Water based mud (WBM) will be used for initial, shallower sections. The deeper more difficult to drill formations will be drilled using synthetic based mud (SBM) which will be re-used to maximum extent. Blowout preventers (BOP) will be installed to forestall possibility of any potential blowout.

30. At the end of well drilling almost the entire volume of SBM will be collected for re-use in next drilling operation. WBM typically consists of water, bentonite, polymers and barite. Spent WBM will be disposed offshore as per MoEFCC guidelines. Other chemical additives viz. glycols and salts may be used in conjunction to mitigate potential problems related to hydrate formation. Drill cuttings will be generated due to crushing action of the drill bit. Cuttings will be then separated from drilling mud using shale shakers, hydro-cyclones (including de-sanders and de-silters), and centrifuges. The major liquid, solid waste anticipated due to drilling operations include spent drilling mud and drill cuttings. These wastes are stored, handled and disposed as per the requirements of the applicable Indian regulation, APPCB and MARPOL Convention. The sewage generated will be treated and disinfected onboard in a Sewage Treatment Plant (STP) before it is disposed offshore beyond 3 nautical miles (nm) from shore complying with the MARPOL requirements.

5.5 Project Utilities and Resource Requirements

31. **Camp Site:** For onshore activities, a camp site will be established with porta cabins at one of the two previously constructed onshore well pads WP-7 (RX-8) or WP-8 (RX-9) for deployment of labour for well pads construction and for drilling activities. Some of the skilled manpower will be provided accommodation in the existing Ravva Living Quarters. Unskilled manpower for well pads construction activities will be hired from local villages.

32. **Power Requirement:** Power requirement for drilling of an onshore well and campsite will be met through diesel generators. Diesel generators of 1,010 kVA (800 kW) capacity and 350 kVA (280 kW) will be operated at the well pad site while one diesel generator of 1,000 kVA will be kept as standby during drilling operation. There will also be one diesel generator of 350 kVA capacity catering to the power requirements of the campsite. There will be alternate power

supply to the well pads either through state grid or through captive power from the Ravva Terminal. To make the power arrangement work, an overhead power transmission line (OHL) will be laid along the earmarked road connecting to the onshore well pads.

33. For offshore drilling activity, diesel generators are incorporated in the design / infrastructure for self-sustained operations at sea. The power that will be available onboard the rig for offshore drilling and lighting the quarters at the rig. Power supply shall be made available through 2 of the 3 main diesel generators each of 2,000 kVA (1603 kW) typically installed on board the jack up rig. There will also be one diesel generator of 250 kVA capacity catering to the emergency auxiliary power supply.

34. **Water Supply:** For onshore well drilling there will be water requirement of ~50 m^3/day for onshore well drilling activities for ~ 50 days per well and domestic water requirement for the same period will be ~5 m^3/day at the drilling site and ~5 m^3/day at onshore campsite. Thus average water requirement for onshore well drilling is expected to ~60 m^3/day. All water requirement for onshore activities will be met through existing reverse osmosis (RO) plant available at existing Ravva Terminal using saline ground water as input to RO Plant.

35. For offshore drilling activity, typically a jack up rig has storage of drill water of ~4,000 bbls (~635 m^3) and domestic and other water storage of ~800 bbls (130 m^3). The drill water is mainly consumed for preparation of mud. Minor quantities are used for washing and cleaning the rig. Average daily water requirement for offshore drilling operations will be 85 m^3/day, of which 45 m^3/day will be saline water to be sourced from sea and 40 m^3/day will be fresh water to be sourced from nearby port through supply vessels.

36. **Manpower:** There will be ~100 workers engaged for construction of well pad sites for a period of ~50 days. For onshore drilling activities for a well there will be ~80 manpower (skilled and semi-skilled) which will be camped at the campsite. At any point of time at the onshore drilling location, there will be ~50 manpower available onboard rig at each well pad site which will comprise of engineers, skilled workers and support staff. For offshore drilling, manpower of ~100 will be onboard the jackup rig.

37. **Well Abandonment:** In case of exploration/appraisal wells found as dry and is to be abandoned, several cement plugs will be set in the open-hole section at various positions in the casing and the casing will be cut and retrieved as deep as possible both for onshore and offshore locations complying with the requirement of OISD 175. For offshore, all strings of casing are cut ~3 m (10 feet) or more below the seabed, and all structures above this point will be recovered.

5.6 Pollution Sources & Embedded Controls

38. **Air emissions:** From both onshore and offshore drilling, point source air emissions will be generated from diesel generators. The emissions from diesel generators will be controlled through optimized operations and discharged through stack of adequate height as per CPCB criteria. For storage and handling of bentonite and other materials covered sheds will be provided to minimize fugitive dust emissions. Vehicles movement to onshore well pads will be allowed through designated route only at low speed (~30 kmph) to minimize disturbance and fugitive dust emission.

39. **Noise & Vibrations:** At the well pads, noise and vibration will be controlled by establishing proper foundation for the rig and effective maintenance of rotating equipment. Noise barriers will be installed surrounding the noise generating equipment. Diesel generators at the well pads will be provided with integral acoustic enclosure.

40. **Liquid, Solid and Hazardous Wastes** from onshore and offshore activities will be as per the following Table

S.N.	Nature of Waste	Quantity	Treatment/ Temporary Storage	Disposal
A.	**Onshore Drilling Activity**			
A.1	Drill cuttings containing oil	250 m^3/ well	Temporary storage in HDPE lined impervious pits within well pad sites	APPCB approved common hazardous waste treatment, storage and disposal facility (CHWTSDF)
A.2	Residual drilling mud	200 m^3/well		
A.3	Used lubricating/waste oil	10 m^3/ well	Dedicated paved area for storage	
A.4	Food waste	25 kg /day	Temporary storage before daily transfer to the Ravva Terminal	Will be composted in-house or sent to piggeries
A.5	Non-combustible waste (i.e. metallic residues, glass)	20 kg/ day	Temporary storage in dedicated bins	Recycling vendors
A.6	Packaging wastes	1000 kg/ well		
A.7	Left over chemicals & materials	250 kg/ well	Temporary storage in secured stores bins	Disposal through supplier vendor
A.8	Cement, grit, & painting waste	500 kg/ well	Temporary storage in bins	APPCB approved CHWTSDF
A.9	Wash wastewater	5m^3/ day/ well	Primary treatment in modular ETP at well pad before transfer through tankers to Ravva Terminal ETP	ETP at Ravva Terminal for final treatment and disposal through existing marine outfall.
A.10	Sewage	4.5m^3/day/ well	Primary treatment in modular STP at campsite and well pads before transfer through tankers to Ravva Terminal STP	STP at Ravva Terminal for use of treated sewage in land application
A.11.	Biomedical wastes	Minor quantity	Collected in specific bins	APPCB approved vendors

S.N.	Nature of Waste	Quantity	Treatment/ Temporary Storage	Disposal
B.	**Offshore Drilling Activity**			
B.1	Drill cuttings	220 m^3 / well	Treated in shale shakers and centrifuges to separate mud from cuttings.	Drill cuttings and spent WBM will be intermittently disposed offshore at a rate of 50 bbl/hour/well. Oil content of <10 g/kg in drill cuttings from oil bearing zone will be met before offshore disposal. SBM will be collected for re-use in next drilling operation
B.2	Residual drilling mud	150 m^3 / well		
B.3	Domestic wastewater (kitchen shower, toilet & laundry)	30 m^3/day	Treated in an on-board STP	To be discharged offshore as per APPCB and MARPOL requirements beyond 3 nm from shore.
B.4	Bilge water	10 m^3 / well	Treated on board for oil and grease content of < 15 ppm.	To be discharged offshore as per APPCB and MARPOL requirements beyond 3 nm from shore.
B.5	Wash water and deck drainage	200 m^3 / well		
B.6	Cooling water	200 m^3/hour	Seawater cooling water is passed through oil- water separator.	Seawater with < 15 ppm oil content for offshore disposal.
B.7	Packaging materials, paper, plastic, tin, glass etc	~500 kg/wellg	Segregate and store in on-board storage facility	Disposal at nearby port.
B.8	Food waste	20-25 kg/ day	Food waste will be macerated to less than 25 mm particle size and	Discharged offshore beyond 3 NM from shore
B.9	Oily rags	100 kg / well	Temporary storage on board rig	Disposal to onshore APPCB approved CHWTSDF
B.10	Waste & used oil	5 m^3 / well	Temporary storage on board rig	Disposal to onshore APPCB approved CHWTSDF
B.11	Biomedical wastes	Minor quantity	Collected in specific bins	Disposal through APPCB approved vendor.

Note: For existing operations, Vedanta Limited (Cairn Oil & Gas) has taken up membership of Coastal Waste Management Project, Vizag, AP

6.0 ENVIRONMENTAL BASELINE

6.1 Study Area

41. The PKGM-1 Block is located along the East Coast of India in the East Godavari District of Andhra Pradesh. The block lies in the area between Latitudes: 16° 20' 44.8" N to 16° 33' 26.6" N and Longitudes: 82° 04' 17.3" E to 82° 19' 04.3" E. A 10 km zone around the apex points of the block (G-A-B-C-D-E-F) has been considered as the study area for the baseline study including to ascertain presence of sensitivities/ sensitive receptors in this region. For the marine region south of the apex points F-G, the study area boundary has been limited to the block boundary. For detailed socioeconomic studies, a radial zone of 2 km around the PKGM-1 Block boundary has been considered.

6.2 Geomorphology

42. The coastal area along PKGM-1 Block is dominated by the large delta of Godavari River with prominent geomorphic features comprising of flood plain terraces, river mouth bars, lagoons, mud flats, mangrove swamps and spits. The coastal alluvium occurs in the coastal region varying in width between 10 and 20 km. The onshore topography is undulating and relatively low lying.

6.3 Drainage

43. The PKGM-1 Block area lies mostly offshore from the Godavari Delta. The Godavari River branches at Dowleswaram into two distributaries i.e. eastern branch of Gautami Godavari and western branch of Vasishta Godavari. Between the two lies the Godavari Central Delta. The Gautami Godavari branches into Nilarevu and Varudha Gautami Rivers. Estuary of Vrudha Gautami River and Nilarevu River are located northeast of the PKGM-1 Block.

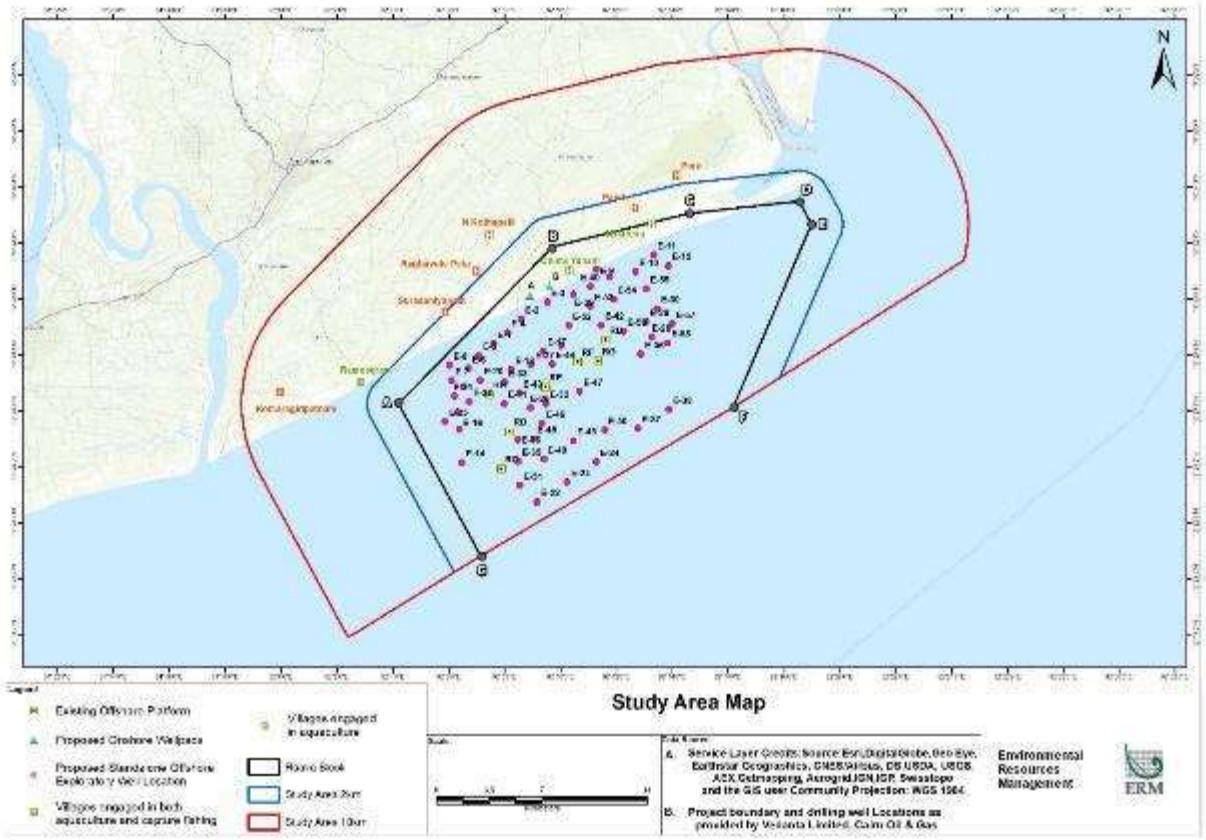
44. Kakinada Bay occurs at 45 km north of Ravva Terminal, and has a shallow (<5m) sandbar-built water bay. The Vasishta Godavari branches near Gannavaram as Vasistha Godavari and Vainateyam Godavari. Vainateyam Godavari River is located at 19 km west from nearest RC Platform in PKGM-1 Block while Vasishta Godavari drains near Narsapur and Antarvedi is located at approximately 45 km to the west from RC Platform.

6.4 Hydrogeology and Land Subsidence

45. Groundwater occurs under water table conditions and confined conditions. The depth to groundwater level in general is varying from 3 m to 4 m and near canals and less than 2 m near drains. Groundwater flow direction in the area is tending towards Bay of Bengal from the Amalapuram in all seasons.

46. There exists a network of canals, which provide perennial source for irrigation as well as drinking water in the area. The canals are contributing for groundwater recharge and improving quality of groundwater in the area.

47. Ravva Field is operative for over last 25 years and no distortion or evidence of land subsidence has been reported by Vedanta Limited (Cairn Oil & Gas) on the infrastructures including platforms, pipelines, boat-landing deck and landfall-point (located 540 m from shoreline). Cairn (Oil & Gas) is injecting saline water back into subsurface hydrocarbon reservoirs to maintain reservoir pressure for over 20 years as per the best industry practice. The hydrocarbon reservoirs sub-surface extent is far away from shoreline and it is controlled by sub-surface faults running parallel to shoreline.



6.5 Climate & Meteorology

48. The climate of the region is tropical, maritime and seasonal in character. Air temperature and humidity are high throughout the year. The climate is greatly influenced by southwest and northeast monsoons. The weather conditions are characterized by four seasons. The pre monsoon (March to May) and post monsoon seasons (northeast monsoon) (October to December) are the transition periods and are characterized by occurrence of cyclonic storms. The Southwest monsoon (June to September) is characterized by strong and persistent wind and rough sea conditions. Winter season (January to February) is characterized as fair weather season with light, variable winds and usually calm sea conditions.

49. The mean highest temperature of 41.9ºC occurred in June while mean lowest temperature of 17.0ºC occurred in January and December. Average relative humidity values varied from 59% in April-May-June to 82% in August-September. The humidity is relatively higher in the morning hours than the evening hours.

50. Monthly average wind speed distribution ranged from 6.0 km/hour in March to 10.5 km/hour in November. Predominant wind directions mostly are from NE and SW in the morning hours and SE and SW during the evening times.

51. The rainfall in the region mainly occurs during south-west monsoon (June to September) and north-east monsoon (October to December). The annual rainfall in the area is about 1,175.9 mm with considerable variations from year to year. More than 90% of the rainfall is recorded during the months of June to November. Cyclones occur mostly in Northeast monsoon i.e. in October and November with a few in May and September.

6.6 Ambient Air Quality

52. Ambient air quality (AAQ) was monitored at eight locations in the study area during January to March 2018 through NABL and MoEFCC approved Vimta Labs, Hyderabad. The monitoring results showed PM_{10} varied from 43.6 /µg/m^3 to 56.3 µg/m^3 as against corresponding national ambient air quality standards (NAAQS) of 100 µg/m^3; $PM_{2.5}$ varied from 18.4 µg/m^3 to 25.7 µg/m^3 as against corresponding NAAQS of 60 µg/m^3. Other gaseous pollutants NOx, SO_2, CO, O_3 and NH_3 were observed well within NAAQS specified limits. Hydrocarbons at all locations were observed below detection limit of 0.1 ppm whereas total VOC levels varied from < 0.1 to 0.18 ppm. Heavy metals (As, Pb and Ni) were well within the NAAQS. H_2S varied from below detection limit of 0.1 µg/m^3 to 1.6 µg/m^3. Benzene and Benzo-a-pyrene (BAP) reported within NAAQS. Overall, AAQ was observed well within stipulated norms under NAAQS.

6.7 Ambient Noise Quality

53. The baseline noise monitoring in the study area was carried out at eight locations during March 2018. The equivalent ambient noise level for residential areas during daytime ($L_{eq\ day}$) varied from 50 to 53.5 dB(A) as against corresponding standard of 55 dB(A) while $L_{eq\ night}$ in residential areas varied from 40.1 to 43.5 dB(A) as against corresponding standard 45 dB(A). At the commercial location, noise levels recorded for daytime was 59.4 dB(A) against prescribed limit of 65

dB(A) and night time noise levels of 53.8 dB(A) against prescribed limit of 55 dB(A). Overall, noise levels in residential and commercial areas in the study area were observed to be well within the prescribed norms.

6.8 Landuse

54. The land use pattern of the study area shows sea area of 60.24% followed by agriculture land area of 12.73%, aquaculture land area of 13.14%, reserve forestland of 4.68% (3.96% mangrove vegetation + 0.72% Casuarina Plantation), backwater of 2.83%, Casuarina plantation of 1.42%, settlements of 0.99% and sand dunes of 0.86%.

6.9 Soil Quality

55. Soil samples were collected from six locations from surrounding villages in the study area. Texture of soil varied from clayey (in S1, S2 and S3 samples) to sandy loam (in S4 and S6 samples) and sandy (in S5 sample). pH ranged from 6.1 to 7.5. SAR varied from 3.8 to 13.2. The analysis results also indicated that there is no enrichment of heavy metals in soil.

6.10 Ground and Surface Water Quality

56. Groundwater quality of the study area was assessed by collecting and analyzing samples from four locations. pH of the groundwater varied from 7.1 to 7.4 which remained within corresponding drinking water norm (IS:10500) of 6.5 to 8.5 while turbidity ranged from 1 to 3 NTU which is within acceptable limit of 5 NTU. The groundwater samples collected from Challapalli and Samanthakur Villages showed higher levels of chlorides, TDS, alkalinity and hardness probably due ingress of saline marine water in ground water. The groundwater collected from Vedanta Limited (Cairn Oil & Gas)'s Living Quarters and Uppalaguptam Village showed levels of chloride, TDS, alkalinity and hardness within permissible limits of IS:10500. The groundwater samples did not reveal presence of any metallic or biological contaminants.

57. Surface water samples were collected from four locations i.e. Surasaniyanam Backwater, Cherriyanam Backwater, Challapalli Canal water and creek near Surasaniyanam. The surface water from the canals, creeks and backwater areas is used for washing and catching fish. The surface water quality revealed that the water conforms to CPCB Water Quality Criteria of Class "B "(Outdoor Bathing Organized) and Class "D" (propagation of wildlife and fisheries).

6.11 Marine Water Quality

58. Marine water samples were collected from eight locations from three water depths for each location during April 2018 in the PKGM-1 Block. In general, the marine water samples collected from three depths (i.e. surface, mid depth and bottom) did not reveal much variation in terms of concentrations of physicochemical parameters. The marine water samples collected revealed metal and oil and grease contents below detectable limits to very low levels of Cadmium, Copper, Lead and Total Chromium.

6.12 Marine Sediment Quality

59. Sediment samples were collected from eight locations within PKGM-1 Block. The results showed, silt as the dominant fraction (average 50.5%), followed by sand (average 39.0%) and clay (average 10.5%). Organic matter varied from 0.47% to 1.24% (average 0.81%). TPH varied from 0.29 mg/kg to 0.53 mg/kg (average 0.41%), showing low level of TPH at the monitored stations. The sediment samples did not reveal presence of heavy metals or oil pollution in the area.

6.13 Marine Ecology

60. **Phytoplanktons:** 15 genera of phytoplanktons were identified in the study area, with average composition of Chlorophyceae (64%), Cyanophyceae (20%) and Bacillariophyceae (16%).

61. **Zooplankton:** 6 genera of zooplankton were identified in the study area including 2 species of Copepods, 2 species of Cladocerans, 1 species of Rotifer and 1 species of Protozoa.

62. **Benthos:** Benthos were composed of a wide variety of species living in burrows in the sediment or on the sediment surface. Meiobenthic community is represented by Copepods, Nematodes, Turbellarians, Nemertins, Foraminifera, Kinorynchs, Halacarids etc. Macrobenthic community is represented by Polychaetes, Molluscs, Cumceans Amphipods, Isopods, Cnidarians, Oligochaetes and Tanaidacea etc.

63. **Marine fishes:** 11 species of cartilaginous skeleton fishes without swim bladder and 37 species of fishes with boney skeleton and swim bladder were enumerated from the secondary data.

64. **Marine Reptiles:** Olive Ridley's Turtles (*Lepidochelys olivacea*), listed as Vulnerable by IUCN Red list of Threatened Species and listed as Schedule I of Wildlife Protection Act 1972, is known to occur mainly in Sacramento Shoal and beyond 10 km from nearest well proposed to be drilled in PKGM-1 Block. Some solitarily nesting sites have also been reported along the coast in the study area.

65. **Cetaceans:** Cetaceans generally occurs in water depth of 50 m or more. Water depth in PKGM-1 Block gradually increases to 10 m up to ~10 km from shore followed by further increase beyond southern boundary of the block. As the block has shallow water depth, Cetacean species have not been reported in the study area. However, sporadic with rare sighting of dolphin species - short-beaked Common Dolphin (*Delphinus delphis*) and Bottlenose Dolphin (*Tursiops truncates*) cannot be ruled out in lower water depths. Cetaceans Minke Whale (*Balaenoptera acutorostrata*) and Unidentified Baleen whales have been reported in deeper water off Kakinada region much away from PKGM-1 Block.

6.14 Terrestrial Ecology

6.14.1 Terrestrial Flora

66. **Beach Vegetation:** Beach habitat is represented by two shrub species, three climber species and two herb species. The highest density calculated for shrubs is for *Thespesia populneoides* (4.71 individuals/sq.m.), for herbs is for *Tephrosia purpurea* (15.29 individuals/sqm). Highest density for climbers is calculated for *Ipomoea biloba* (5.14 individuals/sq.m) as the species grows well in the shade of the adjoining shelter belt while *Spinifex littoreus* is limited to the dry areas.

67. Casurina - shelter belt plantation was found along the coast with varied density. The *Casurina equistifolia* is prominent tree species planted along the coast in the study area. Habitation close to coast include species of *Cocos nucifera, Borassus flabellifer* and the palm species were also encountered.

68. Vegetation in areas of backwaters/lagoons included mangrove species *Avacinia officianalis* and mangrove associate species such as *Sueda maritima*, *Salicornia brachiata* and *Sesuvium portulacastrum*.

69. Dense plantation of coconut (*Cocos nucifera*) are maintained along aquaculture ponds in the study area. Apart from coconut plantations, other preferred species are *Albizia saman*, *Azadirachta indica*, *Mangifera indica*, *Millettia pinnata*. In some area above inundation level *Prosopis juliflora* was observed.

70. In the study area reserve forest patches of Balusutippa RF, Kandikuppa RF, Kothapalem I, Kothapalem II, mainly in the mangrove habitat comprised of mature vegetation up to 8 to 10m height in well-protected areas. A total of 16 species of trees and one climber, one shrub and four herbaceous mangrove associates were enumerated from the mangrove habitats. The highest importance value index (IVI) calculated for tree species is *Avicennia officianalis* (11.77) while the lowest IVI calculated for tree species is *Scyphiphora hydrophyllacea* (1.63).

71. The agricultural lands predominantly rice fields are away from the coast where fresh water are supplied from Dowleswaram Barrage through a network of canal system. A few tolerant wild species (*Sarcolobus, Ficus hispida, Urena lobata, Sida spp., Chloris sp.*) grow along canals and bunds. Shrub flora is dominated by *Lantana camara, Eupatorium odoratum, Calotropis*, etc.

72. Vedanta Limited (Cairn Oil & Gas) has developed mangrove plantations in 55 acre adjacent to the Ravva Terminal in Surasaniyanam Village. The mangrove plantation provide excellent roosting site to many avifaunal species and refuge to the smooth coated otter. With the supervision of security, the mangrove plantation provide safe refuge to otter family.

73. Coringa Wildlife Sanctuary: Coringa wildlife sanctuary is located beyond 18 km north of the block (Apex Point D) and ~25 km from nearest proposed well (E-11), a part of Godavari mangroves is located in East Godavari River Estuarine Ecosystem (EGREE) area of Coastal region of the Bay of Bengal in the East Godavari District of Andhra Pradesh. Sacramento Shoal is located ~ 12 km from the nearest proposed well E-11 and beyond 4.5 km from PKGM-1 Block.

6.14.2 Terrestrial Fauna

74. **Butterflies:** A total of 26 species of 17 genera belonging to 4 families of butterflies were observed from the study area. None of these species bear any conservational status from IUCN or Wildlife Protection Act, 1972 (WPA).

75. **Amphibians:** A total of three (03) species of amphibians Common Asian Toad, Indian Skipper Frog and Indian Bull Frog pertaining to freshwater habitats such as village ponds and fresh water canals were observed. None of the species are listed in IUCN Red List v2017.3 and the WPA.

76. **Reptiles:** A total of 14 species of 11 genera belonging to 7 families of reptiles were enumerated from the study area. These belong to variety of habitats from fresh water to marine, terrestrial and human habitation. Most have been assessed as "Least Concern". Three species Olive Ridley Turtles (*Lepidochelys olivacea*), Indian flapshell turtle (*Lissemys punctata*) and Monitor Lizard (*Varanus benghalensis*) are listed as Schedule-I species and two species Rat Snake (*Ptyas mucosus*) and Checkered Kelback (*Xenochrophis piscator*) are listed as Schedule–II species of the WPA, 1972.

77. **Avifauna:** A total of 96 species of 70 genera belonging to 40 families of avifauna were observed in the study area. Out of the total 96 avifauna species observed 68 were resident bird species, 26 were winter visitor species and one vagrant species. Two species western Black Tailed Godwit (*Limosa limosa*) and Black Headed Ibis (*Threskiornis melanocephalus*) were listed as Near Threatened as per IUCN red list category and four species Osprey (*Pandion haliaetus*), Brahminy Kite (*Haliastur indus*), Shikra (*Accipiter badius dussumieri*) and Pariah Kite (*Milvus migrans*) listed under Schedule-I of the WPA. Indian Pond Heron (*Ardeola grayii*) and Little Egret (Egretta garzetta) were the most abundant bird species.

78. **Mammals:** 25 species observed/reported from the study area. Two (2) species Fishing Cat and Smooth Coated Otter are listed as Vulnerable category and one (1) species as Near Threatened as per IUCN red list. Three (03) species Fishing Cat, Smooth Coated Otter and Indian Pangolin are listed as Sch.-I of the WPA. Six (06) species Jackal, Indian Fox, Jungle Cat, Small Indian Civet, Common Palm Civet and Grey Mongoose are listed as Sch.-II species of the WPA.

79. **Coringa Wildlife Sanctuary:** The sanctuary has a rich variety of avian fauna together with a fair population of golden jackal, fishing cat and a healthy breeding population of smooth coated otter. The sanctuary has long sand pit where olive ridley sea turtles nest from January to March every year.

6.15 Socioeconomics

80. Socio-economics show that the study area primarily comprises of rural settlements. The area of Ravva Terminal and surrounding falls under Uppalaguptam Mandal of East Godavari District. Area of immediate vicinity of Ravva Terminal is scarcely populated. Within 2 km radius, Surasaniyanam and Chirrayanam Villages fall with total population of 3,878 and 1,736 respectively as per 2011 census. Within 2 to 10 km, there exist 32 villages with total population of 181,764 as per 2011 census. Average literacy rate is 63.42% and female literacy rate of 58.98%, lower than the district literacy rates.

81. There is no archaeological protected site within the study area. One locally famous Lord Hanuman temple (about 8 yrs. old) is located in Surasaniyanam Village close to the Ravva Terminal. Kundawaleshwaram Temple is also located in study area, which is locally very popular. Besides these, small temples were observed in most of the villages in the study area.

82. Consultation with health officials suggested common form of ailments in the area include Viral Fever, Diarrhoea, Conjunctivitis, Mumps, Cold and Cough, Dengue, Malaria, Jaundice and Water borne diseases. Ambulance facility in case of medical emergency is also available there.

83. Surasaniyanam is the closest village from the Ravva Terminal. Most houses of this village have access to their own toilet and household level water supply connections. Cairn (Oil & Gas) has taken up number of CSR programs in this village.

84. Agriculture (mostly paddy cultivation) and fishing (both culture and capture) are the mainstay of economy of the study area. The farm sector employs ~70% of active and productive work force whereas non-farm sector (agriculture labour; labour in oil & gas operations or other small scale business/trading) employs ~30% of the workforce in study area. The overall work participation rate (WPR) is ~50%. The WPR was found to be higher among males as compared to females.

85. Land parcels beyond the coastal area are largely irrigated used for multiple cropping. Higher proportion of irrigated land is also linked to the fact that this area has good coverage of canals developed for irrigation. Rice, coconut and Banana are the most produced crops in the study area. Crops are cultivated during Rabi as well as Kharif seasons.

86. There are number of fish culture tanks rearing fishes and prawns in coastal area up to 2 km area from the shoreline in study area. The main fish species include Katla, Rohu, Mrigala, Barbus, Catfishes, Murrel, Mullets, Hilsa, etc. Fishing communities are dependent on fishing and associated aquaculture industries for their livelihood. Owners of these tanks have access to big land holding and usually belong to general category, whereas the labours working on these tanks are typically either from scheduled caste or from other backward caste of the society.

87. Other sources of livelihood in the study area include direct or indirect employment opportunities in oil & gas operations and other small scale factories available the area. Cairn (Oil & Gas) operation provides direct, indirect or contractual employment to 400 people; however most of the employment benefit is restricted to Surasaniyanam Village only.

7.0 IMPACT ASSESSMENT & MITIGATIONS

7.1 Potential Impacts due to Onshore Activities

7.1.1 Impact on Landuse

Potential Impacts

88. The land requirement for an onshore well pad is 3.83 hectares (ha). For two onshore well pads WP-7 and WP-8, previously developed by Vedanta Limited (Cairn Oil & Gas) in 2006-07, there will be land requirement of ~8 ha. The government land falling for the well pads area will be taken on lease initially for three years. In case of commercially viable discovery of hydrocarbon resources, lease will be extended for a longer term till decommissioning of the wells.

89. The land requirement for the laying of onshore subsurface pipeline corridor (of ~8 km long for 15 m wide corridor) is 12 ha. The land use assessment along the proposed pipelines corridor reveals that 87.9% of the area is under coastal land (landward side of beach and Casuarina plantation), 5.0% is under backwater and 7.1% is under aquaculture. With the laying of pipelines, the existing land use along the pipelines corridor (ROW) will be meant for industrial use. The pipelines will be subsurface and no structural development is envisaged which may lead to loss of value of land.

Mitigations

a) Land area for pipelines corridor will be brought to its best achievable original state after completion of the pipelines laying activity, to merge it with surrounding land use.
b) All wastes from area surrounding onshore well pad sites and pipelines corridor will be removed after completion of the drilling / pipelines laying activities.

7.1.2 Impact on Physiography and Drainage

Potential Impacts

90. There will be development of previously established two onshore well pads. The unplanned raising of well pads together with strengthening of approach road, without provision of adequate cross drainage may disturb drainage pattern and potentially affect drainage in coastal area. It can also potentially lead to instances of localised flooding/water logging.

91. The pipelines in the ~8 km onshore pipelines corridor will be buried through a combination of horizontal directional drilling (HDD) technique (at water crossings) and open trenching with limited excavations at some locations resulting in

low and temporary impact on micro-drainage. In beach area, depth of pipeline will be maintained 1 m below surface. Existing roads will be strengthened for access to two onshore well pads. Trenching, earthworks and stockpiling associated for pipeline and road strengthening works if not managed, can potentially disturb micro-drainage of the area.

Mitigations

a) Adequate drainage system for the two well pads to be provided to maintain the micro-drainage of area;
b) Site approach roads will be strengthened with due consideration of micro drainage;
c) Land after completion of the pipelines laying to be appropriately reclaimed and reinstated;
d) Maintain the cross drainage structures along the pipelines route.

7.1.3 Impact on Soil and Sediment Quality

Potential Impacts

92. **Disturbance of the top soil:** The two onshore well pads located along coastal area within PKGM-1 Block were previously developed by Vedanta Limited (Cairn Oil & Gs) in 2006-07 based on EC obtained in 2006. Earthwork activities will result in limited disturbance of topsoil at two well pad sites.

93. **Handling of oil, chemical and waste:** The drilling chemicals, cement for mud preparation, fuel and lubricants will be stored in dedicated paved storage sheds within two well pad sites. The hazardous waste (spent oil & used oil), batteries, and municipal waste (including food waste) will be stored within designated storage areas of the well pad sites before final disposal. Thus, contamination of soil can happen only due to accidental spillage of fuel, lubricants and paints from storage areas and during the transfer of fuel and chemicals. Any contamination of soil with fuel, lubricants and paints may affect the soil microbes and bacterial growth and can affect soil quality.

94. **Storage and disposal of drill cuttings and spent mud:** Vedanta Limited (Cairn Oil & Gas) is proposing use of water based mud (WBM) for the upper sections and use of synthetic base mud (SBM) for deeper and more difficult formations. It is estimated that ~250m^3 drill cuttings and ~200 m^3 spent WBM is likely to be generated from each well drilling. For onshore well pads, the project design takes into account construction of HDPE lined impervious pits for storage of drill cuttings, drilling mud and drilling fluid respectively. At the end of drilling of a well almost the entire amount of the SBM will be collected for maximum reuse in next drillings, while spent WBM and SBM (after maximum reuse) will be disposed at CHWTSDF. Accidental spillage of drill cuttings and spent mud on nearby open soil may lead to change of soil characteristics due to chemical contamination.

95. **Surface Runoff:** Surface runoff during monsoon season from disturbed well pad site, construction material storage, waste storage and any chemical/oil spillages have the potential to degrade soil quality due to deposition of foreign materials, hydrocarbon and other hazardous waste in the nearby land or back water area.

96. **Laying of Pipeline:** The soil dug during trenching will be reused for covering after laying the pipelines. Care will be taken to restore the location of the concealed pipelines to its original state. The pipelines laying will be taken up one year after commercially viable discovery of hydrocarbons. The pipeline laying is expected to be completed within a short period of ~ 3 months.

97. **Wastes:** Any wastes if not managed well, it will cause nuisance and cause pollution of the soil and marine water.

Mitigations

a) Fill material for restablishment of well pads is to be sourced from approved quarries only;
b) Project and related development activities, to the extent possible, will be done during non-monsoon seasons;
c) Drainage system at site is to be provided with sedimentation tank and oily-water separator to prevent contaminants, especially oil and grease, from being carried off by surface runoff;
d) Construction waste generated from the onshore well pad sites will be utilized for backfilling within the site itself;
e) All wastes will be disposed of as per inbuilt embedded controls. Food waste generated from the labour camp and construction sites will be transferred to the Ravva Terminal and composted in house or sent to piggeries;
f) HDPE lined pits will be provided for temporary storage of drill cuttings, spent muds, drilling wash wastewater and oil containing residues.
g) Testing of drill cutting will be undertaken to determine if they are hazardous in nature and accordingly their disposal will be planned.
h) Dedicated paved impervious area will be identified for storage of drilling chemicals, fuel, lubricants, oils within well pad sites;
i) Spills of contaminants on soil will be managed using spill kits. Contaminated area will be reinstated;
j) Best practices e.g. use of pumps and dispensing nozzle for transfer of fuel, use of drip trays, etc. will be adopted.

7.1.4 Impact on Air Quality

Potential Impacts

98. **Fugitive emission:** Fugitive dust emissions are expected primarily from earthwork for well pads development, handling and transportation of fill material and re-entrainment of dust during movement of the vehicles on village roads, handling of dry powdery ingredient of drilling mud during well drilling and excavation and soil handling during pipelines laying.

The dust generated generally will settle down on the adjacent areas (expected to be within 500 m from the source) within a short period due to its larger particle size.

99. **Emissions from Vehicles/Equipment:** The pre-drilling, drilling and decommissioning operations will involve movement of diesel operated vehicles and operation of machineries and equipment. Use of heavy vehicles will be particularly intense during site preparation and decommissioning phases. Gaseous pollutants such as NOx, SO_2, CO and hydrocarbons are likely to be emitted from operation of vehicles and machineries.

100. **Sour Gas:** Crude produced from Ravva is sweet and light (API 35 degree) and gas produced is having CO_2 with ~2% of mole fraction but no H_2S is encountered. However, in the event of any H_2S encountered during drilling, adequate controls need to be in place.

101. **Operation of Diesel Generators:** There will be emission from operation of diesel generators of 1,000 KVA and 350 KVA capacities for drilling and auxiliary activities at onshore well pad sites and a 350 kVA DG set at camp site.

102. **Flaring:** Test flaring will be done only for exploratory and appraisal wells. The emission from the test flaring will be due to estimated combustion of 0.105 mmscmd equivalent of hydrocarbon per day, which will be only for a short period of 1 to 2 days per drilling location. During initial period of operation phase, in case of emergency situation, there will be elevated flaring from onshore well pads.

103. The emissions from the power generation due to diesel combustion and test flaring during drilling of a well and emission from emergency elevated flaring during initial period of production from well pads are considered as the principal input sources for the air quality dispersion modelling conducted for the study. The resultant ground level concentrations have been observed within limits prescribed standards i.e. NAAQS for pollutants PM_{10}, NOx, SO_2 and CO hence, will have minor impact on health related issues for human and biological/ecological receptors in the surrounding area.

Mitigations

a) Regular water sprinkling will be carried out at the site during dry season;
b) Stockpile will be maintained against the wall or obstruction, which will works as a windbreak;
c) Vehicle, equipment and machinery used for drilling would conform to applicable emission norms; regular preventive maintenance to be undertaken.
d) Drilling chemicals and materials would be stored in covered areas to prevent fugitive emissions;
e) DG set and flare stacks would have adequate height, as per statutory requirements, to be able to effectively disperse exhaust gases;
f) Trucks used for transport of material during site preparation and decommissioning will be covered with impervious sheeting;
g) During well pad development, the approach road will be kept clean, free from mud and slurry to prevent any entrainment of dust;
h) No cold venting to be resorted during well testing. Adequate storage facilities will be provided to minimize flaring during well testing;
i) The hydrocarbon resources in the Ravva field are sweet in nature i.e. free of H_2S. However, in the event of H_2S being encountered during drilling, adequate controls including installation of H_2S detectors will be in place.

7.1.5 Impact on Noise

Potential Impacts

104. **Construction machinery/equipment noise:** The construction stage activities such as transportation of raw materials for civil works, operation of heavy equipment and construction machinery, etc. are likely to cause increase in the ambient noise levels in and around two onshore well pad sites. The noise generated is likely to be attenuated within 500m and may cause discomfort for the workers / villagers who are within 500m of the well pad sites.

105. **Noise from Vehicular Traffic:** Vehicles supplying material and manpower to the sites will result in increase in noise levels and may cause incremental noise disturbances to residents near site approach roads.

106. **Operation of drilling rig and ancillary equipment:** Noise during operational phase are anticipated from operation of drilling rig and ancillary equipment viz. shale shakers, mud pumps and diesel generators. The average equivalent noise levels of drilling rig and ancillary equipment is estimated to be 95 dB(A).

107. Noise modelling has been done using SoundPlan 7.2 model to predict noise levels from drilling rig. The resultant noise levels at nearby villages will remain well within the prescribed equivalent noise standards i.e. 55dB(A) $L_{eq\ day}$ and 45 dB(A) $L_{eq\ night}$ both from drilling activities at the well pad site as well existing operations of Ravva Terminal. The predicted noise level at the fence line of well pad site is expected to be less than 75 dB(A) during day time and 70 dB(A) during night time.

108. Occupational health and safety impacts viz. Noise Induced Hearing Loss (NIHL) is anticipated for personnel working close to such noise generating equipment unless they are wearing appropriate personnel protective equipment.

Mitigations

a) Provide noise barriers surrounding the high noise generating equipment at the well pad site.

b) All equipment involved for well pad development and drilling activity are to be provided with noise control measures. All diesel generators would be provided with acoustic enclosures;
c) Regular maintenance of vehicles and machineries;
d) Ensure low speed (less than 30 kmph) of vehicles plying through roads near villages;
e) Restrict unnecessary use of horns by trucks and vehicles near settlement areas;
f) Ensure use of appropriate PPEs (e.g. ear plugs) by workers while working near high noise generating equipment.

7.1.6 Impact on Road and Traffic

Potential Impacts

109. Daily ~10 trucks/trailers load materials during ~50 days of two well pads construction will be transported during predrilling phase. During drilling activity 5 to 7 trucks/trailers load materials will be transported during mobilization and demobilization (each of 4 to 5 days) of a well drilling at a well pad site. Additionally, 10 to 15 light motor vehicles will be used for transport of site workers during drilling of a well.

110. Based on the traffic survey conducted, it is noted that Amlapuram –Kakinada – Chirayanam, Amlapuram-Surasaniyanam Road and village roads from Ravva Onshore terminal to Surasaniyanam and Challapalli are the principal roads that will be used for transportation of construction material and drilling rig and machineries.

111. The increase of traffic during construction phase will cause perceptible changes in the existing road traffic volume. This may cause deterioration of existing road infrastructure. The increased traffic may also cause disturbance to community of the nearby villagers and at sensitive man-made habitat like schools.

Mitigations

a) Avoid traffic movement during school hours and market times;
b) Ensure regular maintenance of access roads; and
c) Deploy traffic marshals at important road junctions and near sensitive receptors (e.g. schools) for management of Project related traffic.

7.1.7 Impact on Surface Water Quality

Potential Impacts

112. **Surface run-off from well pad site:** The well pad site development activity viz. site raising with soil/ sands during site construction may result in increase in soil erosion that might lead to an increased silt load in the surface run-off. The surface run off from drilling waste (cuttings and drilling mud) storage areas, hazardous waste (waste oil, used oil, etc.) storage areas and chemical storage areas is likely to be contaminated. Two onshore existing well pads sites WP-7 (RX-8) and WB-8 (RX-9), previously used in 2006-07, will be developed within coastal area. Any accidental runoff from onshore well pad sites and production facilities (including during monsoon) will create an adverse impact upon the water quality and aquatic ecology of the receiving streams (inland/estuarine water bodies).

113. **Hydro Testing of New Pipelines:** Discharge of untreated hydro testing of pipelines before their commissioning will have adverse impact on nearby coastal water, thus requires prior treatment.

114. **Discharge of Drilling and Domestic Wastewater:** There will be drilling wash wastewater and domestic wastewater generation during drilling of wells at the onshore well pad sites. As defined in paragraph 40 above, embedded controls on wastes including for wash and domestic wastewaters in place at onshore well pad sites covering arrangement of primary treatment of wash wastewater of ~5 m^3/day in modular ETP before its transfer through tankers to existing Ravva Terminal ETP (of 3,000 m^3/day capacity) for final treatment and disposal of treated effluent through existing marine outfall. The sewage generated will be treated in modular STP at well pad and campsite before transfer through tankers to Ravva Terminal STP for final treatment and use of treated domestic wastewater in platation at Living Quarters and Ravva Terminal. The embedded controls will result in insignificant impact on coastal water quality. However, any accidental release of untreated wash wastewater and domestic wastewater will adversely affect coastal water quality.

115. **Discharge of Treated Wastewater from Ravva Terminal:** All wastewater generated at Ravva Terminal will continue to be treated through primary, secondary and tertiary three stages treatment at ETP to comply with the applicable standards before treated wastewater discharge offshore through existing marine outfall. Produced water comingled with saline groundwater will continue to be treated in PWRI system before its injection into hydrocarbon reservoirs to maintain reservoir pressure.

Mitigations

Mitigation measures to minimize impact on surface water resource include the following:

a) There will be modular ETP and STP for primary treatment at a well pad site followed by final treatment at Ravva Terminal/Living Quarters. The treated wastewater will be disposed complying with discharge standards as prescribed in the EPA Rules, 1986 (GSR 546 E) of 30 August 2005 and by APPCB before treated wastewater discharge offshore through existing marine outfall;
b) Hydro test wastewater for pipeline commissioning will be transferred to ETP at Ravva Terminal for treatment and final disposal;

c) All surface runoff from the construction site will be channelized through storm water drainage system; adequate size double chambered sedimentation tank will be provided;
d) Proper treatment of all wastewater and produced water discharges will be undertaken to ensure that treated wastewater comply with criteria set by the regulatory bodies (MoEFCC and SPCB);
e) All chemical and fuel storage areas, process areas will have proper bunds so that contaminated run-off cannot escape into the storm-water drainage system;
f) An oil-water separator will be provided at the storm water drainage outlet, to prevent discharge of contaminated run-off;
g) Spill kits will kept available for removal of any oil or chemical spillage on site.

7.1.8 Impact on Ground Water Resources

Potential Impacts

116. **Abstraction of ground water:** Water requirement at the Ravva Terminal is met through groundwater resources. Presently, Vedanta Limited (Cairn Oil & Gas) is withdrawing saline groundwater of 9,570 m^3/day through old deep wells. Of the 9,570 m^3/day water requirement, 9,170 m^3/day is used for injection into reservoir to maintain reservoir pressure by filling the void created due to fluid extraction and remaining 400 m^3/day is fed to RO Plant for domestic use; present approved capacity is 10,413 m^3/day while additional requirement of ~7,872 m^3/day is anticipated, for which necessary permission will be obtained from Andhra Pradesh State Water, Land and Tree Authority (APWALTA).

117. During onshore drilling activities the average daily requirement per well will be 60 m^3/day. The required water for drilling activities will be sourced from the existing ground water wells within Ravva Terminal.

118. Vedanta Limited (Cairn Oil & Gas) sponsored a study on groundwater abstraction at Ravva Terminal by National Geophysical Research Institute (CSIR-NGRI), Hyderabad. The study was conducted in two different phases i.e. 2006-2008 (Phase I) and 2014-2016 (Phase II). The study highlights the following points:
    a) The depth to groundwater level in general is varying from 3 to 4 m and near canals and drains it was reported less than 2 m. Groundwater flow direction in the area is tending towards the Bay of Bengal from the Amalapuram in the all seasons.
    b) The highly saline groundwater with salt concentration of more than 25,000 mg/l is being withdrawn from aquifer zones at depths 70 m up to 140 m below mean sea level through borewells located inside the onshore Ravva Terminal . The groundwater pumping rate has been sustained @ 600 m^3/hour since beginning of groundwater withdrawal and has been continuously injecting the salt water into the oil producing wells in offshore.
    c) Overall, comparison of water levels and water quality data from 2006 -2008 to 2014-2016 indicated in the area there is no decrease in groundwater levels in the shallow aquifer. Cairn Oil & Gas has permission to withdraw groundwater from APWALTA for extraction of 10,413 m^3/day of saline ground water from existing six bore wells.

119. With continual withdrawal of groundwater, no significant change in drawdown in pumping wells has been observed indicating no over exploitation of groundwater from onshore terminal wells. The water is drawn from saline aquifer, which is not used for irrigation, animal husbandry or domestic usage. This abstraction is not affecting any fresh water aquifer.

120. Drilling of wells if not controlled, it may intersect existing ground resource and affect groundwater quality and quantity.

Mitigations

Mitigation measures to minimize impact on ground water resource include the following:

a) Proper engineering controls including providing multiple steel casings and cementing which act as barrier between drilled sections and surrounding area; and
b) Periodically monitor groundwater levels in surrounding area to ascertain any impact of groundwater withdrawal.

7.1.9 Impact on Ground Water Quality

Potential Impacts

121. Ravva Terminal comprises of crude oil process and storage tanks and hazardous waste storage areas. Any accidental spill may contaiminate subsurface and ground water quality. For drilling of a well, fuels, chemical lubricant etc., would be stored at a designated paved and impervious area within the well pad sites. Any accidental spillage of fuel, lubricants and chemicals from storage areas or spillage during their transfer may lead to contamination of subsurface and groundwater.

122. The drill cutting and the spent mud would be stored in HDPE lined pits at the well pad sites. Improper lining system or any puncture in the liner system can lead to the potential contamination of soil and subsequently ground water.

123. Other impact on groundwater quality will be due to the drilling activity. Water based mud will be used. However, synthetic based mud will also be used for deeper sections. Possibility of contamination of subsurface and unconfined aquifers may also exist if the casing and cementing of the well is not carried out properly leading to infiltration or seeping of drilling chemicals or mud into porous aquifer regions.

124. Treated produced water comingled with saline groundwater from deeper aquifer will be injected through water injection wells to maintain hydrocarbon reservoir pressure. This process is not expected to have any adverse impact on groundwater regime, subject to compliance of MoEFCC standards (injection of produced water into confined hydrocarbon reservoir structure at more than 1,000 m with oil in water content of less than 10 ppm).

Mitigations

Mitigation measures to minimize impact on ground water quality include the following:

a) Ravva Terminal, being an old facility, Vedanta Limited (Cairn Oil & Gas) is to ensure periodic monitoring of groundwater quality surrounding all process and storage tank and hazardous waste storage areas, where required necessary mitigation of restoring integrity of that area.
b) In case of any accidental spills, Vedanta Limited (Cairn Oil & Gas) is to recover spilled crude oil/chemical or fuel oil and adequately treat the area, thus to prevent any subsurface contamination; regular trainings in this regard is to be imparted to its staff.
c) Drill cutting along with spent mud will be stored in HDPE lined pits.
d) After completion of drilling activity, all drilling waste will be disposed off to nearby CHWTSDF.
e) Impervious storage area will be provided especially for fuel and lubricant, chemical, hazardous waste, etc.
f) All fuel transfer operations will be conducted in paved areas;
g) Spill of paint/fuel (if any) will be adequately cleaned by trained personnel;
h) Regular monitoring of ground water quality in the vicinity of well sites will be conducted.

7.1.10 Impact on Ecology

Potential Impacts

125. **Habitat Disturbance during onshore Well Pad Construction:** There exists backwater nearby of well pad locations which are potential sites of migratory birds represented by 26 species mostly small waders. These bird species are listed as Least Concern as per IUCN Red list for threatened Category and Sch-IV of Wildlife Protection Act, 1972. There are sufficient wintering shallow water wading sites available in the study area.

126. **Habitat Disturbance during Strengthening of Approach Road and Pipeline Laying:** Existing road to the two onshore wellpad sites will be strengthened. The access road is not part of any critical habitat such as forestland and its strengthening is unlikely to result in any major removal of trees from the shelter belt. The onshore pipeline will be laid along the approach road and will be subsurface. The road and pipeline construction activity may cause temporary habitat disturbances for small burrowing animals.

127. **Noise generation during construction activities (drilling, movement of vehicles, etc.):** Noise generated from the construction activities, drilling and movement of machinery will lead to habitat disturbances to the surrounding avifaunal species (resident as well as migratory).

Mitigations

Mitigation measures to minimize impact on ecology include the following:

a) The project activity of drilling of wells will be limited within the onshore well pad sites. Spill-over of activities on adjoining or other lands will be avoided.
b) Any tree cutting shall be avoided and existing roads will be used to the extent possible.
c) The construction phase should avoid migratory season of birds (Oct-February). In case the migratory season cannot be avoided due to project schedules, early morning and evening activities should be avoided which usually experience peak bird activity;
d) Night activities to be avoided to the extent possible, if the same is unavoidable, then low lights and illumination used should be used.

7.1.11 Impact due to Loss of Land

Potential Impacts

128. The land requirement for an onshore well pad is 3.83 ha (~225m x ~170m), thus for two well pads, there will be requirement of ~8 ha of land. The two well pad sites of WP-7 (RX-8) and WP-8 (RX-9) are not having any settlements / structures and belong to government. Therefore, resettlement and rehabilitation will not be applicable for this Project.

129. The land requirement for the two onshore well pads is ~8 ha. In addition, land of ~12 ha will be required for pipelines corridor of ~8 km on Right of Use (ROU) basis. The land for pipelines corridor will be available for restricted land use.

130. Land for well pad sites will be taken on lease initially for 3 years for exploration purpose and in case of commercially viable discovery of hydrocarbon resources, the land lease for the onshore well pads would be converted into long term lease for life of the Project, also land for pipelines corridor will be taken on RoU basis.

Mitigations

Mitigation measures to minimize impact on loss of land include the following:

a) Vedanta Limited (Cairn Oil & Gas) will compensate all affected landowners for any loss from land resulting out of the proposed onshore drilling program in accordance with their Standard Operating Procedure (SOP) on direct land procurement / lease / renewal / surrender (SOP VL-Land-SOP-DP/LDL-00A3 dated 20 April 2018).
b) Vedanta Limited (Cairn Oil & Gas) will ensure that livelihood of local community, if any affected by the proposed project, are identified and compensated through adequate compensation and other livelihood restoration activities directly or indirectly through CSR activities.

7.1.12 Impacts due to Labour Influx

Potential Impacts

131. There will be average 100 workers engaged for construction of well pads and 80 manpower for activities related to drilling of a well at onshore well pad site which will comprise of technical personnel, skilled workers and support staff. While the technical personnel and skilled workers are expected to be migrant, the unskilled workers (especially required during well pad site development activities) will most likely be local community members. While the engineers and skilled workers directly hired by Vedanta Limited (Cairn Oil & Gas) will be accommodated at the existing living quarters, the contractors will provide accommodation to their workers by hiring rooms and residences on rent in the surrounding villages and some of necessary workers will be accommodated in campsite to be developed at a well pad.

132. This influx of labour for the project activities is thus likely to create both positive and negative impacts on the local community. This migrant workforce is to be hired through contractors and is likely to be comprised of male workers from neighbouring areas /states. In keeping with this, the major potential risks and impacts may include:

- Conflicts with local community due to difference in socio-cultural behaviours between the local community and migrant workforce;
- Increase in pressure on local resources (water, food supplies etc.) and infrastructure (road, local public transportation system etc.);
- Resentment amongst the local community due to competition for employment opportunities in the project;
- Increase in economic opportunities for the local community while servicing the migrant workforce (room rentals, supply provisions, etc.)

Mitigations

Mitigation measures to minimize impact due to labour influx include the following:

a) A code of conduct should be developed for all laborers involved in the project to prevent them from being involved in illegal and immoral activities. This code of conduct should make the workers aware about the local cultural sensitivities and should be made aware about the Sexually Transmitted Diseases and HIV/AIDS;
b) Ensure that the Grievance Mechanism allows for the local community to report any concern or grievance regarding the conduct of the migrant workers.

7.1.13 Impact on Livelihoods and Economic Opportunities

Potential Impacts

133. While no direct additional permanent employment is to be generated, temporary employment opportunities will be created during the well pad development and drilling activities of the Project. It will include opportunities for semi-skilled and unskilled labour for construction of well pads, strengthening of site approach roads and laying of pipelines, economic opportunities due to influx of migrant workers and income generation due to expenditure on supplies and equipment, which together with rentals etc. will provide minor inputs to the local economy.

134. Other than this, the only socio-economic interactions will be with fishermen of the area. The proposed development may result in impacts on fishing and aquaculture activities in the backwater close to onshore well pads in terms of access restrictions.

Mitigations

Mitigation measures to minimize impact on livelihood of local people include the following:

a) Vedanta Limited (Cairn Oil & Gas)'s policy on local content will be implemented for this Project. As per the policy, wherever possible, engagement of local contractors and workers during the construction/ development phase will be preferred.
b) Vedanta Limited (Cairn Oil & Gas) should ensure that livelihood of fishermen, if affected by the proposed development are identified and compensated through other livelihood restoration activities directly or indirectly through CSR activities.

7.1.14 Impacts on Community Health and Safety

Potential Impacts

135. The community within 5 km from well pads WP-7 (RX-8) and WP-8 (RX-9) include villages Chirrayanam, Gachakoyla Pora, Raghvulu Peta, Surasaniyanam, and. All villages are located beyond 1.5 km from any of the well pads. The major community health and safety risks includes:

- Exposure to air and noise pollution;
- Hazards due to operational pipelines and abandoned infrastructure;
- Potential road hazards associated with movement of construction vehicle and equipment;
- Potential exposure to spills, fires and explosions;
- Nuisance due to improper waste handling; and
- Cultural interference due to migrant labour.

Mitigations

Mitigation measures to minimize impact on community health and safety include the following:

a) Fences and warning signs will be put up at appropriate places. Public access control through deployment of adequate security will be implemented for the facility;
b) A community emergency preparedness and response plan that considers the role of communities and community infrastructure will be developed. Community consultations to be done to educate on do's and don'ts to be followed. Clear guidance on access and land use limitations in safety zones or pipelines corridor ROU will be provided.
c) A grievance redressal mechanism will be in place. Vedanta Limited (Cairn Oil & Gas) will regularly monitor the grievances and their solutions during the proposed Project activities.

7.1.15 Impact on Visual Quality

Potential Impacts

136. Physical presence of rig and associated equipment by setting up of rig, DG set and other machineries on well lpads will create an impression of an industrial setup. The well pad sites are all located in rural settings. The industrial setup is likely to cause visual impacts for the surrounding settlements.

137. There will be potential impact due to light and visual intrusion during drilling of wells round the clock drilling over average ~50 days and requires use of strong lighting to illuminate drilling rig at night. Well testing will be conducted at the end of exploratory drilling through ground flaring, thus will have minimum impact of light and visual intrusion.

138. Laying of interconnected pipelines and strengthening of site approach roads along the sea beach. The trenching activity in ~8 km of running length, the storage of soil and materials on the Right of Use (ROU) of the pipelines corridor and the temporary storage of pipelines will create visual disturbance and will be aesthetically displeasing.

Mitigation

139. Following mitigation measures will be in place

a) Storage facility for construction materials will be provided in enclosed sheds within well pad sites;
b) Labour camp with sanitation facility, solid waste collection facilities will be set up within well pad site not in use.
c) All construction activities will be restricted within designated sites;
d) Appropriate shading of lights to be arranged to prevent scattering;
e) Along the coast, trenching for pipelines once laid will be covered immediately with burrowed soil and levelled as per the surrounding land.
f) On completion of work all temporary structures, surplus materials and decommissioning wastes will be completely removed from site and disposed at a designated area.

7.2 Impacts due to Offshore Activities

7.2.1 Impact on Air Quality

Potential Impacts

140. The air emissions during drilling of a development or exploratory / appraisal well will result from:

- Power generation on board rig for drilling of a well through diesel generators;
- Test flaring of hydrocarbon during testing of an exploratory/appraisal well; and
- Dust generation during loading of bulk solids from supply vessels.

141. The emissions due to power generation on board rig and during test flaring have been modelled and the incremental concentrations of PM_{10}, NOx, SO_2 and CO have been found to remain well within the corresponding NAAQS.

Mitigations

142. Mitigation measures will be in place to minimize potential adverse impacts of air emissions on health of receptors. Receptors of air quality include coastal birds and human receptors, which will not be resident in the offshore region. Following mitigations will be in place:

a) Diesel generators to be maintained to achieve high combustion efficiency and therefore reduce emissions;
b) Low sulphur diesel oil will be used;
c) No cold venting to be resorted during well testing;
d) The flare boom shall be so located HC gas concentration on the platform remains within acceptable limits for personnel safety, under worst operating & environmental conditions;

e) Although the crude found in the block is sweet. H_2S gas detectors will be provided onboard the rig to ensure that the exposure to personnel is managed by use of appropriate personnel protective equipment (PPEs);
f) Other fugitive emissions will be reduced by appropriate storage and handling; and
g) Loss of ozone depleting materials from the rig's systems will be kept to a minimum by preventive maintenance of all relevant equipment.

7.2.2 Underwater Noise

Potential Impacts

143. **Noise from Support Vessel:** Support vessels that will be used to guard drilling activities will maintain their position by using thrusters when manoeuvring close to jack up rig. Support vessels generate underwater noise while maintaining their dynamic positioning. Noise produced is typically broadband noise, with some low tonal peaks.

144. **Noise from Drilling Activity:** Drilling of developmental and exploratory wells generate underwater noise as the drill bit penetrates into the seabed strata.

145. It is to be noted that noise from routine helicopter flights during landing and take-off from rig and machinery noise generated from power generating units on-board will have insignificant underwater noise propagation.

146. The increase of underwater noise level may have impact on marine mammals, marine fish population and sea turtles.

147. The underwater noise level in range of 174 to 190 dB re 1 µPa is expected from offshore drilling and 180 to 185 dB re 1µPa is expected from support vessel in offshore locations in PKGM-1 Block. None of the noise sources from the Project are capable of causing instantaneous injury because the source levels are not high enough, even at very short ranges. Considering, a noise source of 190 dB re 1µPa from drilling, the background noise level of 120 dB re 1µPa will be achieved within 3.2 km while threshold for behavioural effects on fish of 160 dB re 1 µPa will be achieved at 31.6 m from source.

148. For operation of support vessel, considering a noise source of 185 dB re 1 µPa, the background noise of 120 dB re 1 µPa will be achieved at 1.77 km while distance for threshold for behaviour effects on fish of 160 dB re 1 µPa will be achieved at 17.8 m from source. The behaviour effect is also related with the fact that marine animal is to remain for 30 minutes or more at this threshold noise level for deafness or behavioural effects.

Mitigations

a) Sudden loud noises, such as from the moving and putting down of heavy equipment, to be avoided, when cetaceans are observed in the region;
b) Vessel and all noise generating equipment to be maintained in good working order.

7.2.3 Ambient Noise

Potential Impacts

149. In offshore region, typical noise generation sources propagating through air include helideck during landing and take-off, rotary bit during drilling, power generation through diesel generators, moving pumps and miscellaneous operations at the control room affectingliving quarters on board the rig. The incremental noise propagation from rig operations within 500 m will be 47.5 dB(A), which together with the baseline noise level will be well within acceptable level.

Mitigations

150. Following mitigations will be in place to minimize ambient air noise levels:

a) Diesel generators at the rig are housed in enclosure at the deck and the exhausts are provided with silencers.
b) Helicopters must maintain a minimum in-transit flying altitude of 500 m;
c) Direct flight paths between Ravva LQ (onshore) and rig must be adhered; hovering or circling over any marine fauna or coastal areas with birds will be avoided;
d) All pilots and crew to be aware that deviations to flight paths are not permitted unless for technical or safety reasons.

7.2.4 Impact on Seabed and Sediment Quality

Potential Impacts

151. **Positioning of Rig for Wells Drilling:** Positioning of the rig due to anchoring at a drilling location may result in temporary physical seabed disturbances and can result in increased turbidity in the water column causing disturbance to benthic and marine faunal health in localised and limited area surrounding the footprint of jack up rig and support vessels near the selected drilling location. A small area of approximately 0.1 km x 0.1 km (0.010 km^2) is expected to be disturbed due to positioning of the rig at a drilling location. As the area is shallow in water depth varying from 10 m to 20 m, it is likely that the majority of organisms being mobile would re-establish themselves in close proximity.

152. Suspended sediment due to seabed disturbance could however lead to the smothering of benthic fauna. The disturbance at seabed is expected to be short-term during positioning of rig and the exposed populations (of low sensitivity) are expected to recover relatively quickly.

153. **Discharge of Drill cuttings and Spent Mud:** Vedanta Limited (Cairn Oil & Gas) is proposing use of water based mud (WBM) for the upper sections and use of synthetic base mud (SBM) for deeper more difficult formations. WBM typically

consists of water, bentonite, polymers and barite. At the end of drilling of a well almost the entire amount of the SBM will be collected for re-use in next drilling operation, while spent WBM will be discharged offshore. It is proposed that ~150 m^3 (~240 tonnes) per well of WBM of low toxicity will be disposed offshore.

154. Drill cutting consists of inert geological material. The amount of drill cuttings generated is estimated to be 220 m^3 (484 tonnes) per drilling of a well planned in PKGM-1 Block. It is estimated that about 4% by weight of drilling mud will remain on the cuttings after treatment. In total, it is therefore anticipated that a mass of 504 tonnes of drilling cuttings will be discharged offshore per well. For the planned drilling of 90 wells (73 exploratory + 17 developmental) in offshore region, Vedanta Limited (Cairn Oil & Gas) will dispose offshore ~45,000 tonnes of drill cuttings over a period of 10 years.

Mitigations

155. Following mitigations will be in place to minimize impact on seabed and sediment quality:

a) Vedanta Limited (Cairn Oil & Gas) will comply with MoEFCC Guidelines for Disposal of Drill Cuttings and Drilling Fluid for Offshore Installation notified as per GSR 546 (E) dated 30 August 2005 under the EP Rules, 1986;
b) Before offshore disposal of drill cuttings and unusable drilling mud (spent WBM only), Vedanta Limited (Cairn Oil & Gas) will ensure prior laboratory composition testing as well as their low toxicity testing, thereby ensuring use of low toxicity chemical additives for preparation of drilling fluids;
c) Only WBM/SBM with low toxicity drilling mud additives shall be used in the programme. Vedanta Limited (Cairn Oil & Gas) will ensure that chemical additives used in the drilling fluid (WBM or SBM) should be biodegradable;
d) Offshore discharges to be done at 3 to 5 m below the sea surface; for offshore disposal within 4.8 km from shore line, prior approval from APPCB will be obtained;
e) Spent SBM will be brought onshore for disposal to CHWTSDF;
f) Vedanta Limited (Cairn Oil & Gas) is to ensure that well wise records of data on quantity and quality of drilling fluid and drill cuttings generation and disposal options used offshore, along with effluent quality is maintained and submitted to MoEFCC every six months as part of the compliance reporting;
g) Vedanta Limited (Cairn Oil & Gas) is required to monitor the petroleum hydrocarbon and heavy metal concentration in the marine fish species regularly and report the same to MoEFCC regularly.

7.2.5 Impact on Marine Water Quality

Potential Impacts

156. **Discharge of Drilling Waste:** Drilling process generates spent drilling mud and drill cuttings. The drill cuttings from the drilling fluid (mud) are separated in shale shakers, desanders and desilters. Waste and mud residues if discharged offshore, these will have potential to cause an increase in suspended solids in the water column and also have toxic effects due to mud additives.

157. **Discharge of Waste water from support facility:** Sanitary wastewater from Rig: Jack up rig operations will typically result in the generation of 30 m^3 per day of sewage and wastes from the kitchen, shower and laundry area (black and grey water). Approximately 12 m^3/day of black water (sewage) and 18 m^3/day of grey water will be generated. Black water will be released to the marine environment after treatment in an on-board STP. The treated wastewater discharge in accordance with Indian discharge requirement as well as MARPOL requirement will not consume dissolved oxygen from marine water and will have high dilution, thus will not impact on marine water quality and marine fauna.

158. **Sanitary wastewater from Barge, Tugs, Support Vessels:** Tugs and support vessels used for the drilling program will generate sewage and wastes from the kitchen, shower and laundry area (black and grey water). Black water will be released to the marine environment at the locations of the support vessels, tugs and barges after treatment in accordance with Indian discharge requirements as well as MARPOL requirement.

159. Wash water and deck drainage runoff including WBM/SBM spills will be recycled to mud system or recirculated in mud preparation. Excess wash water of approximately 200 m^3/ well will be treated to ensure oil and grease content of less than 15 ppm as per MARPOL requirement before offshore discharge at 0.6 m from sea surface.

160. **Bilge water discharge:** Water that accumulates in the drains and bilges of the Rig and other support vessels would likely to become contaminated with low levels of hydrocarbons and other chemicals. Unmanaged discharge of this water to the sea represents a potential impact on local water quality and marine organisms. It is expected that the bilge water will be treated on board and discharged offshore at 0.6 m from sea surface complying with MARPOL requirement of 15 ppm of oil and grease content. Oily water or bilge water containing more than 15 ppm of oil & grease content will not be discharged offshore. It will be treated onboard and oil will be collected in waste oil tank and waste oil will be brought to shore for treatment and disposal.

161. **Cooling water:** Seawater is pumped on board the Rig, where it is deoxygenated and sterilised by electrolysis (by release of chlorine from the salt solution) and then circulated as coolant for various plant, including air conditioning condensers and air compressors. The discharge cooling water will be heated up to 4 to 5ºC above ambient temperature. The anticipated temperature at the sea surface will be in the vicinity of 3ºC above ambient temperature within 15m from point of discharge and less than 0.5ºC above ambient temperature within 100 m from point of discharge. No adverse

impact is expected from the discharge of cooling waters during the drilling of the wells given the fact of rapid dilution of cooling water and relatively smaller volume of cooling seawater involved.

162. The above offshore discharges will be treated as per Indian discharge requirements as well as MARPOL requirement and will not have toxic constituents, hence will have minimum impact on water quality and marine fauna.

163. **Solid Waste:** The solid wastes like packaging materials, paper, plastic, tins, glass, etc. will be generated from the offshore drilling facility. It is proposed to segregate these waste and store it on-board storage facility and dispose them in the land based disposal facility. However, if these waste are disposed in the sea, they can act as potential hazard to seabirds and other marine life through accidental ingestion and if it contains chemical toxins then it can cause poisoning. It also constitutes a visual pollutant as flotsam, either at sea or when it ends up on the shore or the seabed.

164. **Kitchen waste:** Kitchen waste comprises biodegradable food waste. Kitchen waste will be disposed as per MARPOL requirement. Kitchen discharges include food scraps which will be macerated to less than 25 mm particle size and discharged offshore (beyond 3 NM i.e. 5.4 km from shore). If these wastes disposed without maceration, they can pose an issue of food floating on surface and possibly result in choking in marine fishes on consuming the food waste.

165. **Hazardous Wastes:** The hazardous wastes like oily rags, used oil, and oily waste (bilge oil from surface water drainage and waste engine oil) will be generated from offshore drilling activity. As per MARPOL disposal into sea is prohibited. Vedanta Limited (Cairn Oil & Gas) will arrange for its disposal in an onshore disposal facility (CHWTSDF). Any accidental discharge of these hazardous wastes will affect the marine water quality.

166. **Biomedical Waste:** Biomedical wastes like stained bandages, used syringes, blades, etc will be generated from offshore medical room. These waste will be collected in specific bins provided with biomedical waste containing sealable bags for disposal onshore to APPCB approved vendors.

Mitigations

167. Following mitigations will be in place:

a) **Drill Cutting & Drilling Mud**: Vedanta Limited (Cairn Oil & Gas) will comply with MoEFCC Guidelines for Disposal of Drill Cuttings and Drilling Fluid for Offshore Installation notified as per GSR 546 (E) dated 30 August 2005.

b) **Liquid Wastes**: Treatment and marine water dischargse will be undertaken in accordance to the standards prescribed in the Environment (Protection) Rules, 1986 and MARPOL requirements:
   - Rig deck and drainage system will include coamings around the main decks to contain leaks, spills and contaminated wash-down water to minimise the potential for uncontrolled overboard release. A closed drain system will collect hazardous fluids from process equipment in hydrocarbon service; if the deck becomes contaminated, oily deck drainage will be contained by absorbents or collected by a pollution pan for disposal to onshore;
   - Oil discharge monitors are used to ensure oil in water content targets are not exceeded. Records will be maintained of all discharges with oil content to verify controls in place are working effectively. Regular monitoring of drainage discharge for oil content to be analysed to ensure compliance with standards;
   - For any offshore discharges within 4.8 km from shore line, prior approval from APPCB will be obtained;
   - Staff to be suitably trained to deal with spills and discharges;
   - Recording of spills and irregular discharges as incidents, in accordance with required incident report procedures as described in Vedanta Limited (Cairn Oil & Gas)'s Oil Spill Contingency Plan;
   - Provision of screen at the intake pipe of cooling water lift to prevent any entrainment of fish; and
   - The movement of Jack up Rig is required to be monitored to ensure that its movement avoids any MARPOL demarcated sensitive areas en-route to the drilling location in the PKGM-1 Block.

c) **Solid Waste**: Following mitigations will be in place:
   - No garbage would be disposed of to the sea;
   - Wastes will be segregated and stored on-board in appropriate labelled containers and transported back to shore where they will be either recycled or hazardous wastes will be disposed of at an approved landfill CHWTSDF; these wastes will not be discharged to the marine environment;
   - Organic food wastes generated will be macerated to pass through a 25 mm mesh and discharged beyond 3 NM from land with no floating solids or foam. For offshore discharge of food waste within 4.8 km from shore line, prior approval from APPCB will be obtained;
   - Complying with MARPOL standards before disposal. No plastic to be disposed to sea;
   - Plastic, scrap metal and other non-combustibles should be segregated and disposed onshore;
   - Residual solid waste and rubbish generated on the drilling and support vessels should be segregated, weighed and documented in waste manifests prior to disposal at appropriate facilities onshore;
   - Biomedical waste is to be collected in specific collection bins provided with collection bags for onshore disposal; and
   - All hazardous waste (e.g. fluorescent tubes, batteries, oily rags and spent fuel etc.) will be collected and retained on-board for final disposal at onshore CHWTSDF reception facilities.

7.2.6 Marine Ecology

Potential Impacts

168. Impacts due to sea bed disturbances: A small area of approximately 0.1 km x 0.1 km (0.010 km^2) is expected to be disturbed due to positioning of the jack–up rig at a drilling location in offshore part of the PKGM-1 Block. As the area is shallow in water depth varying from 10 m to 20 m, it is likely that the majority of organisms would be mobile to re-establish themselves in close proximity. Suspended sediment due to seabed disturbance can lead to short term smothering of benthic fauna.

169. Impacts due to underwater noise: Potential underwater noise generation have been identified due to:

    a) Propellers and thrusters of support vessels engaged for drilling of development and exploratory wells and laying of subsea pipelines;
    b) Rotation of drilling bits while drilling of wells;

170. Pathological damage or mortality and behavioural disturbance occur to marine fauna due to underwater noise source if located in immediate vicinity when noise level is 160 dB re 1µPa at 1 m or more and marine animal remain within this threshold for 30 minutes or more as against the background noise level of 120 dB re 1µPa (also refer to description given above in paragraphs 147 & 148). Underwater noise is unlikely to cause damage or disturbance to marine mammals in shallow water area, as marine mammals generally occur in water depth of 50 m or more which is present beyond 5 km from existing facilities in PKGM-1 Block. Behavioural impacts if any are likely to be limited to individuals in the vicinity of noise source as marine fauna will tend to avoid being closer to the noise source.

Mitigations

171. Following mitigations will be in place

    a) Contractor to visually inspect the area before start of activities;
    b) Sudden loud noises, such as from the moving and putting down of heavy equipment, will be avoided when cetaceans are observed in the region;
    c) The vessel and all noise generating equipment will be maintained in good working order;
    d) Noise emissions should begin at low power, increasing gradually until full power is reached. The soft start procedure should be of 20 min duration at least;
    e) Dedicated and independent Marine Mammal Observers (MMO) should watch the Exclusion Zone (EZ) for 30 min before the beginning the soft start procedure (120 min for highly sensitive species).

7.2.7 Impacts on Community Health and Safety

Potential Impacts

172. The receptors for impacts on community health and safety include the settlements near shore areas and fishermen likely to interact with the offshore facilities and activities. The major community health and safety risks include:

    a) Potential exposure to spills, fires and blowouts;
    b) Accidents involving fishermen and fishing vessels;
    c) Hazards due to operational pipelines and abandoned infrastructure;
    d) Exposure to noise pollution; and
    e) Improper waste management.

173. In the event of a serious oil spill, significant and long lasting impacts (potentially in excess of 5 years) are anticipated on socio-economic resources particularly fisheries/aquaculture resources in the areas.

Mitigations

174. Notification of the location of offshore facilities (including subsea hazards) and the timing of offshore activities should be provided to local and regional maritime authorities, including fishery groups. The position of fixed facilities and safety exclusion zones should be marked on nautical charts. Clear instructions regarding access limitations to exclusion zones should be communicated to other sea users.

175. Subsea pipeline routes should be regularly monitored for integrity and if required should be repaired in a timely manner.

176. A spill response plan should be formulated. This plan should include arrangements for the Public training to warn of existing hazards, along with clear guidance on access and land use limitations in safety zones or pipeline rights of way. The spill response plan should be effectively communicated to the fishing community.

177. The grievance redressal process should be regularly tracked and monitored as part of the management function.

8.0 ONSITE RISKS & MITIGATIONS

178. Risk Assessments for both onshore and offshore activities have been undertaken as part of the EIA Study. From onshore activities, following risk scenarios have been identified:

    a. Blowouts / loss of well control (resulting in blowout pool fire);
    b. Hydrocarbons leaks due to loss of containment while drilling & testing (resulting in flash fire and jet fire); and

c. Interconnecting hydrocarbon pipeline network failure (resulting in jet fires associated with pipework failures, vapour cloud explosions and flash fires).

179. As per the consequence modelling results, the effect zones are expected to remain within 200 m from the release site for the heat effect threshold of 5 kW/m^2. The overall potential loss of life (PLL) for a platform operations was estimated to be 4.59 x 10^{-4} per year. The transportation accident risk was found to be the highest risk contributor to the overall risk, which accounts for approximately 89% of the total PLL due to the high frequency. The Individual Risk for workers working on a platform was calculated to be 4.98 x 10^{-5} per.

180. A Ravva Field Emergency Response Plan (RFERP) has been specifically developed by Vedanta Limited (Cairn Oil & Gas) for operations and associated activities related to PKGM-1 Block . This plan applies to the emergency situations that are likely to arise in the following operations at onshore Ravva Terminal, off-shore platforms, marine operations, helicopter operations, living quarters and vehicle transport operations.

181. An oil spill modelling study of 2017 by Environ Software, sponsored by Vedanta Limited (Cairn Oil & Gas), covered all the months in a year for stochastic and fates for three spill sizes 100, 1,000, and 5,000 tons of Crude oil spill. The outcome of the study indicated that spills during:

- January and March moves to Southwestern coastal zone of PKGM-1 Block,
- February, April and June moves towards Northeastern coast of PKGM-1 Block,
- May moves to Northern coast of PKGM-1 Block,
- July, August and September moves towards North eastern direction open sea; and
- October, November and December moves towards south-western direction open sea.

182. The most vulnerable zone of shoreline landing is on either side of the Ravva Basin; in north/south and west direction. The spilled oil will be moving towards the coast and hence there will be impact on the marine sensitive areas on the shore during January to June. The spills during July to December, moves towards open sea either in eastern or western open boundary hence there will not be impact on the marine sensitive areas on the shore. The spilled crude oil undergoes a number of physical and chemical changes. The major weathering processes, include spreading, evaporation, dispersion, emulsification, dissolution, oxidation, sedimentation and biodegradation. It is estimated that 40% of oil is evaporated within 4 days and very small quantity of oil dissolved into the water. The weathering processes of oil spill are more or less similar in various scenarios irrespective of quantities of oil spill, but it differs depending on the spill landing time, wind speed and temperature. Indepth analysis of the oil spill model results help in formulating a response strategy to prevent, control and manage spills.

183. Accordingly, an Oil Spill Contingency Plan (OSCP) for Ravva operations has been developed by Vedanta Limited (Cairn Oil & Gas). The OSCP has been prepared as per the National Oil Spill Disaster Control Plan (NOSDCP) Guidelines issued by the Indian Coast Guard (ICG) and is intended to respond to any unforeseen oil spills from the operations in the PKGM-1 Block with the involvement of all line personnel in a timely and duty bound manner in order to reduce the effects of such spills on loss of property, damage to marine environment and effect on Company's reputation. The plan is to primarily deal with oil spill emergencies resulting from exploration, production and transportation of crude oil from the Ravva offshore facilities and include the surface facilities viz., platforms, drilling rigs, vessels and subsurface pipelines and all other associated infrastructure required for the production operations. Vedanta Limited (Cairn Oil & Gas) has also taken up membership of International Oil Spill Response Limited, a service provider for combating with any situation of oil spill.

9.0 ANALYSIS OF ALTERNATIVES

184. The PKGM-1 Block has been assigned to Ravva JV by MoPNG in accordance with the PSC. Vedanta Limited (Cairn Oil & Gas) on behalf of Ravva JV proposes exploit contingent hydrocarbon resources. Therefore, there are no options for alternative locations for the PKGM-1 Block and proposed activities within onshore and offshore region of the Block. The basis for selection of a drilling site is dependent on the geophysical and geological interpretations of the prevailing underground strata. Identification of locations for drilling of wells is determined based on data suggesting presence of oil and gas in the area and hence it is therefore implied that the location for drilling cannot be altered.

185. The Project has revised drilling of wells now from two onshore well pads as against earlier proposed eight onshore well pads. Well pads 1 to 5 that were located outside the block have been withdrawn from this proposal due to expected delay in approval from DGH while well pad 6 is withdrawn for environmental reasons. There will be drilling of 33 nos. onshore wells (10 exploratory+23 developmental) from two onshore well pads i.e. WP-7 (RX-8) and WP-8 (RX-9) and 90 nos. offshore wells (73 exploratory+17 developmental wells). All wells will be drilled from within the block.

186. The Project has considered route alternatives for the onshore pipelines corridor proposed between the onshore well pads and the onshore Ravva Terminal. The pipelines corridor has been revised from 15 km length to 8 km due to revision in development of well pads. The recommended alignment avoids water logged area as much as possible and is routed on the landward side of the beach thereby causing minimum disturbance in the beach side area.

187. Whilst not undertaking the contingent resource exploitation to enhance oil and gas production from within the PKGM-1 Block, as per already approved capacity, it would avoid any potential environmental impacts, but at the same time it would preclude the Government of India and the society at large from enjoying the socio-economic benefits from production of oil and gas from national reserves.

10.0 ENVIRONMENTAL MANAGEMENT PLAN

188. An Environmental Management Plan (EMP) has been developed based on established requirements of an environmental management system covering Planning, Implementation, Checking and Review phase to overall ensure continual improvement. The EMP defines Vedanta Limited (Cairn Oil & Gas)'s EHS Policy, EHS Management System (EHSMS), and relevant applicable Indian environmental regulatory and MARPOL requirements. The EMP summarises potential impacts associated with the proposed oil and gas development in the onshore and offshore region of PKGM-1 Block and clearly set out the corresponding control/mitigating measures that need to be implemented. The EMP also set out the organization structure and the environmental monitoring programme for key environmental parameters to be monitored in respect of environmental performance and management review process.

189. The EMP will be a "live" document. It will be reviewed by the Project team prior to start of any activity related to proposed oil and gas exploration and development in consultation with Vedanta Limited (Cairn Oil & Gas)'s HSE department. Periodic review and audits will be done for effective management of environment system and accordingly, where required during the Project life cycle, the EMP will be updated as needed to provide effective management of environmental issues.

190. Vedanta Limited (Cairn Oil & Gas), its contractors and its logistics providers have to implement EMP together with actions on commitments arisen from statutory public consultation held on 11 October 2018, commitments on actions identified with budget of INR 20 Crores to be spent over 10 years on corporate environmental responsibility (CER) and compliance of conditions of regulatory approvals. Overall responsibility of compliance of requirement lies with operator of the block i.e. Vedanta Limited (Cairn Oil & Gas).

11.0 CONCLUSION

191. The EIA study has been revised to restrict development of two onshore well pads as against eight onshore well pads proposed earlier without altering number of wells to be drilled. In all over 10 years period there will be drilling of 123 wells i.e. 33 nos. onshore wells (10 exploratory + 23 developmental to be drilled from two onshore well pads) and 90 offshore wells (73 exploratory + 17 developmental) to be drilled from existing platforms and standalone location within the PKGM-1 Block. The EIA study indicates that the overall impact, in already developed PKGM-1 Block and associated facilities, from the proposed expansion by drilling of additional wells in onshore and offshore parts of the Block will be short to medium term, reversible, localised and are not expected to contribute significantly to the surrounding environment given the compliance of the EMP.

192. Mitigation measures have been suggested to minimize adverse significant environmental impacts. A Wildlife Conservation Plan for Schedule 1 species observed/reported in the study area has been prepared for its implementation (Annex 21). Risk assessment including oil spill analysis has been included as part of the study. Vedanta Limited (Cairn Oil & Gas) has developed an Oil Spill Contingency Response Plan, which will be implemented in the event of any oil spill. An EMP has been developed to cover implementation mechanism for recommended mitigation measures to counter likely adverse environmental impacts arising due to drilling of offshore and onshore wells, strengthening of access roads and laying of ~8 km onshore pipelines corridor connecting two onshore well pads with the onshore Ravva Terminal. With the implementation of the embedded pollution control mechanisms and strengthening of the existing environment and risk management measures, the anticipated impacts from the proposed drilling Project will be mitigated.

193. Vedanta Limited (Cairn Oil & Gas) will also ensure that the environmental performances of all the activities are monitored throughout execution of various Project components. Hazard and consequence monitoring will also be included to cover health and safety related aspects, incidents of accidental spills and effective health and safety management before, during post drilling of wells. Vedanta Limited (Cairn Oil & Gas) will continue to report environmental performance and submit monitoring reports regularly to statutory authorities.

194. The effective management system coupled with monitoring of environmental components and efforts for continual improvements will result in satisfactory environmental performance for the proposed expansion of oil and gas exploration, development and production as planned in the exiting PKGM-1 Block.

1 INTRODUCTION

1.1 BACKGROUND

Vedanta Limited (Cairn Oil & Gas)[1] is one of the largest independent oil and gas exploration and production companies in India. On behalf of Ravva Joint Venture, Vedanta Limited (Cairn Oil & Gas) (erstwhile Cairn India Limited) has been carrying out oil and gas operations in PKGM-1 Block located in the Bay of Bengal in the Krishna-Godavari Basin near Surasaniyanam Village, Uppalaguptam Mandal in East Godavari District, Andhra Pradesh.

Vedanta Ltd (Cairn Oil & Gas), hereinafter also referred to as Cairn (Oil & Gas), is the Operator of Ravva Joint Venture comprising of Oil & Natural Gas Corporation Limited (ONGC), Vedanta Ltd (Cairn Oil and Gas), Videocon Industries Ltd. and Ravva Oil Singapore Pty. Ltd. (ROS) as per the ***Table 1.1*** of participating interests.

Table 1.1 Ravva JV Parties & their Participation Interest in PKGM-1 Block

Ravva Joint Venture Partners	Participating Interest
Oil and Natural Gas Corporation Ltd.	40.0%
Vedanta Limited (Cairn Oil & Gas) [erstwhile Cairn India Limited]	22.5%
Videocon Petroleum Ltd	25.0%
Ravva Oil (Singapore) Pte Ltd	12.5%

Source: Vedanta Limited (Cairn Oil & Gas)

1.2 OVERVIEW OF THE PROJECT

Oil and Gas exploration and development activities in the PKGM-1 Block (also referred to as Ravva Field or Ravva Block) are being taken up as part of existing Production Sharing Contract (PSC) for PKGM-1 Block signed by Ravva JV with the Ministry of Petroleum and Natural Gas through Directorate General of Hydrocarbons, Government of India. The Block has an area of 331.26 sq. km (km^2).

The oil & gas field was discovered in 1988 by ONGC. On 28 October, 1994 when the PSC was signed, the offshore facilities included 4 wells, 2 platforms and 2 pipelines for production of 3,000 Barrels of Oil per day (BOPD) with an onshore processing capacity of 8,600 BOPD. The Ravva JV commenced operations in 1995 and over the years increased production capacity and upgraded facilities. The operatorship of the field was transferred in 1995 to Command Petroleum (India) Pty Ltd which subsequently in 1997 was transferred to Cairn Energy India Pty Limited (CEIL).

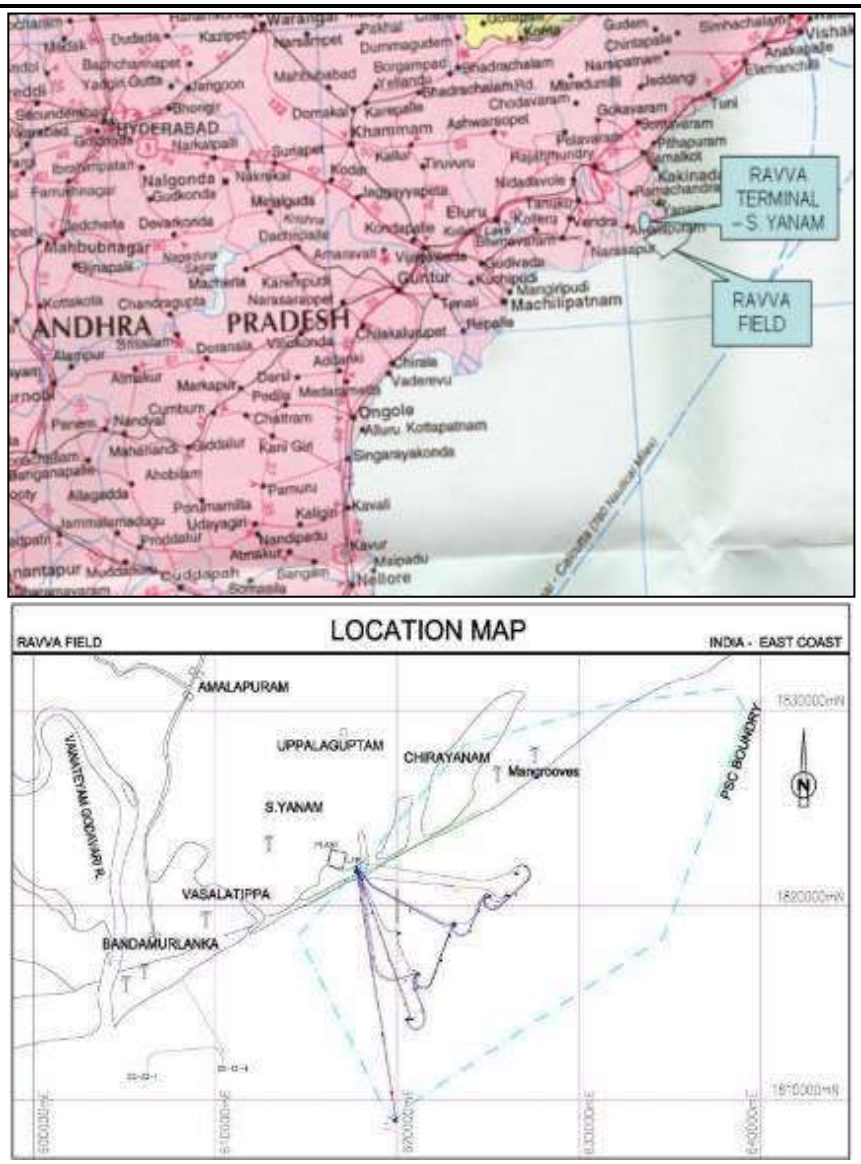
1.2.1 Block Location

The PKGM-1 license area (covering 331.26 km^2) is located mainly (93%) in the offshore region with only a small portion of the block in onshore areas (7%). The sea coast forms the western boundary of the block. Location of the Ravva Field is shown in ***Figure 1.1.*** The offshore block is located in the East Godavari District of Andhra Pradesh. Kakinada is the nearest port town

[1] Cairn India Ltd. got merged with Vedanta Limited with effect from 11th April, 2017

located at ~50 km to the north east of the block. The Vishakhapatnam major port is located ~ 200 km to the north east of the block.

Figure 1.1 Locations of PKGM-1 Block & Onshore Terminal



The block extends between Latitudes: 16° 20′ 44.8″ N to 16° 33′ 26.6″ N and Longitudes: 82° 04′ 17.3″ E to 82° 19′ 04.3″ E. The coordinates of seven apex points of the PKGM-1 Block are listed in ***Table 1.1*** and depicted in ***Figure 1.2.***

Table 1.2 Coordinates of Apex Points of PKGM-1 Block

Apex Point	Distance from Coast #	Latitude	Longitude
A	+2.2 km	16°26'14.93"N	82° 4'12.10"E
B	- 2.2 km	16°31'51.99"N	82° 9'43.38"E
C	- 0.7 km	16°33'3.81"N	82°14'36.43"E
D	+1.5 km	16°33'30.09"N	82°18'32.01"E
E	+3.1 km	16°32'40.78"N	82°18'59.00"E
F	+12.0 km	16°26'6.82"N	82°16'11.03"E
G	+13.6 km	16°20'48.36"N	82° 7'8.59"E

Note: # positive (+) sign indicates distance from shore to seaside & negative (–) sign indicates distance from shore to landside.

1.2.2 *Brief Status of Activities in Ravva Field*

Existing Offshore Facilities

There are presently eight unmanned offshore platforms, a single point mooring (SPM) and subsea pipelines within the offshore areas of the block. An onshore terminal is located around ~1.0 km from the seashore on landward side. The location coordinates of the offshore facilities are given in ***Table 1.3***.

Table 1.3 Coordinates of Existing Offshore Facilities within PKGM-1 Block

S.N.	Surface Facility	Distance from Coast #	Easting, m.	Northing, m.
1	RA platform	+9.1 km	620732.810	1813336.220
2	RB platform	+4.5 km	627387.060	1821896.650
3	RC platform	+9.1 km	620796.250	1813368.590
4	RD platform	+7.2 km	621333.280	1815822.200
5	RE platform	+5.5 km	623600.130	1818798.840
6	RF platform	+5.0 km	625657.150	1820443.190
7	RG platform	+5.65 km	626947.800	1820516.160
8	RH platform	+4.48 km	620010.160	1818267.240
9	Single Point Mooring (SPM)	+13.5 km	619864.820	1807452.840

Note: # # positive (+) sign indicates distance from shore to seaside & negative (–) sign indicates distance from shore to landside; Distances are indicated from Centre of Platform. A new RI Platform in offshore region approved previously through EC and CRZ Clearances by MoEFCC is yet to be established by Vedanta Limited (Cairn Oil & Gas).

Development Wells Drilled in Block

Within the PKGM-1 Block, there exists 55 development wells of which as of now 6 are self-flow producing, 16 are gas lift wells and 9 are injectors spread over on 8 well head platforms (refer ***Table 1.4***), interconnecting pipelines, land terminal at Surasaniyanam (with oil and gas processing and water injection facilities), Single Point Mooring (SPM), and Export pipelines for transport of crude.

Table 1.4 Number of Development Wells Drilled in PKGM-1 Block (as on 31 Dec 2019)

S.N.	Well Description	Number of Wells
1	Self-Flow Producing Wells	6
2	Gas Lift Producing Wells	16
3	Shut in Non-Producing wells	12
4	Injector Wells	9
5	Suspended Wells	4
6	Abandoned Wells	8
	Total	**55**

Pipeline Network

Oil and gas from offshore wells are routed through subsea pipelines to onshore Ravva Terminal located ~1 km from shore near Surasaniyanam Village (also referred to as S.Yanam) in the East Godavari District of Andhra Pradesh. The offshore platforms (RA, RB, RC, RD, RE, RF, RG and RH) are connected through pipelines (of total running length of ~192 km) to onshore Ravva Terminal (RT), transporting wellhead production fluid, injection water, non-associated gas, lift gas etc. The pipeline network is schematically presented in ***Figure 2.6.***

Onshore Oil & Gas Processing Terminal

The existing Ravva Terminal provides for three-stage separation of incoming well fluid through three trains of processing/ stabilization units. The facilities available at Ravva Terminal includes:

- Gas Recovery compressors and treatment plant;
- Gas lift booster compressor (GLBC);
- Crude oil storage tanks;
- Produced Water Handling and Water Injection Facilities;
- Captive Power Generation facility of 10 MW;
- Living Quarters with 90 rooms to accommodate single and double occupancy (available onshore near Ravva Terminal);
- Effluent and Sewage Treatment Plants.

Chronology of Development and Environmental Clearance

A chronology of developments within the Ravva Field and the Environmental Clearances obtained for oil and gas developmental activities from MoEFCC are listed in **Table 1.5.**

Table 1.5 Chronology of Developments within Ravva Field in PKGM-1 Block

Year	Details
1988	Ravva Field was discovered by ONGC
1990	Preliminary EC No. J-11011/11/90-IA dated 30 July 1990 (Phase-I) issued by MoEFCC for oil production from Ravva Offshore Field in the Godavari Basin & Onshore Field Terminal at S.Yanam
1991	Final EC No. J-11011/6/91-IA (Phase-I) dated 19 December 1991 issued by MoEFCC for oil/gas production from Ravva Offshore Field and Onshore Field Terminal at S.Yanam
1993	ONGC commenced operations
1994	PSC signed by Ravva JV (Command Petroleum as the Operator of the Block) with the Government of India for operation of offshore facilities which included 4 wells, 2 platforms and 2 pipelines for production of 3,000 Barrels of Oil per day (BOPD) with an onshore processing capacity of 8600 BOPD).
1995	Ravva JV commenced operations, over the years increased production capacity, and upgraded facilities.
1996	EC No. J-11012/59/95-1A-II(I) dated 03 July 1996 issued by MoEFCC for Oil Production from Ravva Offshore Field in Godavari basin and Onshore Field Terminal at S.Yanam
1997	Operatorship of the field transferred to Cairn Energy India Pty Limited
2001	Environmental Clearance No. J-11011/84/2000-IA-II dated 30 Jan 2001 issued by MoEFCC for Ravva Satellite Gas Development Project
2001	Environmental Clearance No. J-11011/50/2001-IA-II dated 17 Sep 2001 issued by MoEFCC for Exploratory Drilling of 8 wells for oil and gas in PKGM-1 Offshore Block in east coast of India in the Bay of Bengal
2005	Environmental Clearance No.J-11011/207/2004-IA-11 dated 04 Aug 2005 issued by MoEFCC for 15 Infill Well Drilling (Development Wells) in Ravva Oil Field (PKGM-1 Block), Bay of Bengal, AP
2006	Environmental Clearance No. 10-28/2004-IA-III dated 31 March, 2006 issued by MoEFCC for two exploratory drilling in onshore areas of PKGM-1 Block located in Chirrayanam Village, Uppulaguptam Mandal in East Godavari District
2012	Operatorship changed from Cairn Energy India Pty Limited to Cairn India Ltd
2015	Environmental Clearance No. J-11011/81/2013-IA-II dated 23 Feb 2015 issued by MoEFCC for oil and gas development (setting up RI Platform & drilling of 20 developmental + 6 exploratory wells) in existing PKGM-1 Block, located off S.Yanam in the Bay of Bengal, East Godavari District, AP
2017	Cairn India Ltd. got merged with Vedanta Limited with effect from 11April 2017
2017	CRZ Clearance No. 11-20/2015-IA III dated 25 May 2017 issued by MoEFCC for oil & gas development (setting up RI Platform & drilling of 20 developmental + 6 exploratory wells) in existing PKGM-1 Block, located off S.Yanam in the Bay of Bengal, East Godavari District, AP.

1.3 PROJECT PROPOSAL

In order to regain declined hydrocarbon production from within the PKGM-1 Block to the maximum extent possible, Vedanta Ltd (Cairn Oil & Gas) now proposes oil and gas exploration (including appraisal), development and production as presented in ***Table 1.6.***

Table 1.6 Project Proposal

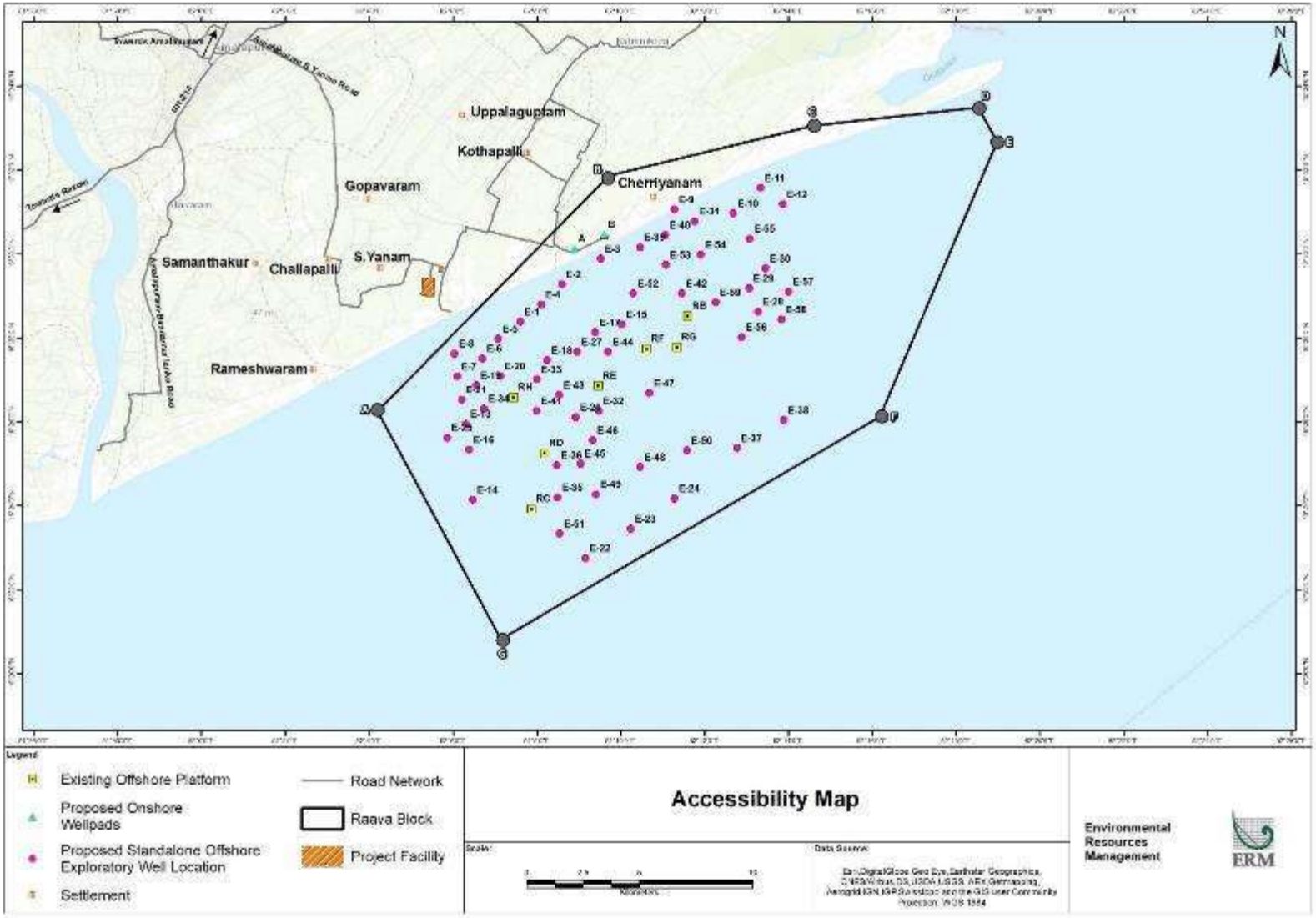
SN	Proposal	Description
1	Drilling of 123 oil and gas wells	a) **83 Exploration wells** (59 from standalone offshore locations + 10 from two (2) onshore well pads + 14 from existing offshore platforms) b) **40 Development Wells** (23 from 2 onshore pads + 17 from existing offshore platforms)
2	Establishing 2 nos. of onshore well pads (typical dimensions of a well pad of ~225m x ~170m) ##	Two onshore well pads existing inside PKGM-1 Block earlier developed in 2006-07. A typical well pad will include facilities for tapping of hydrocarbon fluid and its transportation to Ravva Terminal.
3	Additional ~8 km long pipelines corridor for transfer of hydrocarbon fluid, surface gas lift and injection water at well pads to and from Ravva Terminal	Pipelines corridor of ~8 km length 15 m wide will comprise of three pipelines (accommodating three pipelines) of: a) 8″ sub surface crude oil (well fluid) pipelines connecting onshore well pads to Ravva Terminal b) 6″ sub surface gas lift pipeline connecting onshore well pads to Ravva Terminal. c) 14″ sub surface injection water pipeline connecting onshore well pads to Ravva Terminal.

Note:

1) The locations proposed for drilling of 123 wells are given in ***Table 2.7*** in ***Section 2.***
2) The onshore well pads have been reproposed to two locations which are located within the block after withdrawal of wellpads that were proposed to be located outside the PKGM-1 Block in ONGC PML area and wells to be drilled from such locations will now be drilled from two onshore previously developed well pads numbered as WP-7 (RX-8) or WP-A and WP-8 (RX-9) or WP-B.
3) ##The above given each onshore well pad dimensions represent a typical size of 225 m x 170 m, however, configuration may change depending upon the land availability.
4) Existing approach road will be strengthened to access to the two onshore well pads.

The above proposal is to tap existing hydrocarbon resource pools (that are already being tapped), other discovered undeveloped, near field exploration. MM (Middle Miocene) development and recent perforated LLM (Lower Late Miocene) pools have been reviewed for development based on interpretation of new subsurface data and have been selected for development as part of this Project. The selection is based on the risks, recoverable hydrocarbon volumes and economics.

Figure 1.2 PKGM-1 Block & Drilling Locations of Proposed Wells



1.4 NEED OF THE PROJECT (PROJECT JUSTIFICATION) & ITS IMPORTANCE TO THE COUNTRY

The hydrocarbons sector plays vital role in the economic growth of the country. With the increasing gap between the demand and supply in the hydrocarbons, the scenario is a challenge for India. India depends on imported crude to meet 75 to 80% of its rapidly growing demand for petroleum products. The hydrocarbon resources available in the Ravva (PKGM-1) Block is of immense importance for the country and will help in the growth of the economy and stride to reduce gap of crude oil imports versus self-sufficiency. The production from PKGM-1 Block within already approved capacity will benefit the country by reducing the import bill, save foreign exchange, and contribute to annual revenue to the Government of India.

Over the years due to aging of the field, production of oil and gas has been declined. The on-shore processing facility though has APPCB approved capacity to produce 50,000 barrels of oil per day (BOPD) crude oil and 2.32 million standard cubic meter per day (MMSCMD) of natural gas, the field is presently producing ~ 15,000 BOPD of crude oil and ~1.4 MMSCMD of natural gas.

1.5 EMPLOYMENT GENERATION

Vedanta Limited (Cairn Oil & Gas) operation provides direct, indirect or contractual employment opportunities to 400 people; however most of the employment benefit is restricted to the Surasaniyanam Village only.

The proposed exploration, development and production Project does not anticipate increase in the operations crew. There would however be employment generation during construction of well pads, drilling and laying of onshore pipelines. Wherever possible, engagement of local contractors and workers during the project phase will be preferred.

1.6 PROJECT SCHEDULE & COST ESTIMATE

Vedanta Ltd (Cairn Oil & Gas) has planned to develop the available hydrocarbon resources from the PKGM-1 Block in next 10 years. Drilling of a well together with mobilization and demobilization takes ~90 days. Drilling activities of a developmental well takes average ~45 days and of an exploratory well takes average ~55 days.

The cost of the Project is estimated to be ~ INR 7,924 Crores.

1.7 APPROACH & METHODOLOGY FOR THE EIA STUDY

The approach adopted for the conduct of EIA study is as per the following description:

1.7.1 Step I: Screening

The screening exercise involved:

- Reviewing high level Project Description and activities including alternatives considered by Vedanta Ltd (Cairn Oil & Gas) and identifying their potential impacts on the various environmental parameters;
- Reviewing high level applicable regulatory framework for proposed and existing operations;
- Compiling high level available baseline data for the block and other relevant information;
- Categorization of EIA study under the EIA Notification, 2006

1.7.2 Step II: Scoping Exercise involving submission of Application for Terms of Reference & Appraisal by EAC for Scoping for the EIA study

The purpose of scoping exercise was to identify the likely project activities (as described in Project Prefeasibility Report) influencing environmental components which should be covered in the environmental information as part of the EIA study to be submitted by the developer Vedanta Ltd (Cairn Oil & Gas) in this case) to the regulatory agency (MoEFCC in this case) and, in particular to identify the prevailing environmental baseline conditions which are to be studied in detail. The scoping included identification of range of environmental and socioeconomic topics to be studied (technical scope), the geographical area to be covered (spatial scope) and the timeframes over which the Project will be carried out (temporal scope).

As per requirement of the EIA Notification, 2006, an application for terms of reference (covering checklists as per Form 1 and draft terms of reference) for the EIA study was developed and submitted to MoEFCC on 24 January 2018. The MoEFCC issued the terms of reference for preparation of EIA/EMP study on 24 March 2018 (refer to ***Section 13***), based on which this EIA study has been conducted.

1.7.3 Step III: Project Description

A detailed section on Project Description was developed as per the Project Prefeasibility Report together with additional Project related information collected from Vedanta Ltd (Cairn Oil & Gas). The Project Description covered in ***Section 2*** has been considered as inputs for the impact assessment.

1.7.4 Step IV: Environmental Baseline Data Compilation

As assessed through scoping study, environmental baseline information was collected and compiled from primary and secondary sources.

Primary environmental monitoring in the onshore area surrounding the PKGM-1 Block was collected during Jan – Mar 2018 as part of this EIA Study. Marine monitoring around the offshore installations of Ravva Field was also conducted during April 2018 as part of the present Study. Terrestrial and marine environmental baseline information was also established through ecological study along with socio-economic and other environmental surveys conducted by ERM for the study area surrounding the Ravva Terminal and PKGM-1 Block and through review of available secondary information and studies conducted previously by Vedanta Ltd (Cairn Oil & Gas) in this block.

1.7.5 Step V: Impact Assessment & Analysis of Alternatives

The methodology for assessing impacts associated with the proposed exploration, development and production in the block is presented in ***Section 4*** on **Impact Assessment**. The section covers identification, prediction and quantification through modelling (where appropriate) of potential impacts due to the proposed Project on terrestrial and marine environment.

Mitigation measures have been suggested for significant adverse impacts before, during and after implementation of the Project related activities. The Impact Assessment section discusses the outcomes of the environmental impacts and outlines mitigation measures that are recommended to minimize adverse environmental impacts keeping in mind the compliance with the applicable environmental standards.

The impacts have been assessed based on the proposed activities (as per information provided by Vedanta Ltd (Cairn Oil & Gas), conditions of existing environmental approvals and prevailing environmental baseline conditions in the onshore and offshore regions surrounding the Project activities within Ravva Field. The accuracy of predictions depends upon methods used and quality of the input data available at the EIA stage and the prevailing environment conditions. The impacts have been identified and quantified for the intensity using modelling and/or matrix techniques and evaluated as major, medium, minor or insignificant impacts on the environment. The likely impacts due to oil spills have been included to assess likely consequences on marine environment and nearby coastal areas. Worst-case scenarios have been assumed where uncertainty prevailed and mitigation measures have been developed accordingly. Unplanned events have been identified as part of the risk assessment process. Risk mitigation measures have been included to minimize potential risks.

Analysis of alternatives (see ***Section 5***) has been presented for significant residual impacts to ensure that implementation of alternatives would result in potential adverse impacts and associated risks within acceptable range.

1.7.6 Step VI: CRZ Mapping by MoEFCC Authorised Agency

The recommendation for CRZ Clearance (No Objection Certificate) in this case granted by Andhra Pradesh Coastal Zone Management Authority (APCZMA) with the concurrence of MoEFCC, under the CRZ Notification 2011. The CRZ Notification mandates that a project proponent shall apply for prior clearance to the concerned State Coastal Zone Management Authority and submit documents like Form-1 (Annexure-IV of the notification) and EIA Report; and CRZ map prepared by MoEFCC authorised agency.

In this regard, National Centre for Sustainable Coastal Management (NCSCM), Chennai (a MoEFCC authorised agency) has been engaged for CRZ mapping applicable to the PKGM-1 Block. NCSCM has prepared the CRZ map indicating HTL and LTL in 1:4000 scale and the same has been submitted to APCZMA. NOC dated 3 April 2019 from APCZMA in this regard has been received.

1.7.7 Step VII: Environmental Management and Monitoring Plan

Based on the findings from the impact assessment process, an Environmental Management Plan (EMP) (in ***Section 9***) has been developed for the proposed oil and gas exploratoration, development and production from PKGM-1 Block.

Specific actions to counter the significant adverse impacts have been highlighted in the EMP. The potential impacts identified and recommended mitigation measures are based on the following:

- Project information provided by Vedanta Ltd (Cairn Oil & Gas);
- Baseline information within and surrounding the PKGM-1 Block;
- ERM's past experience in similar projects; and
- Standard international environmental management practices.

The EMP includes the following:

- Introduction to the purpose of the EMP;
- Institutional framework for implementation of the EMP;
- Summary of potential adverse impacts and specific actions to minimise impacts on marine water and biological environment;
- Environmental control technologies, safeguards, sub management plans etc. for mitigation of adverse impacts and associated risks;
- Management of accidental spills of chemicals and oil, control measures.

The monitoring requirements have been separately indicated in ***Section 6*** of this EIA Report.

1.7.8 Step VIII: Statutory Public Consultation

APPCB conducted Public Consultation on October 11, 2018 for the proposed Project as per the procedure defined in the EIA Notification, 2006. The environmental concerns expressed during the consultation have been incorporated in this final EIA Report.

1.7.9 Step IX: Project Approvals

The EIA study assesses impacts and associated risks due to the proposed Project activities in already operating Ravva Field, PKGM -1 Block, and delineates for Vedanta Ltd (Cairn Oil & Gas) to implement agreed specific actions as defined in the EMP together with monitoring plan as part of its environmental management system.

This EIA study along with the CRZ map (prepared by MoEFCC authorised agency) becomes guiding documents for decision making for the proposed Project related approvals by MoEFCC under the EIA Notification, 2006 and APCZMA under the CRZ Notification, 2011.

1.8 SCOPE OF THE EIA STUDY

The scope of work involves conducting an EIA study as per terms of reference approved by Expert Appraisal Committee of MoEFCC for the proposed Project. In this regard, the Term of Reference (TOR) for the EIA study issued by MoEFCC on 24 March 2018 is included in ***Section 13.***

Overall, the EIA study covers the following key elements:

- Establishing the prevailing environmental and socio-economic baseline conditions prevailing in and area surrounding the PKGM-1 Block;
- Impact assessment, development of mitigation measures and environmental management plan together with development of sub management plans and procedures for effective environmental controls;
- Risk assessment and risk mitigation measures for the safe proposed activities; and
- Environmental Management Plan including environmental monitoring planning for effective implementation of suggested mitigation measures required for the significant adverse impacts.

1.9 LIMITATIONS

This EIA study (including Risk Assessment) is based on certain scientific principles and professional judgment to certain facts with resultant subjective interpretation. Professional judgment expressed herein is based on the available data and information.

This report has been developed based on information provided by Vedanta Limited (Cairn Oil & Gas) with the assumption that the information gathered is representative for the proposed oil and gas exploration, development and production. The impact assessment for the Project is based on the project capacities as described in ***Section 2*** on **Project Description**. If information to the contrary is discovered, the findings in this EIA may need to be modified accordingly.

ERM is not engaged in the impact assessment and reporting for the purposes of advertising, sales promotion, or endorsement of any client's interests, or other publicity purposes. The client acknowledges that any report prepared by ERM are for the exclusive use of the client and agrees that ERM's reports or correspondence will not be used or reproduced in full or in part for such promotional purposes, and may not be used or relied upon in any prospectus or offering circular for commercial purposes.

1.10 CONTENTS OF THE EIA REPORT

The EIA report is presented in two volumes, Volume 1 comprises of 13 sections while Volume 2 comprises of relevant ***Annexes*** to the EIA as described in **Table 1.7.**

Table 1.7 Contents of the EIA Report

Section	Description
Volume 1	Final EIA (Main Report)
Section 0	Executive Summary of EIA study includes summary introduction about site and Project, Project Proposal, requirement of the EIA Study, summary compilation of Project description, prevailing baseline conditions, and impact assessment including mitigation measures proposed and environmental management plan and conclusion.
Section 1: Introduction	This section covers Project Background; Overview of the Project (including Operator of the Block), Location and Project proposal; Purpose of the EIA study; Need of the Project; Project Cost and Schedule; approach and methodology for conduct of the EIA, Scope i.e. Terms of Reference for EIA study; and Contents of the EIA report.

Section	Description
Section 2: Project Description	Presents a description of the block, existing and proposed facilities; hydrocarbon prospects; existing Project and process details; proposed developments; potential pollution sources and control measures, adequacy Assessment; raw materials; and photographs of existing areas.
Section 3: Description of the Environment	This section includes a description of existing environmental and social baseline conditions covering both onshore and offshore regions of the Project block and surrounding area.
Section 4: Anticipated Environmental Impact Assessment & Mitigation Measures	This section includes impact identification through scoping, assessment of impact, mitigation measures and evaluation of significance of residual impacts.
Section 5: Analysis of Alternatives	This section includes alternatives available with respect to establishment of proposed drilling locations, pipeline routing and related technologies available and the reason for selection of the adopted alternatives.
Section 6: Environmental Monitoring Program	This section covers environmental monitoring to be scheduled during drilling and operation phases of the Project
Section 7: Additional Studies	This section covers issues raised during public consultation conducted for the Project by APPCB and related response by Vedanta Ltd (Cairn Oil & Gas). The section also covers Risk assessment and Emergency Response Plan.
Section 8: Project Benefits	The section includes financial benefits, social benefits; and on-going CSR activities.
Section 9: Environmental Management Plan	This section covers introduction and elements of EMP i.e. planning, implementation, checking and management review. The section covers actions to be implemented during the Project life cycle both in onshore and offshore components of the Project.
Section 10:Summary and Conclusion	This section presents the overall findings of the EIA study and includes overall justification for implementation of the project and provides explanation of how, adverse effects have been mitigated
Section 11: Disclosure about Consultant	This section povides brief information about ERM and professionals who were engaged for completion of this study
Section 12: Terms of Reference	This section covers Terms of Reference (TOR) issued by MoEFCC for conduct of the EIA Study
Volume 2	Annexes to the EIA Report
Annex 1	Report on Environmental Monitoring around Offshore Installations of Ravva Field (Phase III) Conducted by Marine Biological Laboratory, Department of Zoology, Andhra University for Vedanta Ltd (Cairn Oil & Gas) during Nov 2017
Annex 2	Ship Collisions Risk Assessment
Annex 3	Transport & Occupational Risks
Annex 4	Dropped Object Hazards and Risk Assessment
Annex 5	Waste Management Plan
Annex 6	Relevant Excerpts from Oil Spill Contingency Plan
Annex 7	Relevant Excerpts from Emergency Response Plan
Annex 8	Occupational Health & Hygiene Procedure
Annex 9	Overview of the national and international regulatory and policy framework applicable to this project
Annex 10	Trends in Monthly Environmental Monitoring Results as part of six monthly reporting by Vedanta Ltd (Cairn Oil & Gas) to MoEFCC, Chennai
Annex 11	Certified Copy of EC Compliance Report, Andhra Pradesh Pollution Control Board, Regional Office, Kakinada, 31.01.2019
Annex 12	Report against compliance to the conditions stated in the CFO and the HW Authorisation Order submitted to APPCB on 25 Jan, 2018
Annex 13	Membership Certificate of Vedanta Ltd (Cairn Oil & Gas) with Coastal Waste Management Project (TSDF), Vishakhapatnam
Annex 14	NOC from APWALTA for Ground Water Extraction
Annex 15	Results of Micro-Meteorological Monitoring, Conducted by Vimta Labs in Jan–Mar, 2018
Annex 16	Results of Ambient Air Quality Monitoring, Conducted by Vimta Labs in Jan–Mar, 2018

Section	Description
Annex 17	Hourly Equivalent Noise Levels, Based on Ambient Noise Monitoring Conducted by Vimta Labs during Mar, 2018
Annex 18	Results of Traffic Survey, Conducted by Vimta Labs during Mar, 2018
Annex 19	Phytosociology of Different Vegetation Types
Annex 20	Faunal Species Observed / Reported from the Study Area
Annex 21	Site Specific Conservation Plan & Wildlife Management Plan for Schedule I species
Annex 22	Proceedings of the Environmental Public Consultation
Annex 23	NOC from Andhra Pradesh Coastal Zone Management Authority; Summary Report on CRZ mapping by National Centre for Sustainable Coastal Management (NCSCM), Chennai.
Annex 24	Copy of Agreement with OSRL

2 PROJECT DESCRIPTION

2.1 INTRODUCTION

The PKGM-1 Block (Ravva Field) is located adjoining the coast of Surasaniyanam Village in East Godavari District of Andhra Pradesh as discussed under ***Section 1.2.1.*** Within the PKGM-1 Block, there are presently eight unmanned offshore platforms, a single point mooring (SPM) facility and interconnecting subsea pipelines. An onshore Ravva Terminal is located beyond 1.0 km from the seashore, on the landward side.

2.2 BLOCK LOCATION, ACCESSIBILITY AND ENVIRONMENTAL SETTINGS

2.2.1 Location of Block

Section 1.2.1 describes the location of the PKGM-1 Block and facilities located within the block. The block falls in Uppalaguptam Mandal, the Krishna-Godavari Basin in the East Godavari District of Andhra Pradesh. The block extends between Latitudes: 16° 20′ 44.8″ N to 16° 33′ 26.6″ N and Longitudes: 82° 04′ 17.3″ E to 82° 19′ 04.3″ E. Surasaniyanam Village is the nearest village from the onshore Ravva Terminal and PKGM-1 Block. The sea-coast forms the North-western boundary of the block. The offshore areas of block is adjoining the East Godavari District of Andhra Pradesh. Kakinada is the nearest port town located at ~50 km to the north east of the block. The Vishakhapatnam major port is located ~ 200 km to the north east of the block.

The Ravva Block and its associated facilities along with the proposed offshore and onshore drilling locations on the Survey of India (SOI) toposheet and satellite imagery are shown in ***Figure 2.1*** and ***Figure 2.2*** respectively. As per the revised proposal, Vedanta Ltd (Cairn Oil & Gas) will be establishing two onshore well pads WP-7 (RX-8 or WP-A) and WP-8 (RX-9 or WP-B) (as against 8 onshore well pads proposed during ToR stage).

2.2.2 Accessibility

National Highway 214 (NH-214) is the major road connecting the district headquarters Kakinada. From NH-214, PKGM-1 Block and onshore Ravva Terminal could be accessed through Amlapuram- Surasanityanam Road (through Amlapuram, Gopavaram, Challapalli).

Within the onshore part of the block, there are motorable access roads to connect the onshore Ravva Terminal to proposed two onshore drill pad sites WP-7 (RX-8) & WP-8 (RX-9). The motorable access roads may require further reinforcement prior to the preparation of the two well pad sites and carrying out drilling related to exploaration, devleopmeent and production activities. To avoid the congested settlement area of Gachakayala Pora, Cairn(Oil & Gas) has proposed use existing alternative route to access the well pad sites near Chirrayanam. The nearest railway stations are Palakollu and Narasapur at distances of 45 km and 48 km respectively. The nearest airport is Rajahmundry located at ~90 km from Ravva Terminal. The Vishakhapatnam (VIZAG) airport is located at ~200 km from Ravva Terminal.

Figure 2.1 PKGM-1 Block with Revised Proposed Drilling Locations on SOI Toposheet

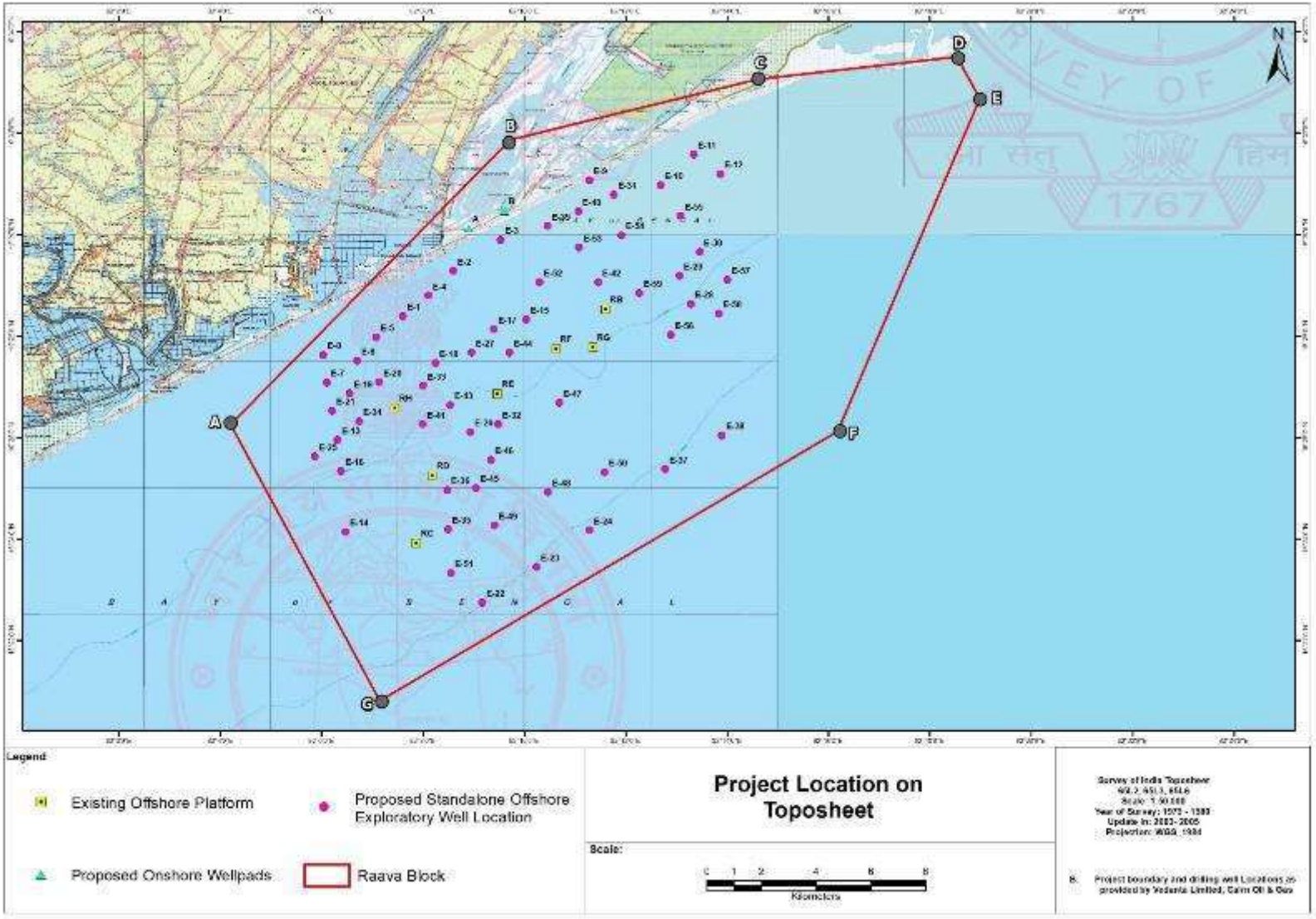
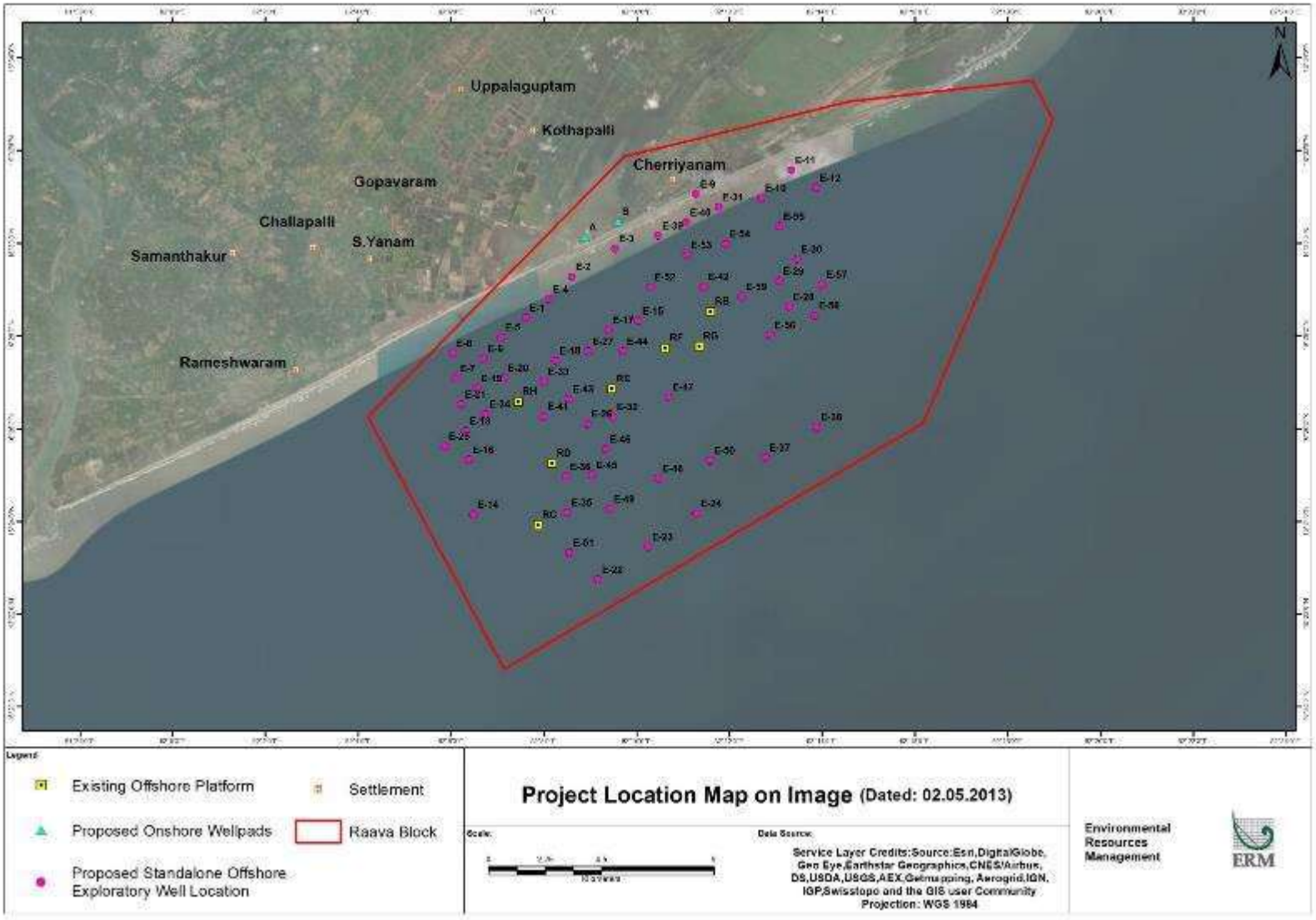


Figure 2.2 PKGM-1 Block with Proposed Drilling Locations on Satellite Imagery



The offshore areas of the block can be accessed by boats / marine vessels from Kakinada Port, which is ~82 km (by road) from PKGM-1 Block. There is a helipad at Ravva Terminal from where sorties are taken up to the unamanned offshore platforms almost every day. All the platforms have helicopter landing and boat landing facilities. The accessibility to the different areas within the block is shown in ***Figure 2.3.***

2.2.3 Environmental Settings

The PKGM-1 Block is primarily an offshore block; however, a small part of the block also falls in onshore area. The total block area is 331.26 km^2; the offshore area is about 307.84 km^2 (93% of the total block area) and remaining 23.42 sq. km^2 (7% of the total block area) falls in onshore. The maximum distance of the block (vertex G) from the shore is ~13.5 km. The environmental settings of the block and onshore well pads are described in the following subsections.

Environmental Setting of Onshore Wells

Onshore Wells: As specified in ***Section 1.3,*** Vedanta Limited (Cairn Oil & Gas) is proposing to drill 10 exploratory and 23 development wells from two onshore well pad sites. The onshore well pads are located beyond 200 m but within 500m from the coastline. Brief environmental setting of the individual well pad sites is provided as following:

- **Well pad WP-7 (RX-8 or WP-A) Site:** This existing well pad was developed earlier for onshore drilling of wells during 2006-07 based on EC obtained in 2006. It is located ~600m SW of the estuarine inlet of Chirrayanam Backwater. The nearest habitation is Gachykola Pora located ~2 km NW. A temporary fishing hamlet, having 50-60 small hutments are located on the beach ~150m South from the well pad. During site visits conducted between Dec 2017 and April 2018, the hamlet was found to be uninhabited.
- **Well pad WP-8 (RX-9 or WP-B) Site:** This existing well pad was also developed earlier for onshore drilling of wells during 2006-07 based on EC obtained in 2006. It is located to the Southwest of nearest settlement Chirrayanam Village at 1.6 km and ~250 m North of the seacoast.

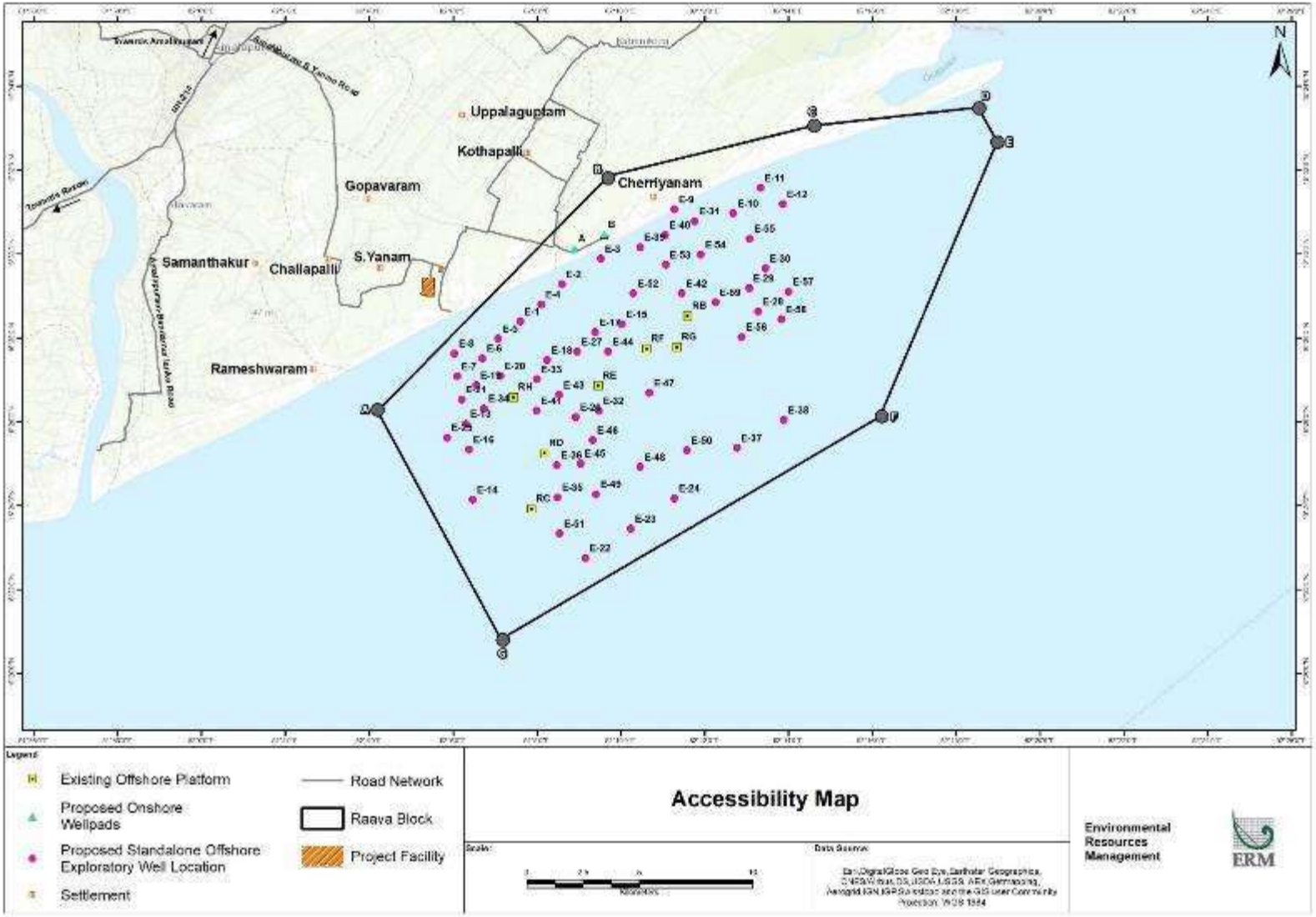
Environmental Setting of Offshore Wells

As specified in ***Section 1.3 & Table 2.4,*** Vedanta Ltd (Cairn Oil & Gas) proposes to drill 73 offshore exploration wells (59 from standalone offshore locations and 14 from the existing offshore platforms) and 17 development well from the existing offshore platforms. For the purpose of the present offshore drilling program, seven out eight existing offshore platforms (i.e. RB, RC, RD, RE, RF, RG and RH) will be utilised. Out of the 59-standalone offshore exploration well locations (E-1 to E-59):

- Six (6) standalone offshore locations are located within 1 km from shoreline (E-2, E-3, E-39, E-40, E-9, E-11);
- Twenty eight (28) standalone offshore locations within 1.0 km to 4.5 km from shoreline.
- Twenty Five (25) standalone offshore locations are located beyond 4.5 km from shoreline.

The existing platforms to be used for the drilling program (i.e. RB, RC, RD, RE, RF, RG and RH) are located within 4.4 to 9.1 km from the shoreline with the nearest platform being RH (at a distance of 4.4 km) and the farthest being RC at a distance of 9.1 km. The environmental setting of the PKGM-1 block is shown in ***Figure 2.4.***

Figure 2.3 Accessibility Map of the PKGM-1 Block



2.3 DESCRIPTION OF PKGM-1 BLOCK - EXISTING & PROPOSED FACILITIES

2.3.1 Description of Existing Facilities - Oil & Gas Production

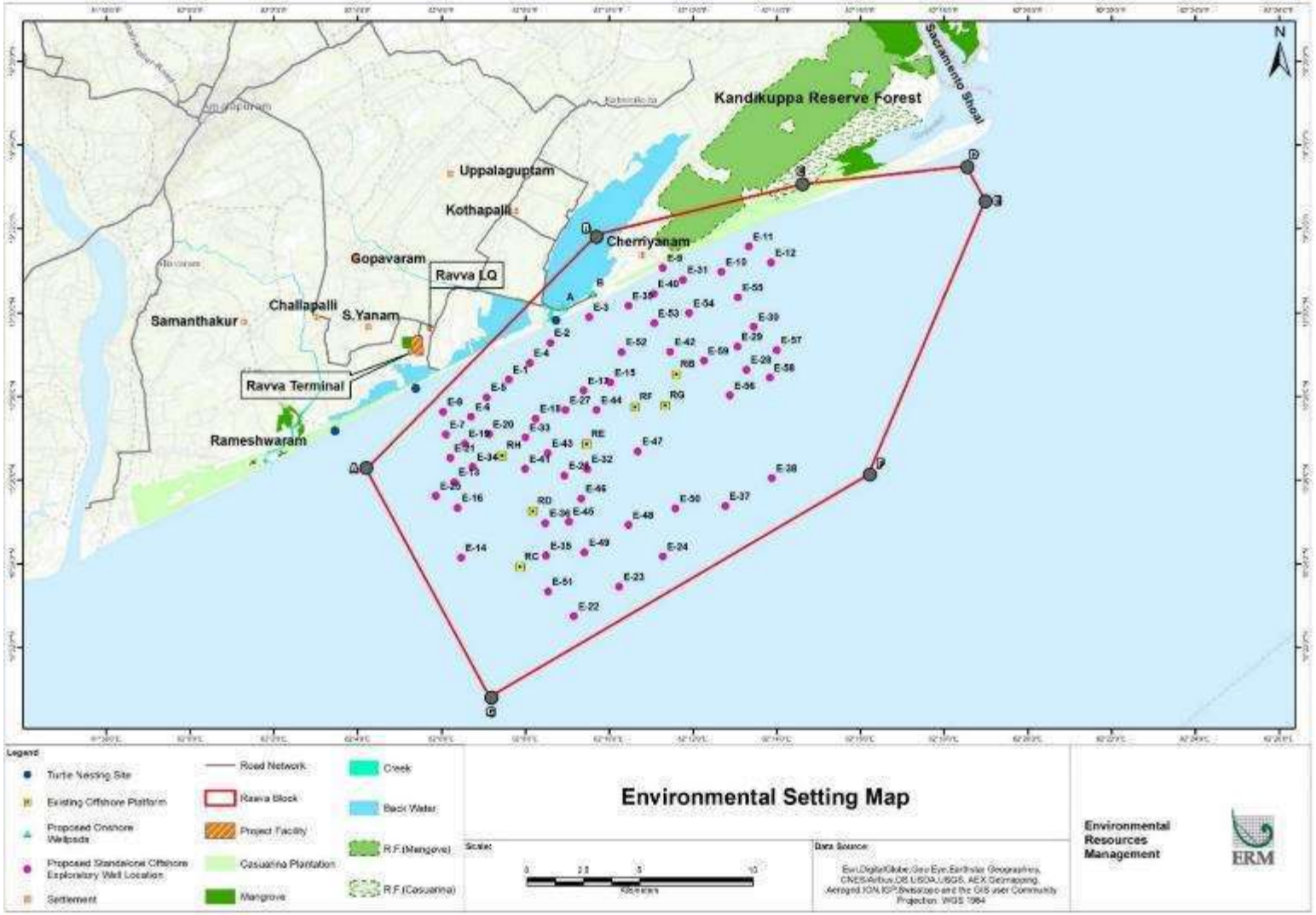
Within PKGM-1 Block, there exists six (6) self-flow producing wells, sixteen (16) gas lift wells and nine (9) injectors spread over on eigiht (8) unmanned fixed well head offshore platforms. Six platforms (RA, RB, RC, RD, RE & RF) are meant for crude oil production while remaining two (RG & RH) for gas production. RA and RC Platforms have an interconnecting bridge. No processing facility and routine discharges or flaring facility exists at the offshore platforms except water separation and treatment facility at platform RC. Well fluid from the offshore platforms is transferred through subsea pipelines to onshore Ravva Terminal near Surasaniyanam for oil and gas processing and water injection facilities. A Single Point Mooring (SPM) facility exists offshore from where crude oil is transported through subsea export pipelines to Shuttle Tankers to Government of India nominated refineries within India.

The treated water and lift gas from onshore Ravva Terminal is transferred to platforms through subsea pipelines. In addition, there are subsea pipelines between the platforms for distributing water for injection and lift gas. The associated systems available at the platforms include:

a) wellheads;
b) production/test manifold with knockout provision;
c) flow pipelines (with pig launchers/receivers);
d) test separator / flow meters;
e) water injection system;
f) gas lift system;
g) instrumentation control panel & telemetry PLC system; and
h) utility system comprising of electrical system, instrumentation gas system, chemical injection system, drain system, vent system and fresh water storage and distribution system.

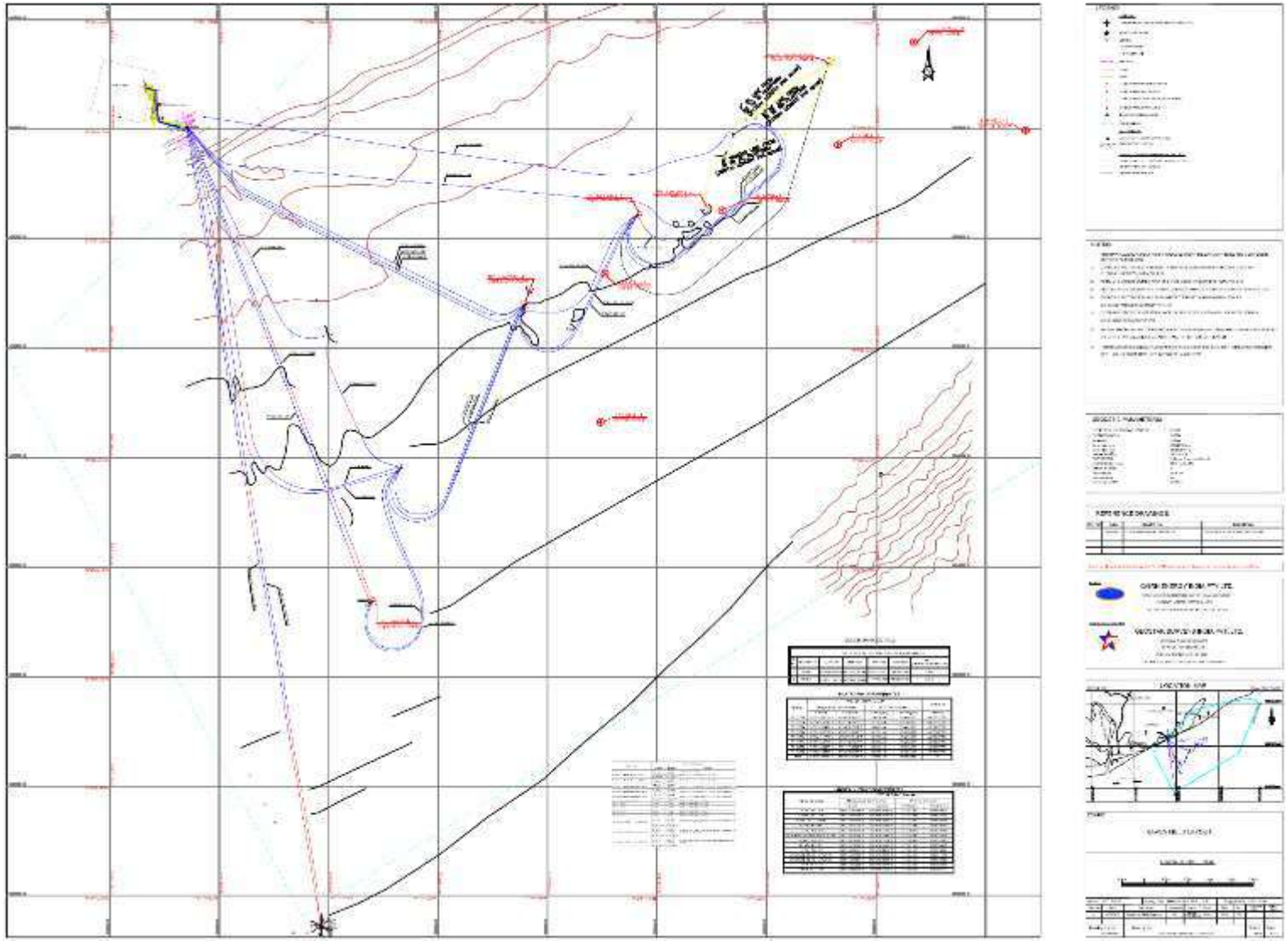
Over the years due to aging of the field, production of oil and gas has declined. The onshore processing facility has APPCB approved capacity to produce 50,000 barrels of oil per day (BOPD) crude and 2.32 MMSCMD of natural gas. The present production is approximately 15,000 BOPD of crude and 1.40 MMSCMD of natural gas. In order to regain the hydrocarbon production, Vedanta Ltd (Cairn Oil & Gas) now proposes additional oil and gas development in the prospects identified within Ravva Field.

Figure 2.4 Environmental Setting Map of the PKGM-1 Block



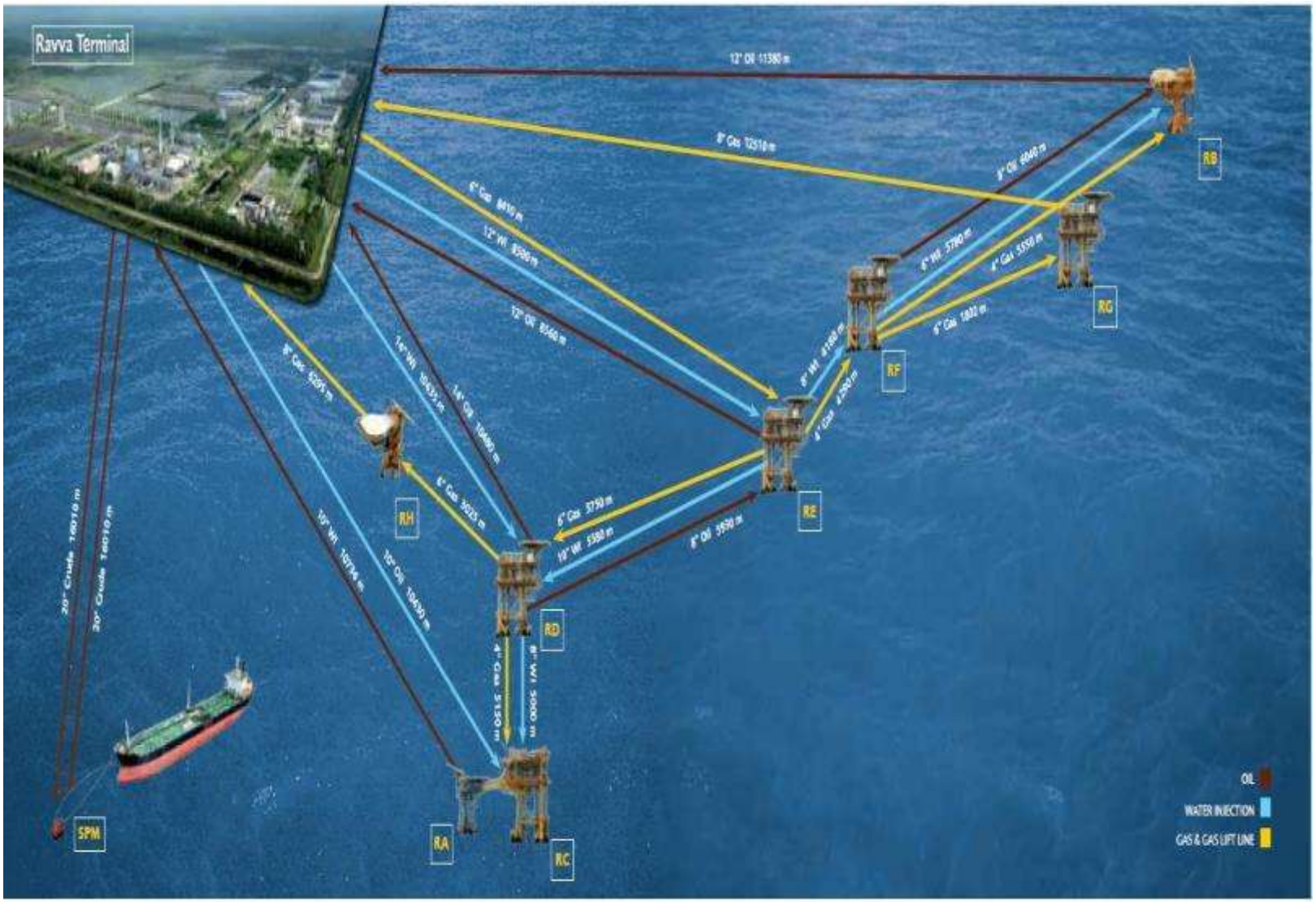
Note:The Map is revised showing two onshore well pads WP-7 (i.e. WP-A or RX-8) & WP-8 (WP-8 or RX-9) as against eight onshore well pads proposed earlier. 33 nos. (10 exploratory+23 developmental) wells are proposed to be drilled from the two well pads. No change in offshore wells drilling.

Figure 2.5 Layout of Existing Offshore & Onshore Facilities in PKGM-1 Block



Source: Vedanta Ltd Cairn (Oil & Gas)

Figure 2.6 Schematic of Existing Platforms and Pipelines in Ravva Field



Source: Vedanta Ltd Cairn (Oil & Gas); Note: Schematic – Not to Scale

2.4 EXISTING PROJECT WITH PROCESS DETAILS

2.4.1 Existing Setup at Onshore Ravva Terminal

1) Layout Plan

Layout of the process set up of existing onshore Ravva Terminal is shown in ***Figure 2.7***. The crude oil and natural gas are processed at Ravva Terminal located at Surasaniyanam Village in ~91 ha (225 acres) of area.

2) Crude Oil Stabilisation Unit (CSU)

The main purpose of CSU is to separate oil, gas and water and to bring the high pressure crude oil to atmosphere conditions for storage. Separation takes place due to difference in density of fluids.

Well fluid from the wellhead platforms are routed to the onshore terminal through flow lines 10"(inches) diameter of RC/RA to RT, 14" diameter RD to RT, 12" diameter RE/RD to RT and 12" diameter RF/RB to RT). Each of these lines are provided with a pig launching faciclity at platforms and pig receiving faciclity at Ravva Terminal (RT) to enable pigging. These three flow lines join in a 16" common header at terminal and well fluids flows to FWKOD (Free Water Knock out Drum) and then to flow splitter. From flow splitter flow is distributed to three CSUs through piping manifold with control valves and other instruments. A schematic of hydrocarbons stabilization and produced water injection system for the Ravva Terminal is presented in ***Figure 2.8***.

3) MPP (Multi Phase Pumps)

Multi-phase pumps (MPP) have been installed to increase draw down by creating low pressure at terminal for increasing total gross fluid rate.

MPP are modified positive displacement pumps that are capable of pumping various ration of liquid and gas without separation. The multiphase pump skid package consists of two no. of TWIN SCREW multiphase pumps (P-1901A & P-1901B).The pumps are mounted on separate skids with one common control system. These pumps have capacity of 36,000 barrels of liquid per day and 727,097 barrels of gas equivalent per day BEPD (which includes gas equivalent volume) at operating conditions. At present MPPs are connected to RD wells and have the facility to connect to wells of RA/RC and RE Platforms.

4) Free Water Knock-Out Drum (FWKOD)

Well fluids from various incoming lines from wells in PKGM-1 Block join and enter into the Free Water Knock-out Drum (FWKOD) at Ravva Terminal. Due to increase in water cut and to reduce the load on downstream separators [high pressure (HP), medium pressure (MP) and low pressure (LP)], FWKOD is installed before flow splitter. Well fluids from various incoming lines joined together and enter into the FWKOD. The FWKOD is sized as a three phase separator. The oil and gas stream separated in FWKOD vessel is mixed together outside the vessel and sent to HP separator via flow splitter. The vessel is designed for 1,000 ppm of oil in water at water outlet at maximum water case conditions. The produced water from this

vessel flows to degasser vessel and Produced Water Surge Tank (T-613). The FWKOD is designed with a main separation compartment and separate water & oil compartments. In the main separation compartment, the inter-phase level is maintained by controlling the water discharge to degasser. A separate level control is provided for the oil compartment by controlling the flow of oil from the oil compartment.

5) Flow Splitter and Crude Stabilization Unit (CSU)

FWKOD out flow is split through three crude stabilisation units (CSU) namely Train 1, Train 2 and Low Pressure (LP) Separator for stabilization of crude in three stages. Each train consists of a high pressure (HP) separator, a medium pressure (MP) separator and a low pressure (LP) separator. The HP and the MP separators are operated in three-phase mode, while the LP separators are in two-phase operation only.

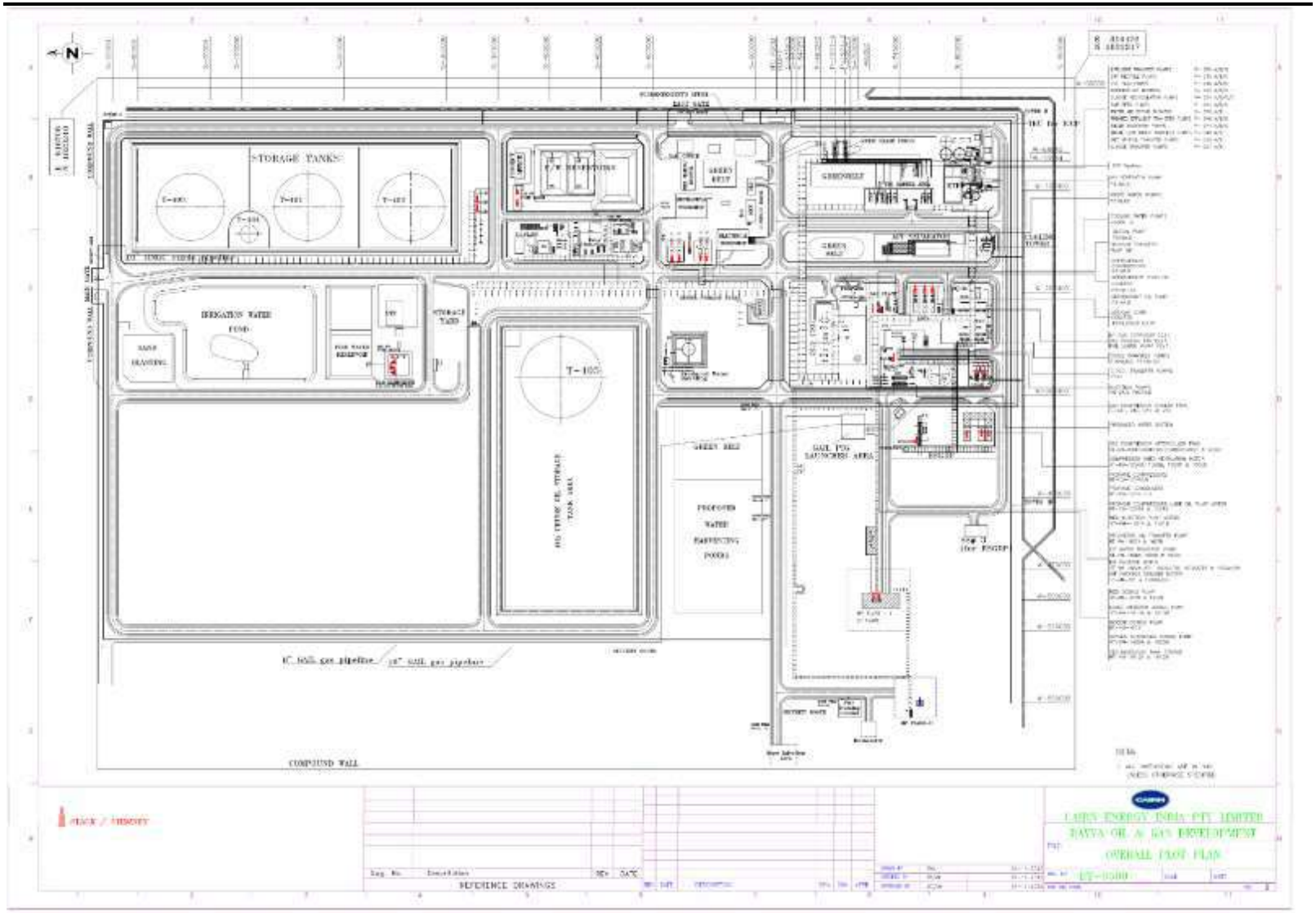
The first stage separator is a spill over weir type three-phase separator and operates at 7.5 kg/cm^2 pressure. Gas flows to the suction manifold of the associated gas compressor where it combines with gas from the other HP separators of Train 2 and old CSU. In the first stage of separation, about 90% of the gas is separated. Produced water flows to the degasser under level control.

The second stage is also a three-phase separator. Crude oil from second stage separator flows under level control to the third stage separator. The second stage separator operates at 3.5 kg/cm^2 pressure. Separated gas combines with the gas from second stage separation of other trains (Train 2 and old CSU) and Separated gas flows into the second stage suction of the TSGR (Third Stage Gas Recovery) Compressor. During any upsurge or compressor failure, gas is flared through pressure control valve. Produced water flows to the degasser under level control.

The third stage separator is a two-phase separator. From the LP separators, the crude oil is pumped to the wash tank through crude oil coolers, cooled by cooling water. In crude wash tank, the final degassing and separation of water from oil takes place. The stabilized crude oil is sent for storage in one of the four floating roof storage tanks. Gas from the third stage is recovered by third stage gas recovery compressor and fed into associated gas compressor suction header after compression. The third stage separator operates at 0.2 kg/cm^2 pressure.

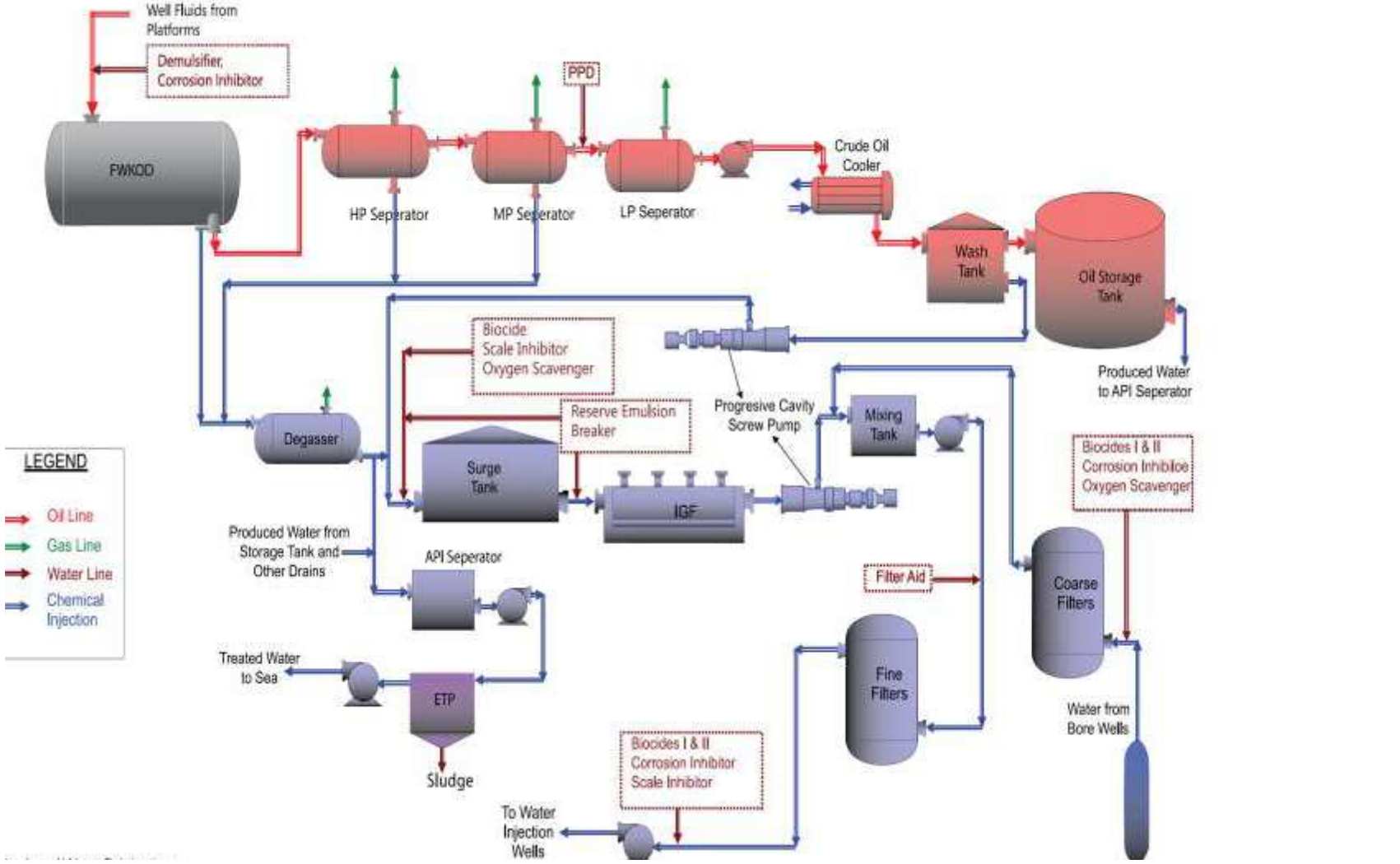
The schematic of hydrocarbon stabilization and produced water generation for its treatment and re-injection into confined hydrocarbon reservoir is shown in ***Figure 2.8***.

Figure 2.7 Layout Plan of the Ravva Terminal



Source: Vedanta Ltd Cairn (Oil & Gas)

Figure 2.8 Schematic of Hydrocarbon Stabilization & Produced Water Injection System



Source: Vedanta Ltd (Cairn Oil & Gas)

6) Crude Oil Storage and Export

Outlet lines from each of the tanks lead to the suction header for the export booster pumps. Lines and valves are provided such that full rate loading can be from any one or combination of tanks at the same time. Export booster pumps provide suction pressure to the export pump. Engine driven export pumps provide the head necessary to transfer crude through the two 20" export pipelines for offshore tanker loading. Each of the two export booster pumps and export pumps are sized for 50% of the export capacity of 20,000 barrels (bbl)/hour. Measurement for custody transfer is done by tank gauge. The export crude is pumped through two parallel 20" subsea pipeline to a Single Point Mooring (SPM) facility. It is designed to handle tanker with capacity up to 120,000 DWT moored to it with wave up to 2.5 m high.

Dehydrated crude is stored in five crude oil storage tanks (number T-401, T-402, T-403, T-404 & T-405 with a total storage capacity as per ***Table 2.1***) from where crude oil is pumped to offshore tankers via single point mooring facility through crude export pipelines.

Table 2.1 Crude Oil Storage Tanks at the Ravva Terminal

S.N	Crude Storage Tank ID	Capacity in m^3
1	T – 401	45,243
2	T – 402	45,243
3	T – 403	45,243
4	T – 404*	2,940
5	T – 405	45,932

Note: * indicates tank used for transportation of ONGC crude; Note: Crude RVP <10 psig, BS&W 0.05 and Pour Point 21°C.

Crude produced from Ravva is sweet and light (API 35 degree) and gas produced is having CO_2 with ~2% of mole fraction.

About 2 to 3 vessels (of 55,000 MT load of crude) per month are being loaded from SPM facility for crude transportation to nearby refineries.

7) Gas Processing

The Gas Lift system consists of Gas Dehydration Unit and Gas Lift Compressor Unit. It removes water from the wet gas stream to achieve the dry gas specification of 5 lb of water/ MMMSF of gas with the use of tri-ethylene glycol (TEG) and the gas is then compressed to 119 kg/cm^2 g and delivered to the gas lift system. For the Gas Dehydration Unit, the major components included Glycol Contactor, Lean Glycol Gas Cooler, Rich Glycol Flash Drum, Glycol Reflux Condenser, Particle Filter, Active Carbon Filter, Lean/ Rich Glycol Exchanger, Glycol Still Column, Glycol Re-boiler, Glycol Stripping Column, Glycol Surge Drum, Lean Glycol Pump, Drum Pump, and Antifoam Storage Tank, pH Control Storage Tank with Antifoam Injection Pump, pH Control Injection Pump.

For the Gas Lift Compressor Unit, the major components included Suction Filter Coalescer, Gas Lift Compressor and Engine, after Cooler, and Discharge Scrubber. Gas Lift Compressor receive feed from existing Ravva Satellite Field Compressor unit at 70 kg/cm^2 g and compress to 119 kg/cm2 g. which is connected to the existing Gas lift network. High-pressure relief and

blow downs from system are routed to the HP Flare II. Low-pressure relief and vents are sent to the existing LP flare.

Heavier hydrocarbons and water are separated by compression and cooling to meet the customer specifications. (Water Dew Point: 33° C; Hydrocarbon Dew Point: 15°C (59°F); CV: 9000 kcal/SCM). Ravva facility consists compressor to recover gas from all stages and aiming for zero flaring. Associated gas from the first stage separators of all trains together with discharge gas from Third Stage Gas Recovery (TSGR) is compressed. Associated gas compressor (AGC) system consists of four (three 2-stage and one 3-stage) reciprocating compressors working in parallel, each sized for approximately 0.25 million standard cubic meter per day (MMSCMD) flow. The compressors are driven by a gas engine. Compressor capacity control is on suction pressure through engine speed variation followed by recycling of gas. AGC-A/B/C/D gas pressure boosts up to 7,500 KPa from 700 KPa. Discharges from the four compressors, after cooling, are routed to the gas treatment system via scrubber. Gas recovered from MP separator and LP separators are compressed by TSGR compressor and delivered to associated gas compressor suction header. It increases gas pressure from 5 KPa to 700 KPa

The gas treatment facility to attain the gas sales specification consists of, refrigerant compressor suction scrubber, low temperature separator and refrigeration unit. Gas is cooled in two stages. Glycol is injected while cooling. Gas, with condensed liquid and glycol, flows into separator where they get separated. Gas becomes dry with the hydrocarbon dew point below 10 °C. Slug catcher gas is precooled in the exchanger. Gas from the associated gas compressor discharge also joins the slug catcher gas upstream of exchangers. Further cooling of gas is carried out to about 0 °C by propane refrigerant. Rich MEG is sent to the MEG regeneration package.

The chilled gas enters the Low Temperature separator where hydrocarbon rich liquids (glycol) and gas are separated. Gas from the separator flows through gas exchanger to precool inlet gas and then sent to users viz., gas lift line, fuel gas system and sales gas to GAIL pipeline. A Pressure Control Valve (PCV) located downstream of the sales gas metering station maintains steady pressure in the upstream pipeline. Treated gas from the gas/gas exchanger flows to the sales gas metering skid. This skid contains 2 x 100% orifice meter and a gas analyser.

8) Produced Water Re-injection

In order to separate produced water and re inject it for reservoir pressure management, produced water is treated to free from oil by multiple stages. The produced water to be re-injected originates from the FWKOD, HP and MP crude oil three phase separators, which are included in each of three trains, and also the wash tank. The water from all these sources is degassed in the Produced Water Degasser vessel and then routed to the Produced Water Surge tank for initial oil-water separation. Separated water from the Crude Oil Wash Tank is pumped directly to the Surge Tank (T-613). Refer to ***Figure 2.9*** for the produced water injection system being adopted at the Ravva Terminal.

In the Produced Water Surge Tank (T-613), sufficient residence time is provided to allow oil droplets to coalesce to form a separate oil layer, which can be drained to Recovered Oil Sump

(RT-T-1603) manually. The water flows out from the Surge Tank (T-613) via a hydraulic loop, which maintains a minimum level in the tank. From Surge Tank (T-613), the produced water then flows by gravity into induced Gas Flotation (IGF) unit. In the IGF gas is induced using dispersers to produce gas bubbles. These gas bubbles cause oil and solid particles to rise to the surface and then skimmed off. The water from the IGF unit is pumped into the mixing tank using low shear positive cavity screw pumps.

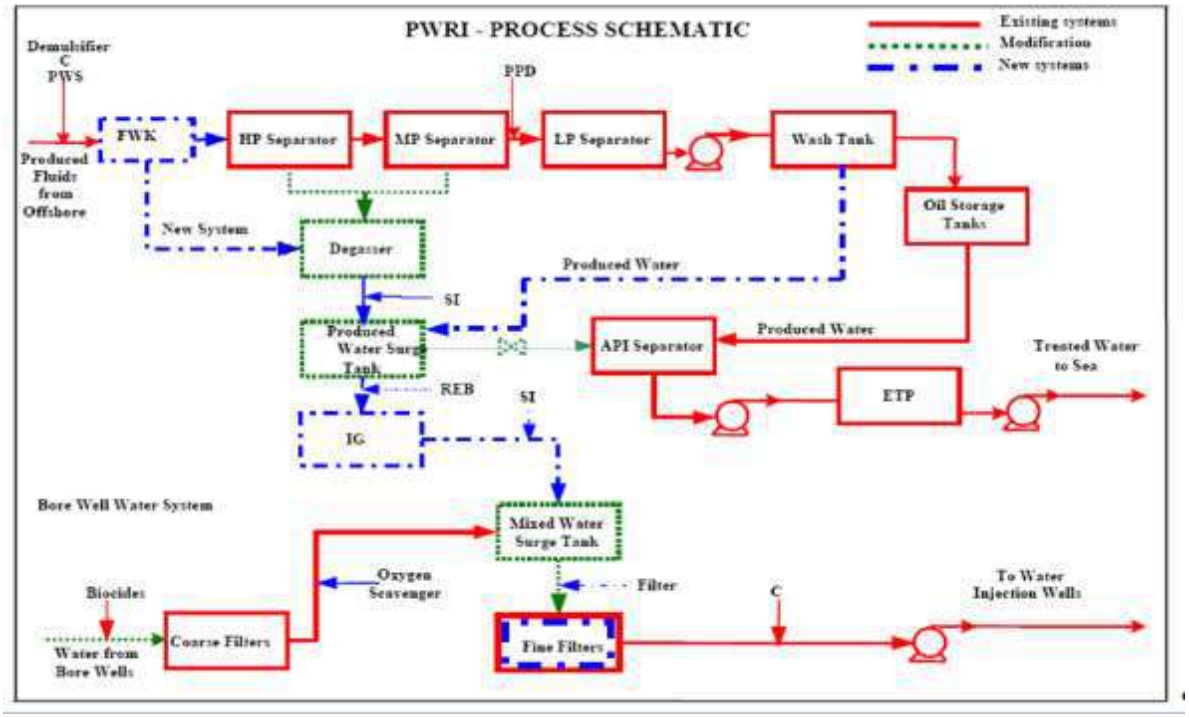
The produced water up to 90,000 barrels per day is treated for reinjection in confined hydrocarbon reservoir with oil in water (OIW) content of less than 10 ppm. Oil skimmed from the IGF's is discharged continuously into an oil recovery sump from where it is pumped by vertical barrel pumps to the Crude Oil Wash Tank (RT-T- 102C) on an intermittent basis using high or low level switches to activate or stop the pump.

9) Water Injection Facilities

There are a total of seven water injection wells currently. Present water injection capacity is 90,000 BWPD @ 9,000 kPa g. The present source of water for injection is from the six bore wells available in the onshore plant and treated produced water from IGF unit of PWRI system. Bore well pumps (Electro submersible pumps) extract the water from a depth of below 40m (brackish water) and feed to the mixing tank (T-501) through a fibreglass reinforced plastic (FRP) header via 3 coarse filters having 80 micron rating. The water is drawn from saline aquifer, which is not used for irrigation, animal husbandry or domestic usage.

The mixing tank is gas blanketed to prevent ingress of oxygen. Water injection feed pumps (4 nos.) takes suction from mixing tank and discharge water to the fine filters (7 nos.). Co-mingled water is filtered to remove oil and suspended solids. These are dual media filters with layers of coarse and fine garnet and a top layer of anthracite. The fine filters are designed to remove 98% of all particulates >5 microns. The water from the fine filters flows into the suction of the injection pumps, which increases the pressure to about 1,305 psig (90 bar g) and sends it through three trunk lines to RD, RE and RC Platforms. From these platforms, the water is routed to the other platforms and the individual injection wells. Two of the injection pumps are Ingersoll Rand multistage centrifugal pumps driven by electric motors, each rated for 45,000 bwpd. There is one multistage centrifugal pump driven by electric motor rated for 54,000 bwpd. The water injection wellheads are fitted with a cartridge type wellhead guard filter, rated for 40 microns. The chemical treatment of the injection water consists of primary biocide hypochlorite, corrosion inhibitor, scale inhibitor and oxygen scavenger augmented by cyclic biocide shock dosing to prevent from scaling and corrosion. Biocide shock dosing is carried out on regular basis to avoid sulphate reducing bacteria (SRB) growth.

Figure 2.9 Existing PWRI System at Ravva Terminal



Source: Vedanta Ltd (Cairn Oil & Gas)

10) Satellite Gas Development Well and Platform (RSGDP) Facilities

Gas arriving from RH platform is tied into the existing slug catcher downstream of the pig receiver. The slug catcher also receives gas from the existing RG platform. A pig receiver is provided at Ravva onshore terminal for the incoming gas from RH.

Liquid from the slug catcher flows to the existing crude stabilisation system. Two reciprocating, gas-engine driven compression trains are provided. Compression trains are supplied as individual packages and each consist of suction scrubber, compressor/engine Discharge Air Cooler, Discharge Scrubber (and associated auxiliaries.

Gas from compression unit flows to the dew point control package (to treat the gas for achieving sales gas specifications). Dew point control package comprises gas/gas exchanger and propane refrigeration. Gas is pre-cooled by exchanging heat with the cold, dew-pointed gas in the gas/gas exchanger followed by further cooling to -5°C in the propane chiller of the refrigeration Package. Mono Ethylene Glycol (MEG) is injected into the tube sheets of gas/gas exchanger and propane chiller to prevent hydrate formation and corrosion in these exchangers.

The propane refrigeration unit is a standard propane cycle and consists of 2 x 100% trains of compression air-cooled propane condenser, propane and a Propane Chiller. Each propane compression train comprises of a lubricated, screw type propane compressor, an oil separator, a lube oil pump and a lube oil filter.

Dew pointed gas from the propane chiller flows to the low temperature separator where gas, rich Mono Ethylene Glycol (MEG) and condensate (if any) are separated. Gas from the low

temperature separator is routed to the gas/gas exchanger where it exchanges heat with the warm, untreated gas. Rich MEG is sent to the MEG regeneration package and condensate is directed to the existing Crude Stabilisation system.

Treated gas from the gas/gas exchanger flows to the sales gas metering skid. This skid contains 2 x 100% orifice meter runs and a gas analyser. A back-pressure control valve maintains the pressure upstream of the meter at 7500 kPa g. Gas from metering is exported to the GAIL pipeline.High-pressure relief and blow downs from the new facilities are routed to the existing 'old' flare (HP Flare II). Low pressure relief and vents are sent to the existing LP flare.

*11) **Excess Produced & Other Wastewater Generation, Treatment & Disposal***

The drained residual produced water from the process units that is not routed through PWRI is routed to the API separator. The API separator is provided with a slotted pipe type free oil collection and removal system. Sufficient settling time for separation of oil from water and for the gravity settling of oily sludge and inert sediments is provided. Treated water from the API separator is pumped to the equalization tank of the Effluent Treatment Plant (ETP).

Produced Water Generation
In the initial stages of prospects exploitation, the produced water generation is expected to be low in volume. Its volume increases over a period of time. The increase of produced water volume from new prospects in PKGM-1 Block is initially expected to be 1 barrel per barrel of crude oil to as high as 10 barrels per barrel of crude oil with corresponding decline in crude oil production over a period of time. The treated produced water comingled with groundwater (to ~1.1 times of extracted fluid from reservoir) is re-injected into confined hydrocarbon reservoir. It is difficult to predict the exact produced water and production over a period of time. However, an indicative produced water generation, its re-injection and effluent generation is given in Table 2.2.

Table 2.2 Indicative Produced Water & related Effluent Generation

SN (1)	Scenario - Produced Water to Crude Oil Ratio (2)	Produced Water Generation bbl/day [m³/day] (3)	Crude Oil Production bbl/day [m³/day] (4)	Total Fluid Extraction bbl/day [m³/day] (5)	Re-injection Water Needed bbl/day [m3/day] (6)=1.1*(5)	Treated Produced Water from PWRI Available – Reinjection bbl/day; m³/day] (7)=~0.85 of (3)	Additional Groundwater for Comingling with Produced Water bbl/day; [m³/day] (8)	Expected Produced Effluent Generation from PWRI bbl/day; [m³/day] =~0.15 of (4) (9)
1	1:1	50,000	50,000	100,000	110,000	42,500	67,500	7,500
		[7,950]	[7,950]	[15,900]	[17,490]	[6,758]	[10,733]	[1,193]
2	2:1	100,000	50,000	150,000	165,000	85,000	80,000	15,000
		[15,900[	[7,950]	[23,850]	[26,235]	[13,515]	[12,720]	[2,385]
3	4:1	100,000	25,000	125,000	137,500	85,000	52,500	15,000
		[15,900]	[3,975]	{19,875]	[21,863]	[13,515]	[8,348]	[2,385]
4	5:1	100,000	20,000	120,000	132,000	85,000	47,000	150,000
		[15,900]	[3,180]	[19,080]	[20,988]	[13,515]	[7,473]	[2,385]
5	7.5:1	93,750	12,500	106,250	116,875	79,688	37,187.5	14,062
		[14,906]	[1,988]	[16,894]	[18,583]	[12670]	[5,913]	[2,236]
6	10:1	100,000	10,000	110,000	121,000	85,000	36,000	15,000
		[15,900]	[1,590]	[17,490]	[19,239]	[13,515]	[5,724]	[2,385]

Note: bbl/day = barrels per day (1 barrel = 0.159 m³)

For the fluid extraction of 100,000 barrels per day (i.e. 50,000 bbl/day of produced water + 50,000 bbl/day of crude oil), there will be requirement of re-injection of water of ~110,000 bbl/day (i.e. 17,490 m^3/day). The treated produced water of 42,500 bbl/day (6,758 m3/day) from PWRI will be comingled with additional saline groundwater of 67,500 bbl/day (i.e. 10,733 m^3/day) for reinjection into the confined hydrocarbon reservoir.

For fluid extraction of 110,000 bbl/day (i.e. 100,000 bbl/day of produced water + 10,000 bbl/day of crude oil), there will be requirement of re-injection of water of ~121,000 bbl/day (i.e. 19,239 m^3/day). The treated produced water of 85,000 bbl/day (13,515 m^3/day) from PWRI will be comingled with additional saline groundwater of 36,000 bbl/day (i.e. 5,724 m^3/day) for reinjection into the confined hydrocarbon reservoir.

It is to be noted that the requirement of extraction of saline groundwater will be reduced over a period of time with the decline of production but increase of produced water generation. The produced water generated is treated for re-injection into the hydrocarbon confined reservoir as described in ***Sections 2.4.1.8 &9*** and ***Figure 2.9*** above. The expected produced effluent generation for the scenario of produced water to crude oil ratio of 10:1 will be 2,385 m^3/day.

Effluent Treatment Plant

An Effluent Treatment Plant (ETP) of 3,000 m^3/day (i.e. 18,868 bbl/day) capacity has been operating at Ravva Terminal. Apart from the produced wastewater, there are additional sources of wastewater generation from RO Plant for input to effluent treatment plant as given in ***Table 2.3***.

Table 2.3 Wastewater Generation from Reverse Osmosis Plants

SN	Saline Feed water to RO Plant bbl/day [m^3/day	RO Treated Water Use			RO Reject water to ETP bbl/day; [m^3/day]
		Domestic Use		Utilities	
		Domestic Consumption bbl/day; [m^3/day]	Domestic Wastewater bbl/day; [m^3/day]	Cooling & Fire Water make up bbl/day; [m^3/day]	
(1)	(2)	(3)	(4)	(5)	(7)
	[2,516]	[189]	[881]	[440]	[1,006]
	400	30	140	70	160

Note: 1) Domestic wastewater generated is treated in a Sewage Treatment Plant of 175 m^3/day capacity installed at Living Quarters. The treated wastewater from Sewage Treatment Plant is used in watering the plantation in Ravva Terminal and Living Quarters; 2) bbl/day = barrels per day (1 barrel = 0.159 m^3)

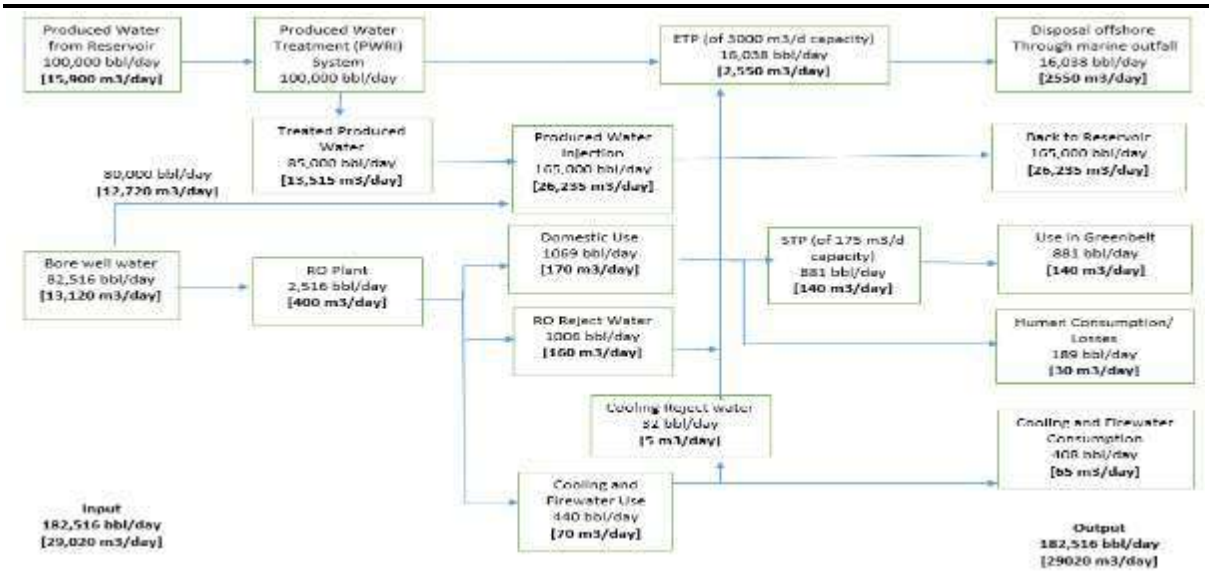
The ETP receives wastewater as given in ***Table 2.4***:

Table 2.4 Wastewater to ETP Inlet (for Peak Scenario Produced Water: Crude Oil Ratio of 10:1)

SN	Produced Waste- water Generation bbl/day [m^3/day] (2)	Cooling Tower Blow Down bbl/day [m^3/day] (3)	RO Reject water to ETP bbl/day [m^3/day] (4)	Total Effluent to ETP bbl/day [m^3/day] (5)
(1)				
1	15,000	32	1006	16,038
	[2,385]	[5]	[160]	[2,550]

Figure 2.10 shows indicative water balance for the proposed enhancement of production to 50,000 bbl/day with water cut of 2:1 i.e. for fluid of 150,000 bbl /d. Water balance will vary with changes in water cut. With ageing of wells, water cut will increase and oil will decrease.

Figure 2.10 Indicative Water Balance at Ravva Terminal (for the Expansion Project)



Note: The above water balance is indicative for water cut of 2:1 (for fluid of 150,000 bbl /d with oil of 50,000 bbl/d)). Water balance will vary with changes in the water cut. With the ageing of wells, water cut will increase and oil will decrease.

The ETP of 3,000 m^3/day treatment capacity consists of primary, secondary and tertiary treatment. The primary treatment involves free and floating oil separation and gravity settling of heavier sediments. The secondary treatment is an aerobic biological treatment to reduce BOD levels. The tertiary treatment involves polishing the treated effluent through a dual media filtration process. The quality of treated effluent from ETP as monitored by Vimta Labs during January to December 2019 is shown as per ***Table 2.5***.

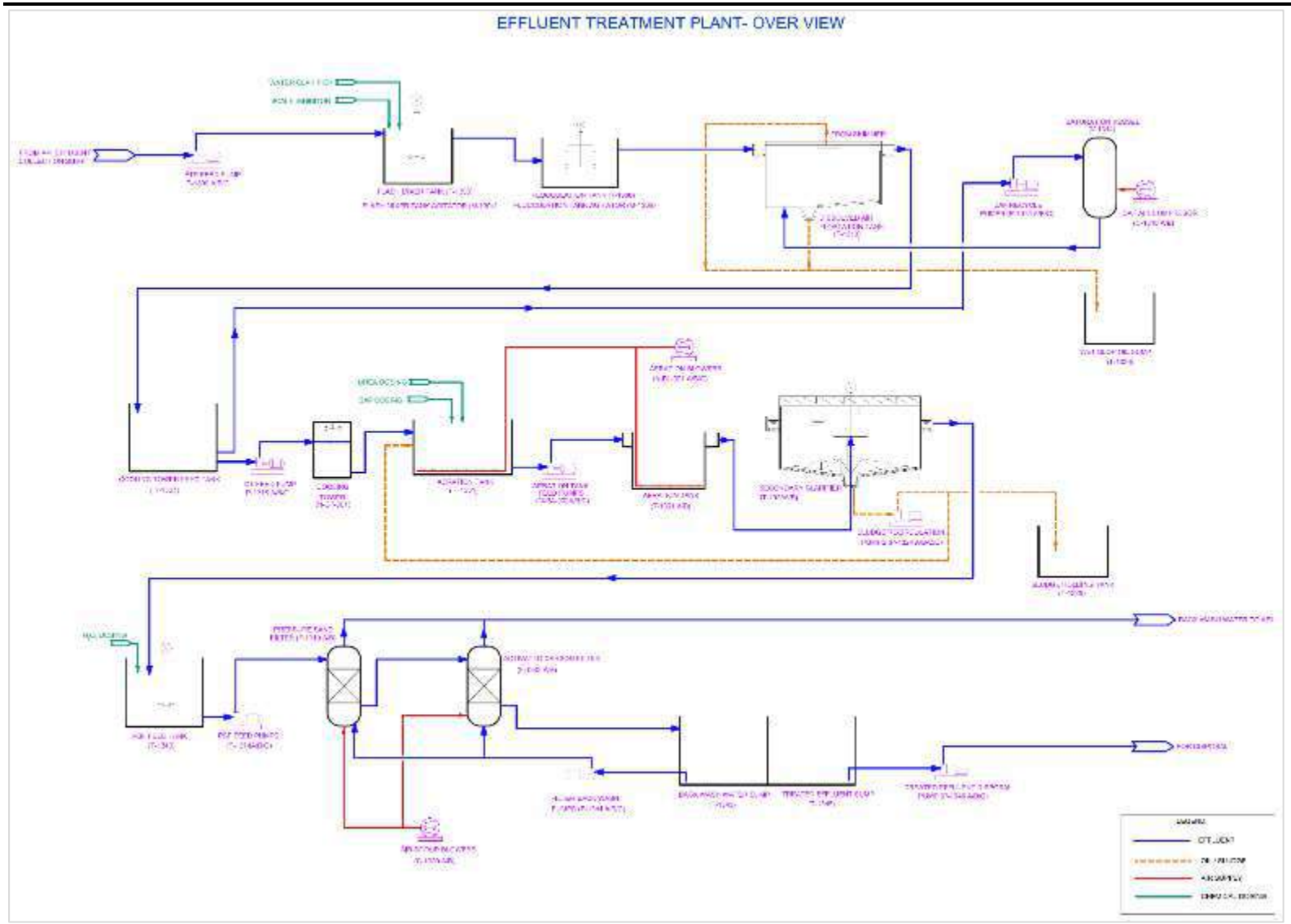
Table 2.5 Quality of Treated Effluent from ETP at Ravva Terminal

SN	Parameter	Results of Treated Effluent from ETP Observed in 2019									EP Rules, GSR 546 (E) Limits
		Jan to March		Apr-Jun		July – Sep		Oct-Dec		Ann. Avg.	
		Min	Max	Min	Max	Min	Max	Min	Max		
1	pH	7.2	7.8	7.8	8.0	7.7	7.9	7.5	7.8	7.7	5.5 to 9.0
2	Oil and Grease, mg/L	6.0	7.0	7.0	8.0	6.0	8.0	6.0	8.0	7.0	10.0
3	COD, mg/L	177.0	218.0	158.0	196.0	152.0	175.0	138.0	157.0	171.4	250
4	BOD (3day, 27°C), mg/L	13.0	18.0	15.0	17.0	12.0	14.0	14.0	16.0	14.9	30
5	Total Suspended Solids, mg/L	48.0	66.0	57.0	68.0	42.0	53.0	56.0	62.0	56.5	100
6	Fluoride, mg/L	0.7	0.9	0.7	0.9	0.6	0.8	0.7	1.0	0.8	1.5
7	Total Chromium as Cr, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
8	Lead, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
9	Copper, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
10	Zinc, mg/L	0.02	0.04	0.04	0.07	0.03	0.06	0.05	0.07	0.0	0.1
11	Mercury, mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
12	Cyanide, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.005
13	Nickel, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1

Source: Vedanta Limited (Cairn Oil & Gas) Results as monitored in January to December 2019 by Vimta Labs.

The treated wastewater is discharged into the sea complying with the discharge standards as prescribed in the EP Rules (1986), GSR 546 (E) for marine outfal. The treated effluent from ETP is disposed of by discharging it through 20 inches pipeline leading to marine outfall located at 82°06'22"E and 16°28'17"N. The effluent pipeline at the marine outfall is ended with T-shaped 2 port diffuser (of diameter 3 inches each, 3.5 m length each at 90°) which is submerged at 5 m depth (1 m above seabed) at 540 m from the shore.

Figure 2.11 Layout Plan of Effluent Treatment Plant at Ravva Terminal



Source: Vedanta Ltd (Cairn Oil & Gas)

12) Utility Systems

a) Flare

Flares are installed to relieve pressure of vessel and piping works during abnormal conditions though plant is equipped for zero flaring. Two types of flare header operated to cater the needs of different pressure. Slug catcher, first stage separator, gas treatment plant and associated gas compressors relief, vent and blow down are connected with high pressure flare header and flows into the high pressure flare scrubber. Gas outlet from the scrubber flows to the flare stack. HP flare tip is Coanda type high velocity sonic flare for smokeless flaring. Low pressure gas from the gas blanketing system, second stage and the third stage separator and other sources flows through a separate LP flare header to a separate LP flare scrubber and flare stack for disposal. LP flare is assisted with external air blower for complete combustion. Flares are equipped with gas pilots and igniters with purge gas. Liquids from the HP and LP flare scrubber are pumped with automatic start pumps according scrubbers level to the bad oil header for water separation at Crude wash tank and then to storage tank.

b) Hot Oil Heater

The hot oil system is a closed loop using heat transfer fluid to provide heat to various exchangers viz., glycol rebolier, fuel gas pre heater and API oil recovery sump heating coil and RSGDP MEG glycol reboiler. The system consists of the hot oil heater, hot oil expansion tank, hot oil circulation pumps, distribution piping, and controls.

c) Electric Power

Electric power is generated on-site by four gas turbine driven generators (2.5 MW each). A diesel engine driven emergency generator (1,000 KVA) is also included in the system to cater emergency needs.

d) Instrument and Control

The instrument and control system includes the following. Basic mode of local process control is pneumatic, with selected loops or measuring system electrical/electronic. The local shutdown devices are pneumatic or electrical. The plant has a central processing system with central control panel, programmable logic controller (PLC), and a supervisory control and data acquisition system with process controllers via PLC.

e) Fire Protection

Nine firewater pumps are provided along with Fire water storage tanks. Fire water network is in place covering the entire plant. Firewater sources are from RO plant and from water harvesting ponds. Firewater header loops are installed around process and hydrocarbon storage areas, complete with monitors, hydrants, hose houses and isolation valves. A foam generation and distribution system supplements the firewater system. Automatic actuated fixed foam system (for rim seal fire suppression) and water spray rings provided on all crude storage tanks. Fire water storage tanks and pump details as per **Table 2.6**.

Table 2.6 Fire Water Storage and Pumps Capacities

S.N.	Particulars	Number	Capacity
1	Fire water storage tanks	3	4100 m^3 , 4600 m^3 and 7065 m^3
2	Fire pumps	9	410 m^3/hour and 560 m^3/hour

For offshore un-manned platforms, multitask vessel with fire fighting capabilities is available round the clock in the field to assist in fire fighting. The multi support vessel has Oil Spill Response Equipment to attend Tier-I Oil Spills.

All over the Ravva Terminal, gas sensors, fusible loop, flame detectors and smoke detectors have been installed to detect any gas leak, fire and smoke.

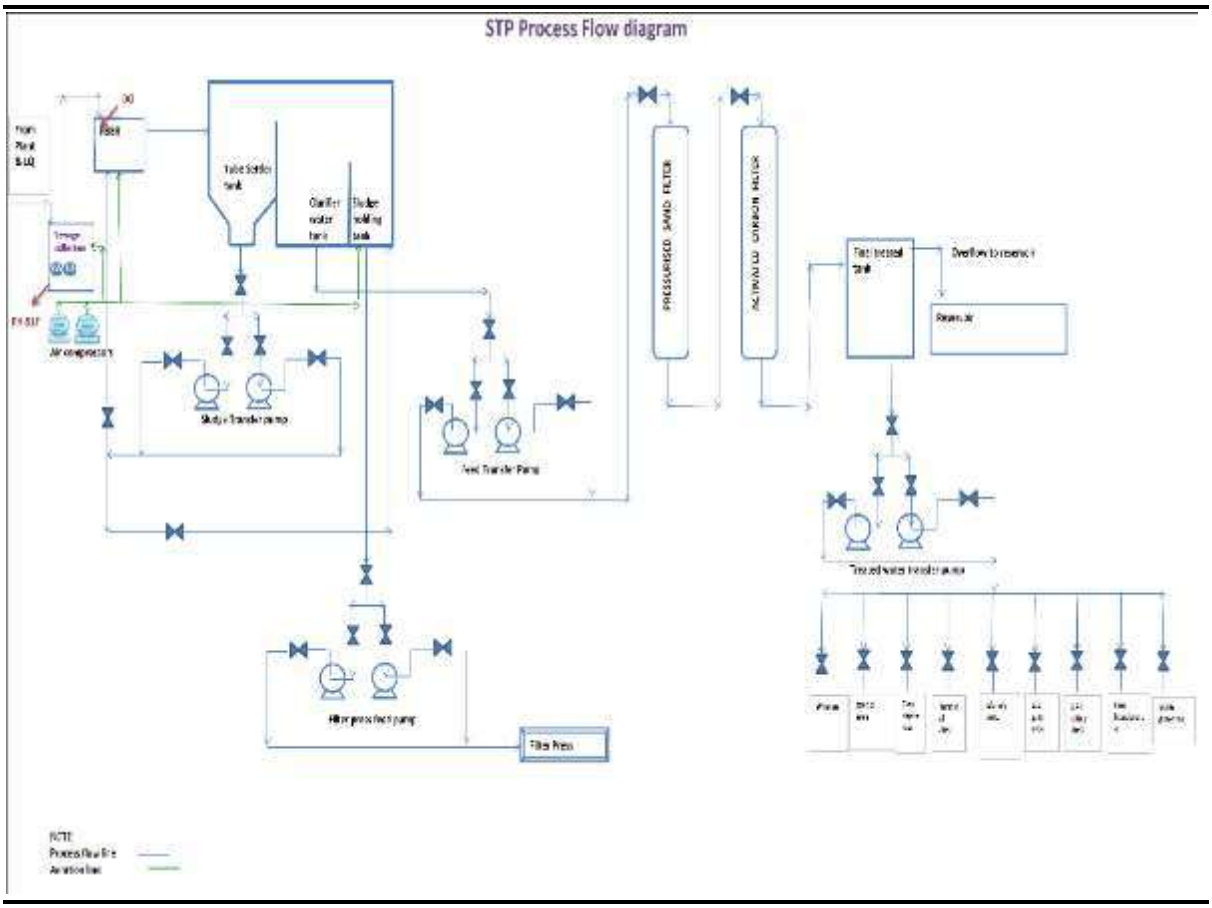
f) R.O Plant

Plant and LQ is supplied with potable water through two stage Reverse Osmosis plant (400 m^3/day capacity) available at Ravva Terminal to produce potable water from saline water.

g) STP

Domestic Sewage from Living Quarters and Ravva Plant are treated in the Sewage Treatment plant (STP) of 175 m^3/day capacity and the treated water is used for green belt development.

Figure 2.12 Schematic Flow Diagram of Operating STP at Ravva Terminal



Source: Vedanta Limited (Cairn Oil & Gas)

h) Instrument air system

Plant equipped with three helical screw compressors to supply continuous air supply with automatic loading and unloading mechanism to maintain air supply header pressure of 8 barg.

13) Living Quarters

Living quarters have been provided with 90 rooms (with single and double occupancy) onshore near the Ravva Terminal.

14) Helipad Services

A helipad has been provided at the Living Quarters, which is located ~1.75 km from shore as per approval of Directorate General of Civil Aviation for taking up sorties to unmanned platforms within Ravva Field.

15) Supply Vessels

Vedanta Ltd (Cairn Oil & Gas) has deputed one supply vessel exclusively for surveillance of existing offshore installations. This supply vessel is also equipped with fire fighting capabilities and oil spill response equipment. The offshore activities are also supported by mechanised boat for petrol and a line boat is available to support tanker movement. All the vessels are operated as per the Directorate General of Shipping and Naval authorities.

15) Explosives Magazine

An explosives magazine is also maintained as per licence from Petroleum and Explosives Safety Organization onshore outside Ravva Terminal.

2.5 HYDROCARBONS POOLS/PROSPECTS IN PKGM-1 BLOCK

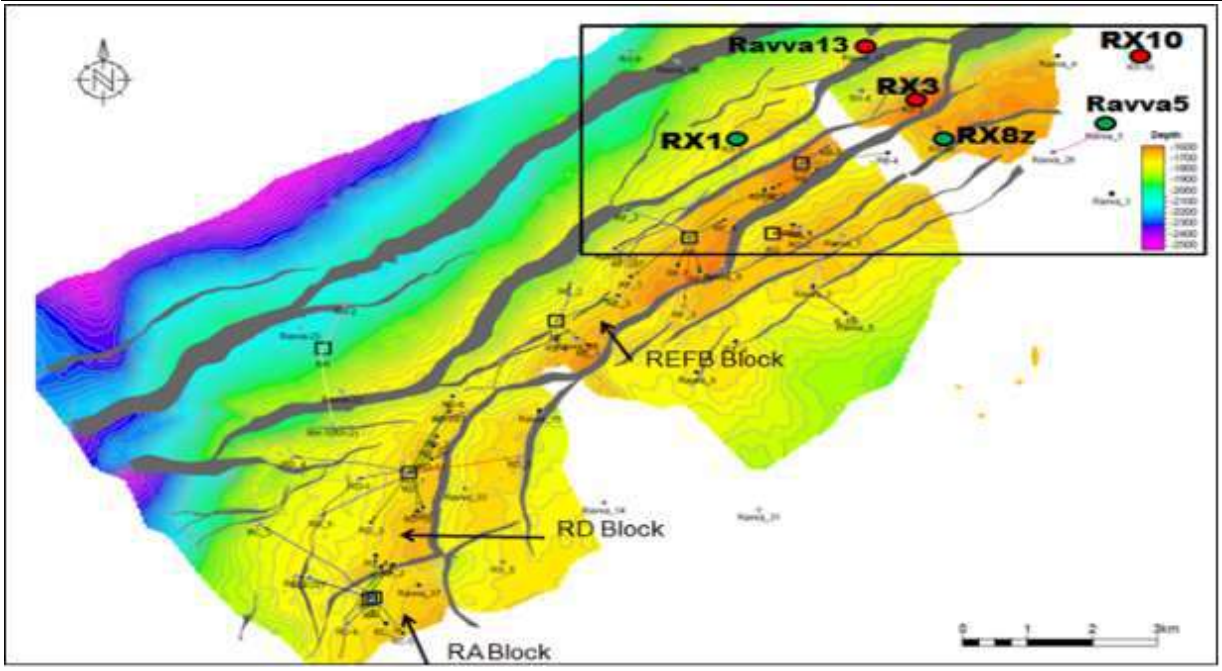
With the proposed offshore development, enhancement from the currently declining oil and gas production levels will ensure that the production levels remain well within the approved plateau of 50,000 BOPD of crude oil and 2.32 MMSCMD of gas as permitted by APPCB.

Apart from the existing hydrocarbon resource pools that are already being tapped, few other resource pools have been reviewed for development based on interpretation of new subsurface data (3D HD seismic data acquired in 2010) as part of the proposed Project. The selection is based on the risks, recoverable hydrocarbon volumes and economics. The location of some of the reviewed resource pools have been shown in ***Figure 2.13***.

Apart from main oil producing facility and satellite gas pools of Ravva Field, several small oil and gas discoveries had been made in the Ravva Field at various reservoir levels in different fault blocks. Based on 3D HD (three dimensional high definitions) seismic data acquired in 2010, 4D (four dimensional) seismic data and the current market hydrocarbon prices and renewed economics of discovered resources it is proposed to have development of the identified resources. This development would allow maintaining the current levels of

hydrocarbon production or enhance it as well as maximise utilisation of the onshore processing facility and other infrastructures within the already approved capacities.

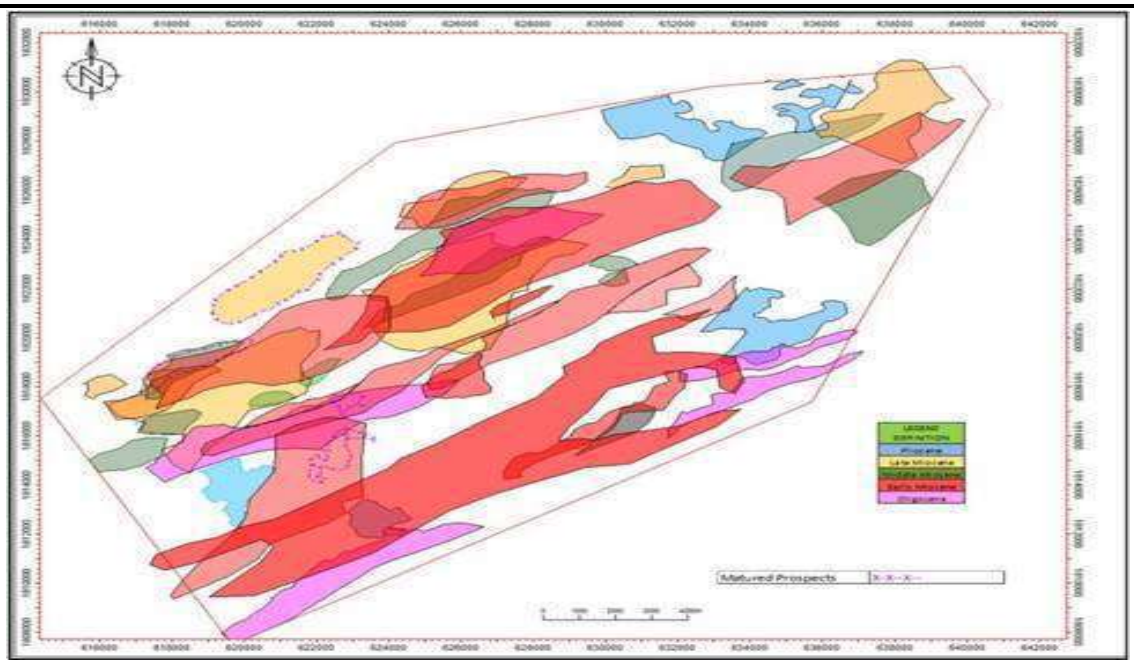
Figure 2.13 Hydrocarbon Resource Pools Available in Ravva Field



Source: Vedanta Ltd (Cairn Oil & Gas)

In addition to the hydrocarbon resource pools that were identified during the 3D HD seismic survey conducted in 2010 few additional subsurface prospective structures have also been identified. These could be candidates for carrying out exploration drilling for identification of presence of hydrocarbon and on exploration success, development activities are envisaged. The resource hydrocarbon pools expected to prevail in the PKGM-1 Block as per ***Figure 2.14***.

Figure 2.14 Hydrocarbon Resource Pools Expected in the PKGM-1 Block



Source: Vedanta Ltd (Cairn Oil & Gas)

2.6 *PROPOSED DEVELOPMENT*

As discussed earlier the intention of this proposed project is to maximise production of hydrocarbons from the Ravva field and optimally utilise the existing infrastructure and facilities. The rated capacities of processing facilities and utilities is sufficient to cater for increase in production due to proposed development more so since there has been a decline in hydrocarbon production from the field. The additional facilities proposed include:

- 83 number of Exploratory wells;
- 40 number of Development wells;
- Establishing 2 nos of onshore well pads;
- Additional 8 km long pipelines corridor (for three pipelines in ~15 m wide corridor).

The development of ~8 km onshore pipelines corridor will be taken up only after commercially viable discovery of hydrocarbon resources. In case of commercially viable discovery is made, initially for up to two years, Vedanta Ltd (Cairn Oil & Gas) is proposing to daily transfer well fluids through road tankers from a well pad to Ravva Terminal.

The detail of well pads and wells to be drilled from onshore and offshore locations is provided in ***Table 2.7.***

2.6.1 *Exploratory Wells*

With the help of 3D HD seismic data reprocessed in 2016, additional subsurface prospective structures have been identified at different stratigraphic levels. These could be candidates to carryout exploration drilling and upon exploration success, development activities are envisaged. In order to ascertain the presence of hydrocarbons in these structures and assess the production potential and commercial viability, it is proposed to drill 83 exploration (including appraisal) wells. It is proposed to drill 10 onshore well from proposed well pads; 14 wells from existing offshore platforms and 59 standalone offshore wells. The locations of the proposed exploratory wells are given in ***Table 2.7.*** Actual geo-graphical surface coordinates of exploratory and development well locations will be within 1 km radius of the proposed coordinates except for wells from existing offshore platforms.

2.6.2 *Development Wells*

As mentioned earlier there has been a decline in production of hydrocarbons from the field over the years. Apart from main oil producing facility and satellite gas pools of Ravva Block, several small oil and gas discoveries had been made in the PKGM-1 Block at various reservoir levels in different fault blocks. The proposed development would allow maintaining the already approved levels of hydrocarbon production as well as maximize utilization of the onshore processing facility and other infrastructures within the already approved capacities.

Moreover, based on the early indications of high prospectivity of the exploration targets in the back-fault area targeting Lower and Middle Miocene sequence and lower late Miocene sequence west of offshore RE Platform, commercial hydrocarbon pool is expected and some high graded prospective area needs an early development plan.

The development of the resource pools for tapping hydrocarbons will be done through drilling of 40 Development Wells. It is planned to drill 17 offshore development wells for existing platforms and 23 onshore wells from onshore well pads. The locations from where these development wells are proposed to be drilled are given in ***Table 2.7.***

The well fluids from the proposed wells in offshore will be routed to the onshore Ravva Terminal through existing subsea infield pipelines interconnecting offshore platforms. No new pipeline will be laid between offshore platforms and onshore Ravva Terminal i.e. there will be no pipeline crossing the seashore. The existing pipelines connecting offshore platforms to the onshore terminal will be used for transporting the well fluids from the identified resource pools to the Ravva onshore terminal. The locations of existing pipelines are shown in ***Figure 2.6.***

Table 2.7 Locations of Proposed Exploratory & Developmental Wells

S N	Well IDs & Location	Latitude, N	Longitude, E	Total No. of Wells	Exploration Wells	Development Wells
A	**Onshore Wells#**					
1	Onshore Pad WP-7 i.e. WP-A (RX-8)	16° 30' 7.237"	82° 8' 54.372"	17	5	12
2	Onshore Pad WP-B i.e. WP-8 (RX-9)	16° 30' 27.742"	82° 9' 36.829"	16	5	11
	Subtotal (A2)			33	10	23
	Total Onshore Wells (A)			***33***	***10***	***23***
B	**Offshore Wells**					
B-1	**Drilling from existing Platforms**					
9	Platform RB	16° 28' 31.366"	82° 11' 36.301"	6	2	4
10	Platform RC	16° 23' 55.116"	82° 7' 52.442"	4	1	3
11	Platform RD	16° 25' 14.853"	82° 8' 11.008"	6	2	4
12	Platform RE	16° 26' 51.288"	82° 9' 28.002"	5	4	1
13	Platform RF	16° 27' 44.405"	82° 10' 37.681"	4	2	2
14	Platform RG	16° 27' 46.533"	82° 11' 21.214"	1	1	0
15	Platform RH	16° 26' 34.650"	82° 7' 26.860"	5	2	3
	Subtotal (B1)			31	14	17
B-2	**Drilling from Standalone Offshore Locations**					
16	Well-E-1	16° 28' 23.444"	82° 7' 36.664"	1	1	0
17	Well-E-2	16° 29' 16.645"	82° 8' 36.273"	1	1	0
18	Well-E-3	16° 29' 53.320"	82° 9' 32.281"	1	1	0
19	Well-E-4	16° 28' 47.705"	82° 8' 6.808"	1	1	0
20	Well-E-5	16° 27' 58.513"	82° 7' 5.183"	1	1	0
21	Well-E-6	16° 27' 30.441"	82° 6' 42.509"	1	1	0
22	Well-E-7	16° 27' 4.947"	82° 6' 6.374"	1	1	0
23	Well-E-8	16° 27' 37.573"	82° 6' 2.435"	1	1	0
24	Well-E-9	16° 31' 3.860"	82° 11' 17.435"	1	1	0
25	Well-E-10	16° 30' 58.237"	82° 12' 41.572"	1	1	0
26	Well-E-11	16° 31' 34.661"	82° 13' 20.871"	1	1	0
27	Well-E-12	16° 31' 11.455"	82° 13' 52.402"	1	1	0
28	Well-E-13	16° 25' 56.812"	82° 6' 18.901"	1	1	0
29	Well-E-14	16° 24' 8.330"	82° 6' 28.706"	1	1	0
30	Well-E-15	16° 28' 19.514"	82° 10' 2.363"	1	1	0
31	Well-E-16	16° 25' 19.888"	82° 6' 23.281"	1	1	0
32	Well-E-17	16° 28' 7.943"	82° 9' 24.103"	1	1	0
33	Well-E-18	16° 27' 27.778"	82° 8' 15.043"	1	1	0
34	Well-E-19	16° 26' 51.871"	82° 6' 33.568"	1	1	0
35	Well-E-20	16° 27' 5.335"	82° 7' 8.329"	1	1	0

S N	Well IDs & Location	Latitude, N	Longitude, E	Total No. of Wells	Exploration Wells	Development Wells
36	Well-E-21	16° 26' 31.436"	82° 6' 12.738"	1	1	0
37	Well-E-22	16° 22' 44.433"	82° 9' 10.258"	1	1	0
38	Well-E-23	16° 23' 26.658"	82° 10' 15.090"	1	1	0
39	Well-E-24	16° 24' 10.136"	82° 11' 17.612"	1	1	0
40	Well-E-25	16° 25' 37.055"	82° 5' 52.001"	1	1	0
41	Well-E-26	16° 26' 6.159"	82° 8' 56.376"	1	1	0
42	Well-E-27	16° 27' 40.052"	82° 8' 57.867"	1	1	0
43	Well-E-28	16° 28' 37.757"	82° 13' 17.471"	1	1	0
44	Well-E-29	16° 29' 10.956"	82° 13' 4.392"	1	1	0
45	Well-E-30	16° 29' 39.419"	82° 13' 27.942"	1	1	0
46	Well-E-31	16° 30' 46.906"	82° 11' 46.304"	1	1	0
47	Well-E-32	16° 26' 15.481"	82° 9' 29.369"	1	1	0
48	Well-E-33	16° 27' 0.777"	82° 8' 0.462"	1	1	0
49	Well-E-34	16° 26' 18.736"	82° 6' 44.679"	1	1	0
50	Well-E-35	16° 24' 11.374"	82° 8' 30.329"	1	1	0
51	Well-E-36	16° 24' 57.764"	82° 8' 28.936"	1	1	0
52	Well-E-37	16° 25' 22.345"	82° 12' 47.019"	1	1	0
53	Well-E-38	16° 26' 2.338"	82° 13' 53.888"	1	1	0
54	Well-E-39	16° 30' 9.768"	82° 10' 28.031"	1	1	0
55	Well-E-40	16° 30' 27.051"	82° 11' 4.464"	1	1	0
56	Well-E-41	16° 26' 15.497"	82° 8' 0.016"	1	1	0
57	Well-E-42	16° 29' 3.539"	82° 11' 27.911"	1	1	0
58	Well-E-43	16° 26' 38.250"	82° 8' 32.625"	1	1	0
59	Well-E-44	16° 27' 40.271"	82° 9' 42.737"	1	1	0
60	Well-E-45	16° 25' 0.084"	82° 9' 2.965"	1	1	0
61	Well-E-46	16° 25' 33.164"	82° 9' 20.647"	1	1	0
62	Well-E-47	16° 26' 40.923"	82° 10' 41.505"	1	1	0
63	Well-E-48	16° 24' 55.157"	82° 10' 28.352"	1	1	0
64	Well-E-49	16° 24' 15.981"	82° 9' 25.129"	1	1	0
65	Well-E-50	16° 25' 18.756"	82° 11' 35.391"	1	1	0
66	Well-E-51	16° 23' 19.562"	82° 8' 33.256"	1	1	0
67	Well-E-52	16° 29' 3.365"	82° 10' 18.460"	1	1	0
68	Well-E-53	16° 29' 44.676"	82° 11' 5.053"	1	1	0
69	Well-E-54	16° 29' 59.142"	82° 11' 55.260"	1	1	0
70	Well-E-55	16° 30' 21.819"	82° 13' 5.364"	1	1	0
71	Well-E-56	16° 28' 1.169"	82° 12' 53.645"	1	1	0
72	Well-E-57	16° 29' 6.129"	82° 14' 0.674"	1	1	0
73	Well-E-58	16° 28' 26.387"	82° 13' 50.747"	1	1	0
74	Well-E-59	16° 28' 50.726"	82° 12' 16.306"	1	1	0
	Subtotal (B2)			**59**	**59**	**0**
	Total offshore wells			***90***	***73***	***17***
	Total (A+B1+B2)	**-**	**-**	**123**	**83**	**40**

Source: Vedanta Ltd (Cairn Oil & Gas);

Note: # The proposal has been revised for onshore drilling of wells. There will be drilling of wells from two well pads located within the PKGM-1 Block. The well pads that were planned to be located outside the block has been withdrawn from the proposal.

Actual geo-graphical surface coordinates of exploratory and development well locations will be within 1km radius of the proposed coordinates except for wells from existing offshore platforms.

2.7 *DRILLING OF ONSHORE WELLS IN PKGM-1 BLOCK*

2.7.1 Site Selection

It is proposed to have two (2) onshore well pads for drilling of 10 exploration wells and 23 developmental wells from within the PKGM-1 Block. The justification of onshore well pads has been discussed as follows:

Justification of the Onshore Well ad Site

Alternative analysis was carried out considering the technical and operational feasibility. The PKGM-1 Block is allocated by the Government of India under the Production Sharing Contract (PSC). ONGC is the Licensee and Vedanta Ltd. (Cairn Oil & Gas) is the Operator. Drilling locations are proposed based on geo-scientific information and alternate sites cannot be considered for the proposed project facilities to tap new prospects located within PKGM-1 Block.

2.7.2 Land Requirement for Onshore Well Pads and Pipelines

The tentative plot plan for each well pad will cover area of approximately 3.83 ha (225m X 170m); however, configuration may change depending upon the land availability. The two onshore well pads are located in the existing well pad sites. The well pad sites have no settlement within them. Therefore, resettlement and rehabilitation will not be applicable for this project. Total land required for two onshore well pads will be ~8.0 ha and will be leased from Andhra Pradesh Government.

The land requirement for laying of three onshore subsurface pipelines in ~8 km long pipelines corridor of 15 m wide will be 12 ha on ROU basis.

2.7.3 Access Road & OHL for Power Supply to Well Pads

The accessibility map (Refer ***Figure 2.3***) shows that the two onshore well pads have all weathered access road from Ravva Terminal. The existing road will be upgraded and strengthened for the rig movement.

Strengthening of site approach road will not require any forestland or involve displacement of any household. As far as possible, existing roads will be used. Cutting of trees will be avoided. If necessary, existing road will be developed by widening, etc. Culverts and drainage channel will be maintained during site preparation.

Overhead power transmission line (OHL) will be developed along the road for supply of power to well pads from state grid or Ravva Terminal.

2.7.4 Method of Land Procurement / Lease

The land allotment process of the government will be followed. The land falling in the proposed well pads area will be taken on lease initially for three years. In case of commercially viable discovery of hydrocarbon resources, lease will be extended for a long-term period till

decommissioning of the wells. With the setting up of well pads, the land use will change coastal area will be diverted to industrial land.

For the onshore pipelines corridor of ~8 km, land parcels will be taken on right of use (RoU) basis.

Vedanta Limited (Cairn Oil & Gas) will compensate all affected landowners for any loss of land resulting out of the proposed onshore drilling program. In accordance with their Standard Operating Procedure (SOP) on direct land procurement / lease / renewal / surrender (SOP VL-Land-SOP-DP/LDL-00A3 dated 20 April 2018)

Box 2.1 SOP for Direct Purchase and/or Lease of Land

The purpose of this SOP is to standardise the procedure to be adopted for direct purchase and/or lease of land in line with the prevalent laws and confirming with the relevant guidelines of the Vedanta Sustainability Governance System (VSGS).

The referred SOP enumerates the guiding principles of Vedanta Sustainability Governance System - "*to obtain land for their projects, all Vedanta's operations shall first explore the option of land purchase through negotiated settlement over land expropriation through Government agencies to considerably reduce the risks of significant adverse impacts and increased vulnerabilities. Negotiated settlement shall be based on 'willing buyer - willing seller' approaches and negotiated amount would be equivalent to, or more than, the 'full replacement cost' of the acquired land, properties etc.*"

The guiding principle for establishing the procedure of Direct Purchase and / or Direct Lease of land is that it should be transparent, efficient and should stand audit scrutiny. The land(s) to be purchased / leased on the "***willing buyer/lessor - willing seller/lessee***" principle ensuring the following advantages for the Company:

- Avoiding forced acquisition and / or eviction
- Improve / Restore livelihoods or standards of living of displaced persons
- Direct interaction and engagement with land owner(s)
- Land owner(s) gets fair market price thereby reducing resistance
- Ability to be innovative in finding solutions & early possession of lands

A multifunctional Price Fixation Committee (PFC) is appointed which will act as an empowered approving authority. The said committee shall have representation as per below mentioned composition. ONGC representative (being a JV partner) shall be invited to be part of this committee.

The PFC shall be authorized for the establishment of fair market price based on location, prevailing market rates, DLC rates, recent sale deed and / or lease deed executed in the vicinity etc. and to assess livelihood and property loss, Rehabilitation & Resettlement requirements based on LARR 2013[1] Act & VSGS guidelines; Property includes dwellings, crops, trees and other related physical and legal (lien) encumbrances.

Source: SOP (VL-Land-SOP-DP/LDL-00A3) dated 20 April 2018, Vedanta (Cairn Oil & Gas)

2.7.5 Construction of Well Pads

The two onshore well pads are compacted as they were developed for drilling in 2006-07 as per EC of 2006. The proposed well pad sites has no vegetation or structures; therefore, vegetation clearance/ demolition activities are not required. The following developmental activities will be carried out.

- ***Land filling***: The two onshore well pads are already raised above HFL and compacted and so landfilling will not be required.
- ***Fencing***: The proposed well pad sites & campsite will be duly fenced to a height of about 2 m using jingle wired fencing or expamet fencing.

[1] *The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013*

- ***Reinforced Cement Concrete (RCC)***: RCC will be used for the construction of foundation system. For the construction of a well pad site, For setting up of an onshore well pad, the indicative quantities required include the following – (i) RCC : 750 m^3; (ii) Rebar: 90 MT; (iii) Sand: 50,000 m^3; (iv) Stone aggregates: 7500 m^3 and (v) Brick/rubble masonry:
- ***Construction of cellar pit*** 1.85m x 2.15m x 1.5 m for installation of well head and BOP
- ***Construction of HDPE lined pit*** of ~2 Nos. of pits of each 800m^3 (typical dimensions of 20m x 20m x 2m) for each well site for temporary storage and disposal of drill cutting (separate storage of WBM and SBM based drill cuttings).
- Construction of HDPE lined pit of 3,000 m^3 for temporary storage and disposal of drilling wash water & waste mud (800 m^3) and rain water (2,200 m^3)

For the development phase, apart from the well completion accessories as minimum, the onshore well pads will have piping connectivity to the main pipeline, MPFM (multi-phase flow meter), instrumentation and control panels, disposal systems connected to the onshore terminal and safeguarding mechanisms. The flow-arms from each well transporting the produced fluid for separation and at the onshore facilities will be onnected to pipelines of 6" 8" and 14 inches through common pipeline corridor of ~8 km length to the existing onshore Ravva Terminal. Relevant ROU will be applicable for such establishments. The typical layout map of onshore well pad site is presented in ***Figure 2.15***.

2.7.6 Transportation of Rig and Associated Machineries

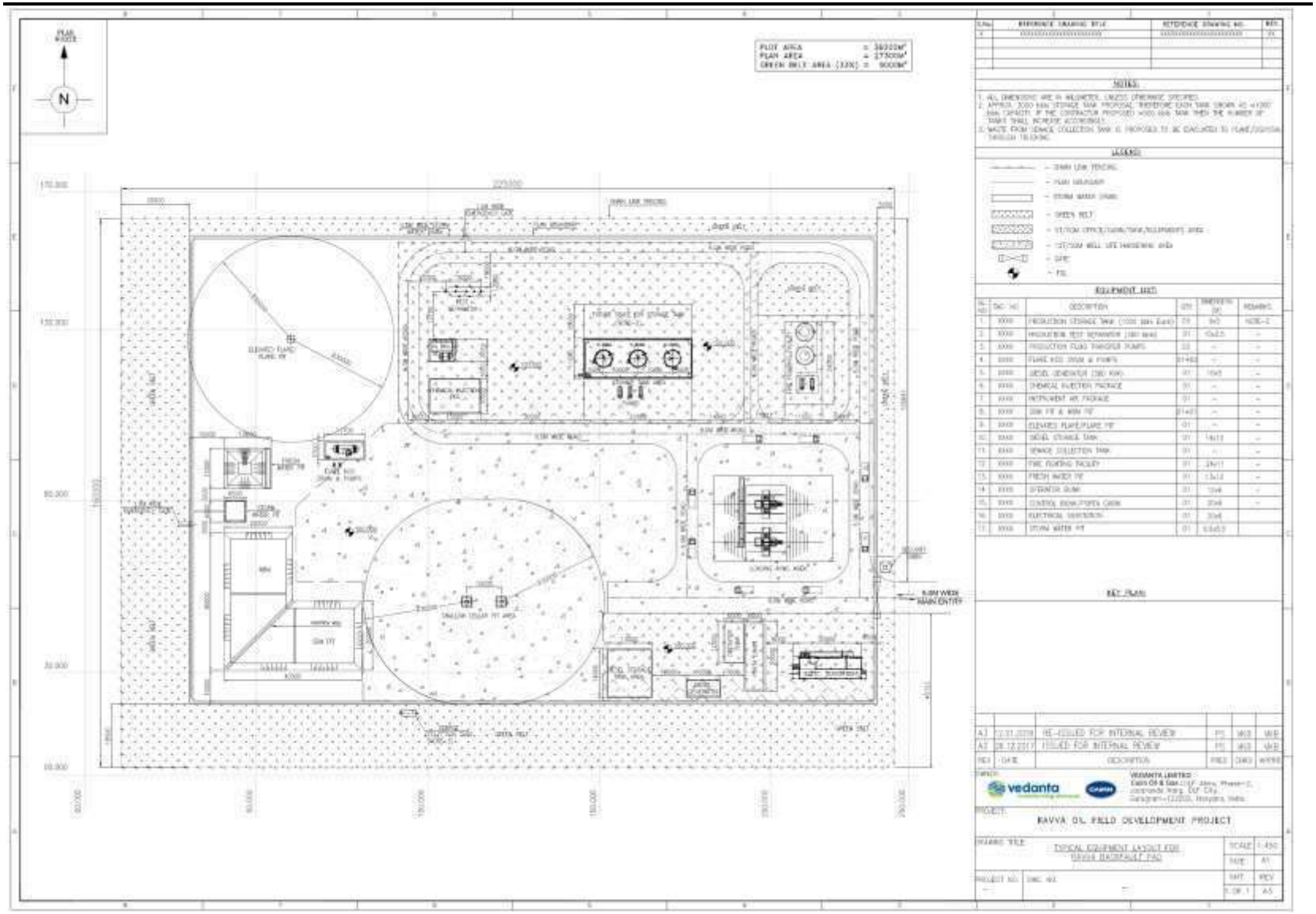
After completion of the construction activities and with the provision of the basic facilities, drill rig will be transported to the site. The drill equipment are designed as modular/ skid mounted type, which facilitates quick mobilization and demobilization. Rig essentially comprises of a mast, a draw work, rotary table, kelly or top drive, mud pumps engines, drilling fluid storage and handling tanks and generators.

The transport of rig including ancillary equipment and camp facilities to the site is expected to comprise around 100 trailer loads for each well drilling. Though the rig and related equipment will be directly brought to site, spares, chemicals and other materials will be received from Vedanta Ltd (Cairn Oil & Gas)'s warehouse located at Surasaniyanam Village. Materials will be intermittently supplied from the warehouse to the drilling site, during operations; a provision will be kept for temporary storage of materials at the drilling site itself.

2.7.7 Rig Mobilization and Rigging up

A rig building process will follow the site preparation activities. This process involves transport of rig including auxiliary equipment and camp facilities, assembling of various rig parts and equipment to drill a well. Once the drilling rig is assembled, thorough rig inspection will be carried out to check equipment working capability and quality standards. The rig will have various allied equipment like mud tanks, mud pumps, compressors, fuel tank and diesel generators etc.

Figure 2.15 Layout of Typical Onshore Well Pad Site of Vedanta Ltd (Cairn Oil & Gas)



2.7.8 Drilling Operation

The drilling process uses a rotating drill bit attached to the end of a drill pipe, referred to as the drill string. Drilling fluid is pumped down the drill string, through the drill bit and up the annular space between the drill string and the hole. As the bit turns, it breaks off small pieces of rock or drill cuttings, thus deepening the hole. The drilling fluid removes the cuttings from the hole, cools the drill bit, and maintains pressure control of the well as it is being drilled. As the hole becomes deeper, additional lengths of pipe are added to the drill string as necessary. Periodically, the drill string is removed and the unprotected section of the borehole is permanently stabilised by installing another type of pipe, called casing. Cement is then pumped into the annular space between the casing and the borehole wall to secure the casing and seal off the upper part of the borehole. The casing maintains well-bore stability and pressure integrity. Each new portion of casing is smaller in diameter than the previous portion through which it is installed. The process of drilling and adding sections of casing continues until final well depth is reached.

1) Drilling Sections

Onshore Drilling: A conductor is grouted to the point of refusal below mud line. The conductor is then cut and cement/concrete is pumped down the annular. A diverter, bell nipple and flow lines are connected. The diverter is then tested. A bit and BHA required to drill surface hole are run to bottom and the casing is displaced to drilling mud. If shallow acquifers are present the surface hole will be drilled with WBM (water based mud). On reaching the section total depth, the well may be logged as per sub-surface requirement. The required length of casing string is made up and RIH and cemented. Casing is pressure tested. Diverter is then nipple down.

Waste Disposal for Onshore Drilling Activties

2) *Blowout Preventer*

A blowout preventer (BOP) is a large valve or series of valves that can seal off an oil or natural gas well being drilled or worked on. If underground pressure forces oil or gas into the wellbore, operators can close the valve remotely (usually via hydraulic actuators) to forestall a blowout, and regain control of the wellbore. Once this is accomplished, often the drilling mud density within the hole can be increased until adequate fluid pressure is placed on the influx zone, and the BOP can be opened for operations to resume. BOPs are fitted with hardened steel shearing surfaces that can actually cut through drill pipe and tool strings, if all other barriers fail. BOPs come in two types i.e. ram and annular. Both Ram and Annular type BOPs are used together during drilling, called the BOP stack. More details on BOP installation as followed by Vedanta Limited (Cairn Oil & Gas) are indicated in the following Box.

Box 2.2 Blowout Preventer Installation

Well blowout prevention: Prevention of blow outs rests on control of any kick/ influx in the well bore. It is achieved by maintaining primary well control. In case the primary well control fails, then secondary well control measures are applied by closing the rams of the well control equipment called Blowout Preventer (BOP) and subsequently circulating the kick (influx) out of the wellbore**.**

Primary well control: This is achieved by overbalance of hydrostatic pressure of the drilling fluid over and above the pore pressure at the corresponding drilling depths.

Secondary well control: This is implemented when primary well control has failed to prevent the influx from formation to the wellbore. Secondary well control measures are applied by closing the rams of the well control equipment called Blowout Preventer (BOP) and subsequently circulating the kick out of the wellbore.

- The BOP stack and wellhead in place at any point during the course of the well must be of sufficient working pressure to contain 10% above maximum anticipated surface pressure from the total depth of the current open hole section.
- Kick detection and shut-in drills shall be held once per week with both crews.
- The Company preferred procedure for shutting-in a well is the HARD SHUT-IN (HCRs closed /Shut- in on Annular) method.
- Wells will be killed with the drill string as near to the bottom of the well as conditions dictate. The constant bottom hole circulation method will be used to kill the well.

n case of failure to maintain primary and secondary well control, which may result in a blowout, then 'Blowout contingency plan and recommended practices' are adopted. Cairn (Oil & Gas) has an contract for Emergency Well Control and Firefighting with Wild Well Control Inc, a contractor of international repute to deal with any contingency situation.

Well control equipment: This includes the diverter system, BOP stack, BOP control system, wellhead, wellhead connector, Kelly cocks, drill string safety valves (inside BOPs), the kill and choke lines and manifold and all associated pipework and valves. All the well control equipment are regularly tested and inspected for its effectiveness. For onshore wells in Rajasthan, diverter for the surface hole drilling and BOP stack for the intermediate & production hole drilling, are used as the blowout prevention equipment.

Diverter equipment and minimum requirements: The diverter is used when the well cannot be shut in because of fear of formation breakdown or lost circulation due to shut in of BOP. All onshore wells, where shallow gas hazard have been identified have a diverter system installed for the surface section drilling. The diverter is installed on a conductor casing with large diverter pipe pointing to a downwind area.
BOP and minimum equipment requirements: In a well, after the surface casing, blow-out prevention (BOP) equipment is installed and maintained before resuming drilling. A typical BOP stack contains a number of ram preventers like Annular BOP, Pipe ram, Shear ram and Blind ram etc. the configuration of the BOP stack depends upon the well depth and expected pressures.

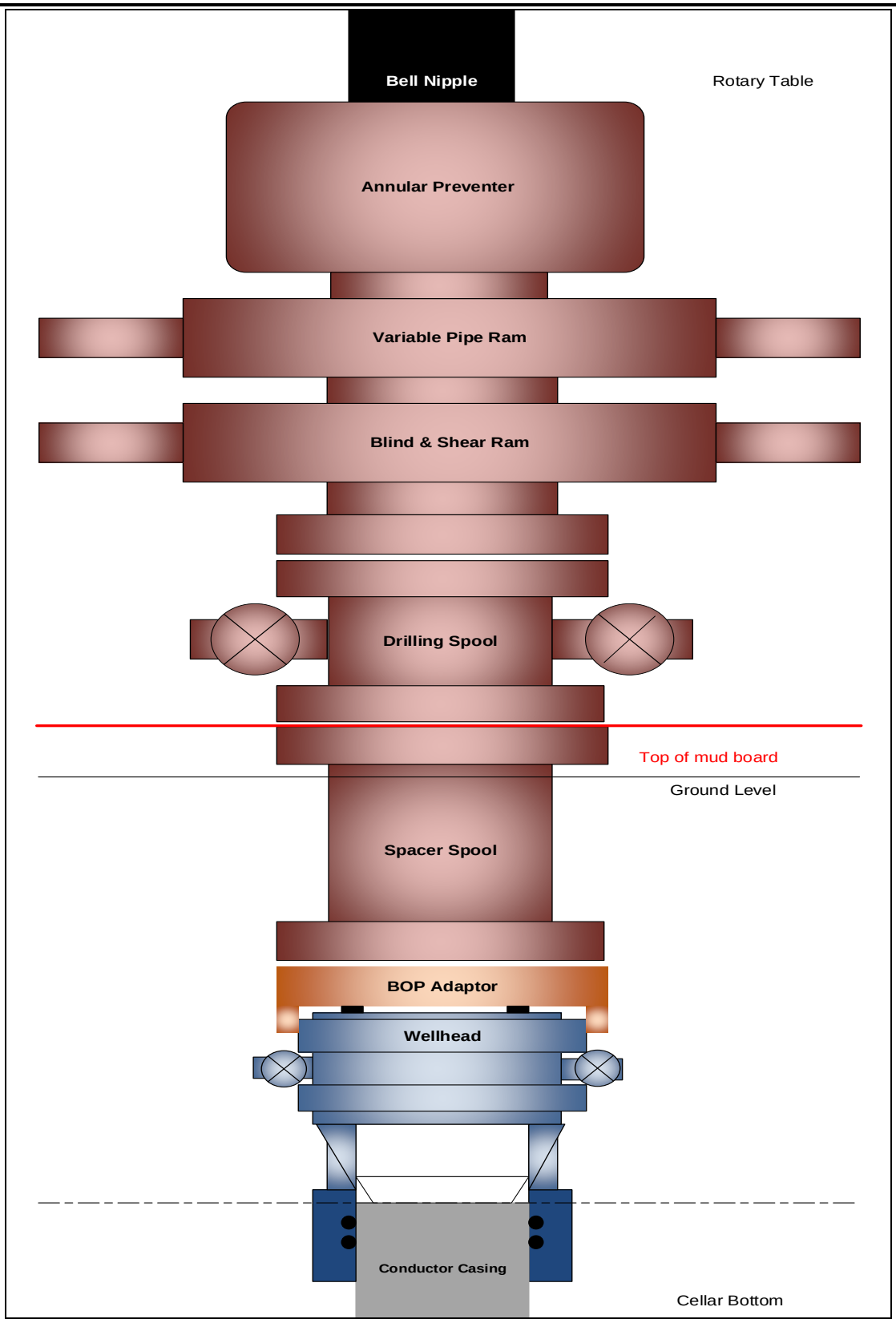
- An annular-type blowout preventer can close around the drill string, casing or a non-cylindrical object, such as the Kelly.
- Pipe rams close around a drill pipe, restricting flow in the annulus (ring-shaped space between concentric objects) between the outside of the drill pipe and the wellbore, but do not obstruct flow within the drill pipe.
- Blind shear rams are intended to seal a wellbore, even when the bore is occupied by a drill string, by cutting through the drill string as the rams close off the well.

The minimum requirements are as follows:

- 5,000 psi or less systems Onshore:1 x Annular and 2 x Rams (1 x pipe and 1x blind shear ram)
- 10,000 psi Onshore: 1 x Annular (5 ksi) and 3 x Rams (1 x blind and shear)
- 15,000psi systems: Onshore: 1 x Annular (10 ksi) and 3 x Rams (1 x blind and shear)

Source: Vedanta Ltd (Cairn Oil & Gas)

Figure 2.16 A Typical View of Blow Out Preventer



Source: Vedanta Ltd (Cairn Oil & Gas)

After N/U BOP, the bit and BHA is made up and run to just above the cement inside the surface casing. To ensure that it is safe to drill ahead, a leak-off test will be performed immediately after drilling out of the casing shoe. The next section of hole is drilled to the required depth, cleaned out and the intermediate casing is run and cemented. If required, drilling may continue to greater depths by drilling a next hole and running and cementing casing.

3) Well Cleaning, Testing and Completion

The zones of interest may be completed in open-hole with sand screens. In which the production casing will be cleaned up and displaced with solid-free mud system followed by screen running and setting against the oil or gas bearing zones. Subsequently, drilling fluid will be displaced with clear fluid brine. A tubing string with a tubing hanger attached will be run through the drilling riser and BOP, on a completion riser and landed in wellhead. The pressure integrity of tubing string, tubing hanger to wellhead seals and the production packer will then be tested. Operation of subsurface safety valve will also be tested. Post which wireline plugs will be set in nipple profile and the tubing hanger. The completion riser will be unlatched from the tubing hanger and retrieved. The BOP stack will be unlatched from the wellhead and riser system will be retrieved. A Christmas installation on wellhead will follow. After retrieving plugs from well, flow from the well will then be initiated for clean-up, production/injection/ well-testing (if any). Well testing in exploratory wells represents a major source of data to engineers and geoscientists investigating viability of the reservoir(s). Testing involves a range of techniques for establishing the characteristics of the reservoir and fluid such as pressure, temperature and flow rate. During testing of onshore exploratory wells, to eliminate flaring, the produced crude will be trucked to Ravva Onshore Terminal, minimizing carbon footprint of the exploration activity. While for offshore produced crude storage facility will be available onboard the rig together with flaring arrangement. The exact duration of well testing will depend on well behavior at the time of well testing.

4) Well Abandonment

In case of exploration and appraisal wells if the well is dry and is to be abandoned, several cement plugs will be set in the open hole section and at various positions in the casing (as per OISD Standard 175) and the casing may be cut and retrieved as deep as possible. All strings of casing are cut at least 5m below the seabed, and all structures above this point are recovered. Hydraulically operated casing cutting tools may be used to cut through the casing strings from the inside.

5) Associated Facilities for Storages at a Well Pad Site

Each well pad site will be provided with facilities such as drilling rig foundation and cellar pit, waste and water storage pits, chemical storage area including fuel storages, drill cutting disposal pit, flare pit and ETP. The drill cutting and spent mud disposal pits will be provided with a impervious lining for temporary storage. Adequate drainage and wastewater conveyance system also will be installed.

2.8 DRILLING OF OFFSHORE WELLS IN PKGM-1 BLOCK

It is also proposed to drill a total of 17 developmental wells from the existing platforms RB (4 nos.), RC (3 nos.), RD (4 nos.), RE (1 no.), RF (2 nos.) and RH (3 nos.). Existing platforms will be extended to facilitate installation of new wells slots and ancillary items. Each new well will be connected to the manifold through the flow-arms and will have all the relevant and applicable instrumentation and control philosophy applicable for the particular platform. Most of the existing production facilities will be used for production and injection. New requirement as part of development plan would be an extension of the existing production and test header manifolds, flow arms for gas lift, production and injection, and the addition of wellhead control panel modules.

2.8.1 Drilling Process

Jack up Rig (For Offshore locations)

A drilling process for development (infill production) and exploration and appraisal wells is similar. Jack up rig will be used in both cases - mat supported jack up or independent leg jack-up may be deployed. Rig suitability study findings will confirm on the type of rig to be utilized for drilling offshore wells.

Figure 2.17 A Typical View of Jack-up Rig

Source: Vedanta Ltd (Cairn Oil & Gas)

A Jack up rig is an offshore structure composed of a hull, legs and a lifting system that allows it to be towed to a site, lower its legs into the seabed and elevate its hull to provide a stable work deck. The hull of a jack up rig is a watertight structure that supports or houses the equipment, systems, and personnel, thus enabling the jack up rig to perform its tasks. When the jack up rig is afloat, the hull provides buoyancy and supports the weight of the legs and

footings (spud cans), equipment, and variable load. The legs and footings of a jack up rig are steel structures that support the hull when the rig is in the elevated mode and provide stability to resist lateral loads. Footings are needed to increase the soil bearing area thereby reducing required soil strength. The legs and footings have certain characteristics which affect how the Unit reacts in the elevated and afloat modes, while going on location and in non-design events. When in the elevated mode, the legs of a jack up rig are subjected to wind, wave, and current loadings.

There are three main groups of equipment on a jack-up rig, the marine equipment, mission equipment, and elevating equipment. Marine equipment are not directly involved in drilling however are used for movement, positioning and communications. Marine equipment include items such as main diesel engines, fuel oil piping, electrical power distribution switchboards, lifeboats, radar, communication equipment, galley equipment, etc. Mission equipment refers to aboard a jack up rig, which are necessary for the jack up to complete the drilling process. Mission Equipment includes derricks, mud pumps, mud piping, drilling control systems, production equipment, cranes, combustible gas detection and alarms systems, etc. Elevating equipment refers to the equipment and systems aboard a jack up rig which are necessary for the jack up to raise, lower, and lock-off the legs and hull of the jack up.

2.8.2 Drilling Mud System

During drilling operations, the drilling fluid (or mud) is pumped through the drill string down to the drilling bit and returns at the drill pipe–casing annulus up to surface back into the circulation system after separation of drill cuttings /solids through solids control equipment.

The primary function of drilling fluid is to ensure that the rock cuttings generated by the drill bit are continuously removed from the wellbore. The mud must be designed such that it can carry the cuttings to surface while circulating, suspend the cuttings while not circulating and drop the cuttings out of suspension at the surface. The drilled solids are removed at the surface by mechanical devices such as shale shakers, de-sanders and de-silters. The hydrostatic pressure exerted by the mud column prevents influx of formation fluids into the wellbore. The instability caused by the pressure differential between the borehole and the pore pressure can be overcome by increasing the mud weight. Hydration of the clays can be overcome by using non-aqueous based muds, or partially addressed by treating the mud with chemicals which will reduce the ability of the water in the mud to hydrate the clays in the formation.

Water based mud will be used for initial, shallower sections where massive shales are not encountered. The deeper and difficult to drill formations will be drilled using synthetic base mud (SBM). Synthetic base mud unlike oil based mud (OBM) is biodegradable but can be re-used. At the end of drilling a well almost the entire amount of the SBM is collected for re-use in next drilling operation. SBM systems promote good hole cleaning and cuttings suspension properties. They also suppress gas hydrate formation and exhibit improved conditions for well bore stability compared to most WBM. WBM typically consists of water, bentonite, polymers and barite. Other chemical additives viz. glycols and salts may be used in conjunction to mitigate potential problems related to hydrate formation. The mud to be used will be continuously tested for its density, viscosity, yield point, water loss, pH value etc. The mud will be prepared onsite (drill location) using centrifugal pumps, hoppers and treatment tanks.

The consumed fraction of the mud, which is mostly WBM will be discharged into sea intermittently in accordance with MoEFCC guidelines.

Offshore Drilling

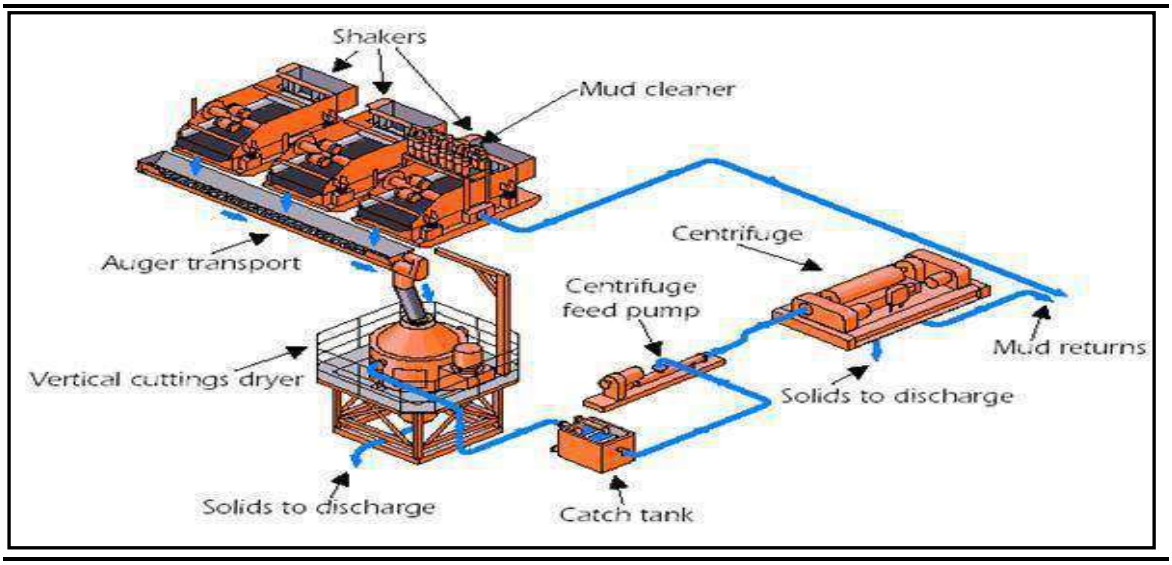
A conductor is driven using a hydraulic jack-hammer to the point of refusal below mud line. The conductor is then cut at the conductor deck and is secured at surface. A diverter, bell nipple and flow lines are connected. The diverter is then tested. A drill bit and clean-out bottom hole assembly (BHA) are run into the conductor to the soil plug and the soil plug is cleaned out using sea water. The clean-out bit is then pulled out to the surface and a bit and BHA required to drill surface hole are run to bottom and the casing displaced to Water Based Mud. The surface hole will be drilled with WBM (water based mud). On reaching the section total depth, the well may be logged as per sub-surface requirement with electric wireline tools. The required length of casing string is made up and RIH and cemented. Casing is pressure tested. Diverter is then nipple down.

The blow out preventer (BOP) and typical BOP will be similary as described in ***Section 2.7.8***.

2.8.3 Drill Cuttings Disposal

During drilling activity, cuttings will be generated due to crushing action of the drill bit. These cuttings will be removed by pumping drilling fluid into the well via triplex mud pumps. The mud used during such operation will flush out formation cuttings from the well hole. Cuttings will be then separated from drilling mud using solids-control equipment. This will comprise a stepped system of processes consisting of linear motion vibrating screens called shale shakers, hydro-cyclones (including de-sanders and de-silters), and centrifuges to mechanically separate cuttings from the mud.

Figure 2.18 A Typical View of Drill Cutting Separation & Treatment System



Source: Vedanta Ltd (Cairn Oil & Gas)

2.9 WATER CONSUMPTION

2.9.1 Offshore Drilling Activity

The jack up rig will have a typical storage capacity of 4,000 – 5,000 bbls (635 - 800 m^3) of drill water and 800 - 900 bbls (130 – 145 m^3) of water for domestic and other consumption. The drill water is mainly consumed for preparation of mud. Minor quantities are used for washing and cleaning the rig. Average daily water requirement for offshore drilling operations will be 85 m^3/day. Of this 45 m^3/day will be saline water sourced from sea and 40 m^3/day will be fresh water to be sourced from nearby port through supply vessels.

The drill water is mainly consumed for preparation of mud. Minor quantities are used for washing and cleaning the rig.

2.9.2 Onshore Drilling Activity

Water will be sourced from the CGWB approved ground water sources from existing Ravva onshore terminal. The approximate water requirement per day for drilling operations is given in ***Table 2.8.***

Table 2.8 Water Requirement for Drilling of an Onshore Well

S. N.	Water Requirement	Quantity
1	Total water requirement per well including mud preparation over a period of ~50 days	2,500 m^3 (50 m^3/day x 50 days)
2.	Domestic water requirement per well	5 m^3/day
3.	Water for domestic use at campsite	5 m^3/day

Note: Water requirement for drilling of an onshore well will be sourced from existing treated water from Ravva Terminal

2.10 POWER AND FUEL CONSUMPTION

2.10.1 Offshore Drilling Activity

DG sets are incorporated in the design / infrastructure for self-sustained operations at sea. The power will be available onboard the rig for offshore drilling and lighting the quarters at the rig. Power supply shall be made available through 2 of the 3 main diesel generator sets 2,000 kVA (i.e. 1603 kW) typically installed on board the jack up rig. There will also be one diesel generator of 500 kVA capacity catering to the emergency auxiliary power supply. Fuel requirement for operation of a 2000 kVA diesel generator is estimated as 320 kg/hour.

2.10.2 Onshore Drilling Activity

The power requirement in the drilling site and the campsites will be provided through diesel generator (DG) sets. The power will be available for onshore rig operaions and lighting. Power supply shall be made available through 1 of the 2 main diesel generator sets 1010 kVA (i.e. 800 kW) typically installed on board the rig. There will also be one diesel generator of 350 kVA capacity catering to auxiliary power supply. The rated capacity of the DG sets required for onshore drilling site is provided in Table 2.9

Table 2.9 Details of Diesel Generators for Onshore Drilling Activity

Location	DG Capacity	Fuel Requirement
Drilling site	2 x 1010 kVA (one working and one standby)	160 kg/hour
	2 x 350 kVA (one working and one standby)	50 kg/hour
Camp site	2 x 350 kVA (one working and one standby)	50 kg/hour

The fuel (diesel) will be received in bulk quantity through tankers and shall be stored in above ground steel diesel tank (~30 m^3 capacity) provided with secondary containment of adequate capacity to control any accidental leaks.

There will be alternate power supply to the well pads either through state grid or through captive power from Ravva Terminal. To make the power arrangement work, an overhead power transmission line (OHL) will be laid along the earmarked road connecting the wellpads.

2.11 MANPOWER

There will be ~100 workers engaged for construction of well pad site for a period of ~50 days. For drilling activities there will be ~80 manpower (skilled and semi-skilled) which will be camped at the campsite. At any point of time at the onshore drilling location, there will be ~50 manpower available onboard rig at each well pad site which will comprise of engineers, skilled workers and support staff.While the technical personnel and skilled workers are expected to be migrant, the unskilled workers (especially required during site and approach road development activities) will most likely be local community members. While the engineers and skilled workers directly hired by Vedanta Ltd (Cairn Oil & Gas) will be accommodated at the existing living quarters, the contractors will provide accommodation to their workers by hiring rooms and residences on rent in the surrounding villages and some of necessary workers will be accommodated in campsite to be developed at one of the two onshore well pads that is not in use (i.e. WP-7 or WP-8). The camp site will be established with porta cabins for deployment of labour for well pads construction and for subsequent drilling activities at any of the well pad site.

For offshore drilling there will be ~100 manpower specially trained for offshore related drilling and related activities will be onboard the rig.

2.12 WASTEWATER, EMISSIONS & WASTES

2.12.1 Onshore Drilling of Wells related Wastewater Generation, Treatment & Disposal

In the onshore part of the PKGM-1 Block, there is a proposal to drill 33 wells (10 exploratory and 23 developmental wells) over a period of 10 years from two onshore well pads, developed previously in 2006-07. Drilling of a well is achieved in average 45 to 50 days.

Onshore Domestic Wastewater Generation

During proposed exploratory and development drilling of wells in the onshore, domestic wastewater of 4.5 m^3/day will be generated by engaging 80 number of manpower. All

domestic wastewater will be collected in a modular STP for primary treatment followed by its collection into a tanker for its final treatment in the existing Sewage Treatment Plant (STP) of 175 m^3/day capacity at the Ravva Living Quarters as shown in schematic of STP in ***Figure 2.11***. The treated domestic wastewater is used in watering the plantation in Ravva Terminal and Living Quarters, to ensure zero discharge of domestic wastewater.

Thus domestic wastewater generated from drilling activities will have **zero liquid discharge (ZLD)** in any water body.

Onshore Wash Wastewater Generation from Drilling of a Well

For onshore drilling of a well, wash wastewater of ~5 m^3/day (containing high-suspended solids, oil and grease and traces of heavy metals) will be generated during washing of drill cuttings on a shale shaker. All wash wastewater will be collected in a HDPE line pit will. From the pit, drill cuttings wash wastewater will be taken into a **skid mounted mobile effluent treatment plant** fitted with primary, and secondary treatment process comprising of the following:

a) **Neutralization of extreme pH values:** Neutralization of extreme pH values in effluent will be done at optimum dose of chemicals and acids;
b) **Chemical treatment for coagulation and flocculation of effluent**: Coagulation and flocculation will be done in chambered flash mixer and flocculator provided with agitator for chemical mixing at desired rate.
c) **Sedimentation, clarification and filtration of separated effluent:** Sedimentation of separated effluent, by the use of dual chambers for separation of oil & grease and smaller solid particles from the separated effluent
d) **Clarification in tube clarifier chamber:** Clarification chamber is provided for removal of suspended particles in clarifier with conical bottom for periodic removal of the solid particles.

A typical skid mounted mobile effluent treatment plant is shown in ***Figure 2.19.***

Figure 2.19 A Typical skid mounted Mobile Effluent Treatment Plant

Source: Vedanta Ltd (Cairn Oil & Gas)

The quality of effluent from the skid mounted ETP is expected to be as given in the following ***Table 2.10***.

Table 2.10 Expected Quality of Effluent from Skid Mounted Mobile ETP

SN	Parameter	Expected Quality
1	pH	5.0 to 9.0
2	Oil and Grease, mg/L	<10.0
3	COD, mg/L	<250
4	Total Suspended Solids, mg/L	<100

Treated effluent from the skid mounted mobile ETP will be taken through a tanker to the existing ETP at Ravva Terminal for further treatment and conformance to the applicable regulatory norms before its final treatment and disposal through existing marine outfall (as per description given in ***Section 2.4.1 (11)*** above). There will be **zero onshore disposal** of effluent in any onshore water body from drilling of any onshore well.

2.12.2 Offshore Drilling of Wells Related Wastewater Generation, Treatment & Disposal

From offshore, there is a proposal to drill 90 wells (73 exploratory and 17 developmental wells) from existing platforms and from standalone locations within the PKGM-1 Block. Drilling of a well in offshore is achieved in average 45 to 50 days from the date of rig mobilization.

Domestic Wastewater from Offshore Rig

Domestic wastewater from kitchen, shower, toilets and laundry area on board drilling rig will be ~30 m^3/day. All domestic wastewater will be treated in IMO approved sewage treatment plant (STP) to be installed on board the rig. The STP will be IMO certified complying with the MARPOL Standards.

Domestic wastewater will be treated in on board STP for physico–chemical and biological treatment through extended aeration system. The treated and disinfected sewage on board STP is disposed offshore beyond 3 nautical miles (nm) from shore complying with the Indian discharge requirements and MARPOL requirements.

Also there is generation of bilge water consisting of rainwater/seawater containing diesel and oil will be ~10 m^3/well. Bilge water will be collected into a sludge tank and then to a water/oil separator on board drilling rig before offshore disposal with less than 15 mg/l of oil and grease content. The typical quality of treated sewage from a certified sewage treatment plant and treated bilge water from an oil in water separator from an offshore rig is given in ***Table 2.11***.

Table 2.11 Typical Quality of Treated Sewage & Bilge Water from an Offshore Rig

SN	Parameter	Treated Sewage Quality	Treated Bilge Water Quality	General Standards of Discharge for Marine Coastal Areas	MARPOL Standards #
1	pH	6.0 to 8.5	6.0 - 8.5	5.5 to 9.0	6.0 to 8.5
2	Total Suspended Solids, mg/L	<35	<35	100	35 above ambient seawater quality
3	Oil & Grease	<15	<15	20	<15
4	COD, mg/L	<125	<125	250	125
	BOD (5 days), mg/L	<25	<25	100	25

Note: # India is a signatory to International Convention on the Prevention of Pollution from Ships (MARPOL) and all its annexes, hence related requirements are to be complied with.

The on-board STP will typically consist of solids / oil separation and chemical oxidation to remove the organic load.

Wash Wastewater from Offshore Drilling of a Well

Wash wastewater is generated during drill cutting washing on shale shaker. Most of the wash wastewater is reused in mud preparation. A maximum of 200 m^3/well wash wastewater generated will be treated on board to ensure oil in water content of less than 15 mg/l before its disposal offshore.

2.12.3 Air Emission

Onshore Drilling Activity

Exhaust emissions are expected from diesel generators to be used for the operation of drilling rig. Emissions are also expected from flaring of gases during drill well testing operations and temporary flaring of associated gas for the initial period of up to 2 years after the commercial viable discovery. Afterwards pipelines corridor will be developed and all well fuid will be transferred through pipelines to Ravva Terminal. Emissions details for emissions from onshore drilling are included in ***Section 4.4.4***. Vehicular emissions are likely to occur during the transportation of construction materials, equipment and workforce to onshore drilling location.

Offshore Drilling Activity

The source of air emissions anticipated from offshore drilling are those resulting from combustion of fuel in Diesel Generator sets on the offshore rigs, exhaust emissions from supply vessels and due to helicopter movements. Vedanta Ltd (Oil and Gas) proposes to use low sulphur HSD as fuel to the DG sets. The DG sets will be equipped with stack suitable for a marine vessel operation and designed to international norms and in compliance to common industry practice. The engines will also be subjected to periodic maintenance to ensure efficient combustion and minimize emission of particulate matter and exhaust gases. Other emission would be from temporary test flaring for 2 to 3 days for the exploratory/appraisal wells, in the event of discovery of hydrocarbons from the new prospect structure. The emissions characteristics during power generation on offshore rig and test flaring can be referred from ***Table 4.13.***

There will also be emissions due to combustion of marine gas oil in engines of 5 to 6 support vessels engaged for providing support services for rig operations as well as for maintaining safety in the exclusive zones of 500 m from the drilling locations.

Ravva Onshore Terminal

Emissions will continue to occur from operations of Ravva Terminal as per approved crude oil production of 50,000 BoPD and natural gas of 2.32 MMSCMD. The **p**oint and flare air emissions from Ravva onshore terminal are described in ***Table 2.12.***

Table 2.12 Air Emissions Sources (Point & Flare) from Ravva Terminal

S. N.	Emission Source Description	Emission Source	Stack ID/ Rating	Stack Coordinates, m		Fuel Type	Fuel Input kg/hr	Dia-meter (m)	Outlet Temp (°K)	Release Height [2] m	Velo-city m/sec	Exit Gas Flow [3] Nm^3/hr	Emissions [4] in gram per sec (mg/Nm3)				
				Easting	Northing								PM10	NOx	CO	SO_2	HC
1a	Crude Oil Export Engine –I	Existing	S-1 (781 KW)	616536.4	1823171.7	NG	240.56 kg/hr (310Nm^3/hr)	0.3	523	6.0	16.90	2,450	0.0034 (5)	0.2382 (350)	0.1021 (150)	0.0022 (3.2)	0.034 (50)
1b	Crude Oil Export Engine– II (Standby)	Existing - Standby	S-2 (781 KW)	616527.9	1823171.7	NG	240.56 kg/hr (310Nm^3/hr)	0.3	523	6.0	16.90	2,450	0.0034 (5)	0.2382 (350)	0.1021 (150)	0.0022 (3.2)	0.034 (50)
2a	Gas Turbine G850C	Existing	GT-1/ 2.5MW	616479.6	1822979.9	NG	543.3 kg/hr (700Nm^3/hr)	1.0	623	11.0	18.6	25,180	0.035 (5.0)	2.45 (350)	1.049 (150)	0.0224 (3.2)	0.35 (50)
2b	Gas Turbine G850D	Existing	GT-2/ 2.5MW	616478.9	1822971.9	NG	543.3 kg/hr (700Nm^3/hr)	1.0	623	11.0	18.6	25,180	0.035 (5.0)	2.45 (350)	1.049 (150)	0.0224 (3.2)	0.35 (50)
2c	Gas Turbine G850A	Existing	GT-3/ 2.5MW	616479.0	1822950.1	NG	543.3 kg/hr 700Nm3/hr	1.0	623	9.0	18.6	25,180	0.035 (5.0)	2.45 (350)	1.049 (150)	0.0224 (3.2)	0.35 (50)
2d	Gas Turbine G850B	Existing	GT-4/ 2.5MW	616479.5	1822946.2	NG	543.3 kg/hr (700Nm^3/hr)	1.0	623	9.0	18.6	25,180	0.035 (5.0)	2.45 (350)	1.049 (150)	0.0224 (3.2)	0.35 (50)
3a	Emergency Diesel Generator	Existing - Standby	EMDG/ 1010 KVA	616490.4	1822962.3	Diesel	152 kg/hr	0.27	573	5.0	20.0	2,140	0.0333	1.022	0.39	0.0422	0.144
3b	Emergency Diesel Generator	Existing - Standby	EMDG/ 1010 KVA	616490.4	1822962.3	Diesel	152 kg/hr	0.27	573	5.0	20.0	2,140	0.0333	1.022	0.39	0.0422	0.144
4a	TSGR Stack A near Gas Plant	Existing	TSGR (448 KW)	616428.7	1822774.3	NG	83.8 kg/hr (108Nm^3/hr)	0.20	523	4.5	13.3	855	0.0012 (5)	0.083 (350)	0.0355 (150)	0.0007 (3.2)	0.012 (50)
4b	TSGR Stack – B near Gas Plant	Existing	TSGR (448 KW)	616428.7	1822774.3	NG	83.8kg/hr 108Nm^3/hr	0.20	523	4.5	13.3	855	0.0012 (5)	0.083 (350)	0.0355 (150)	0.0007 (3.2)	0.012 (50)
5	Hot Oil Heater	Existing	HOH/30 MMBTU/ Hr	616381.6	1822761.4	NG	164 kg/hr (211.3Nm^3/hr)	1.38	498	35.0	0.5	1670	0.0023 (5)	0.139 (300)	0.0232 (50)	0.0232 (50)	0.0232 (50)
6a	Glycol Reboiler (MEG circul[n] of 4.16 GPM)#	Existing	GR-1/ 0.5 MMBTU/ Hr	616367.9	1822679.4	NG	91 kg/hr (117Nm^3/hr)	0.45	498	4	2.7	930	0.0012 9 (5)	0.0773 (300)	0.0129 (50)	0.0012 9 (5)	0.3089 (1200) #
6b	GlycolReboiler (MEG circul[n] of 4.16 GPM)#	Existing	GR-2/ 0.5MMBTU/Hr	616367.5	1822671.3	NG	87 kg/hr (112.1Nm^3/ hr)	0.2	498	6	13.0	890	0.0012 3 (5)	0.0738 (300)	0.0123 (50)	0.0012 3 (5)	0.2954 (1200) #
7a	RSGDP Compressor A	Existing	RSGDP (1088 KW)	616301.6	1822738.9	NG	240.56 kg/hr (310Nm^3/hr)	0.15	523	9.7	16.9	610	0.0008 (5)	0.051 (300)	0.0085 (50)	0.0008 (5)	0.0085 (50)
7b	RSGDP Compressor B	Existing	RSGDP (1088 KW)	616301.6	1822738.9	NG	240.56 kg/hr (310Nm^3/hr)	0.15	523	9.7	16.9	610	0.0008 (5)	0.051 (300)	0.0085 (50)	0.0008 (5)	0.0085 (50)
7c	RSGDP Booster Compressor A	Existing	1088KW	616320	1822740	NG	240.56 kg/hr (310Nm^3/hr)	0.15	523	9.7	16.9	610	0.0008 (5)	0.051 (300)	0.0085 (50)	0.0008 (5)	0.0085 (50)
7d	RSGDP Booster Compressor B	Existing	1088KW	616320	1822745	NG	240.56 kg/hr (310Nm^3/hr)	0.15	523	9.7	16.9	610	0.0008 (5)	0.051 (300)	0.0085 (50)	0.0008 (5)	0.0085 (50)
8a	HP Flare I	Existing	HP-1 (2.55 MMSCMD	616151.3	1822782.2	NG	682 kg/hr (880Nm^3/hr)	0.4	1273	30	20	10,720	0.0893 (30)	0.1935 (145)	1.042 (350)	0 (0)	0.3872 (130)

S. N.	Emission Source Description	Emission Source	Stack ID/ Rating	Stack Coordinates, m		Fuel Type	Fuel Input kg/hr	Dia-meter (m)	Outlet Temp (°K)	Release Height [2] m	Velo-city m/sec	Exit Gas Flow [3] Nm^3/hr	Emissions [4] in gram per sec (mg/Nm3)				
				Easting	Northing								PM10	NOx	CO	SO_2	HC
8b	HP Flare II	Existing	HP-2	616048.6	1822736.7	NG	682 kg/hr (880Nm^3/hr)	0.4	1273	30	20	10,720	0.0893 (30)	0.1935 (145)	1.042 (350)	0 (0)	0.3872 (130)
9	LP Flare	Existing	LP-1 (0.03 MMSCMD	616151.5	1822777.2	NG	273.15 kg/hr 352Nm^3/hr	0.4	1273	30	20	4,290	0.0357 (30)	0.0707 (145)	0.417 (350)	0 (0)	0.1549 (130)
10a	Gas Lift Booster -A Compressors (Gas Engine Driven)	Existing	GLBC-1	616454	1822698	NG	186.24 kg/hr (240Nm^3/hr)	0.3	523	12	13.1	1900	0.0026 (5)	0.1845 (350)	0.0791 (150)	0.0017 (3.2)	0.026 (5)
10b	Gas Lift Booster -B Compressors [Gas Engine (GE) Driven]	Existing	GLBC-2	616455	1822681	NG	186.24 kg/hr (240Nm^3/hr)	0.3	523	12	13.1	1900	0.0026 (5)	0.1845 (350)	0.0791 (150)	0.0017 (3.2)	0.026 (5)
11a	AGC-1 Associate Gas Compressor (Gas Eng. Driven)	Existing	AGC-1	616478	1822724	NG	320 kg/hr (412Nm^3/hr)	0.3	523	5.5	22.5	3260	0.0045 (5)	0.3167 (350)	0.1357 (150)	0.003 (3.2)	0.045 (5)
11b	AGC -2 (Gas Engine Driven)	Existing	AGC-2	616478	1822732	NG	320 kg/hr (412Nm^3/hr)	0.3	523	5.5	22.5	3260	0.0045 (5)	0.3167 (350)	0.1357 (150)	0.003 (3.2)	0.045 (5)
11c	AGC-3 Gas Engine Driven)	Existing	AGC-3	616477	1822741	NG	320 kg/hr (412Nm^3/hr)	0.3	523	5.5	22.5	3260	0.0045 (5)	0.3167 (350)	0.1357 (150)	0.003 (3.2)	0.045 (5)
11d	AGC-4 (Gas Engine Driven)	Existing	AGC-4	616456	1822775	NG	83.8 kg/hr (108Nm^3/hr)	0.2	498	9.7	13	890	0.0012 3 (5)	0.0738 (300)	0.0123(50)	0.0012 3 (5)	0.2954 (1200)
12a	Fire Water Pump Diesel Engine Pump Room PR-1	Existing - Standby	FWP-1-1-2-3	616553	1823127	Diesel	76 kg/ hour	0.3	723	4.5	19.2	2080	0.0235 (40)	0.775 (1340)	0.0439(76)	0.0422 (73)	0.041 (71)
12b	Fire Water Pump Diesel Engine PR-1	Existing - Standby	FWP-1-1-2-3	616553	1823127	Diesel	76 kg/ hour	0.3	723	4.5	19.2	2080	0.0235 (40)	0.775 (1340)	0.0439(76)	0.0422 (73)	0.041 (71)
12c	Fire Water Pump Diesel Engine PR-1	Existing - Standby	FWP-1-1-2-3	616553	1823127	Diesel	76 kg/ hour	0.3	723	4.5	19.2	2080	0.0235 (40)	0.775 (1340)	0.0439(76)	0.0422 (73)	0.041 (71)
12d	Fire Water Pump Diesel Engine PR-2	Existing - Standby	FWP-2-1-2-3	616522	1823031	Diesel	76 kg/ hour	0.3	723	5	19.2	2080	0.0235 (40)	0.775 (1340)	0.0439(76)	0.0422 (73)	0.041 (71)
12e	Fire Water Pump Diesel Engine PR-2	Existing - Standby	FWP-2-1-2-3	616522	1823031	Diesel	76 kg/ hour	0.3	723	5	19.2	2080	0.0235 (40)	0.775 (1340)	0.0439(76)	0.0422 (73)	0.041 (71)
12f	Fire Water Pump Diesel Engine PR-2	Existing - Standby	FWP-2-1-2-3	616522	1823031	Diesel	76 kg/ hour	0.3	723	5	19.2	2080	0.0235 (40)	0.775 (1340)	0.0439(76)	0.0422 (73)	0.041 (71)
12g	Fire Water Pump Diesel Engine PR-3	Existing - Standby	FWP-3-1-2-3	616522	1823031	Diesel	62.4 kg/ hour	0.3	723	5.5	15.8	1710	0.0213 (45)	0.702 (1480)	0.0398(84)	0.0347 (73)	0.037 (78)
12h	Fire Water Pump Diesel Engine PR-3	Existing - Standby	FWP-3-1-2-3	616381	1823250	Diesel	62.4 kg/ hour	0.2	723	5.5	15.8	1710	0.0213 (45)	0.702 (1480)	0.0398(84)	0.0347 (73)	0.037 (78)
12i	Fire Water Pump Diesel Engine PR-3	Existing - Standby	FWP-3-1-2-3	616381	1823250	Diesel	62.4 kg/ hour	0.2	723	5.5	15.8	1710	0.0213 (45)	0.702 (1480)	0.0398 (84)	0.0347 (73)	0.037 (78)

Note: The equipment marked as "Existing" (as their effect has already been captured in the monitored baseline); and b) equipment marked as "standby" (in serial nos. 1b, 3a, 3b, 12a to 12i and 13 b) are equipment to be run in emergency situation only.

GHG Emissions

For the year 2017, GHG emissios from Ravva Field related operations are reported by Vedanta Ltd (Cairn Oil & Gas) as 11,694.667 tonnes.

2.12.4 Noise Generation

Construction Activity

Noise will occur from operation of construction equipment like loaders, tippers, bull dozers etc., for onshore well pads. The expected noise generated will be around 60-65 dB (A). During erection offshore rigs noise will be generated in the range of 80 to 85 dB(A).

Drilling Operation

The operations of drilling rig and associated machinery including diesel generators will lead to noise emissions. The diesel generators would be provided with acoustic enclosures to comply with the regulatory requirements. oise emissions during drilling of wells at the rig include the following:

- Diesel Generators: 75 to 85 dB(A) at 1 m from enclosure
- Mud Pumps at the Rig: 90 to 95 dB (A)
- Miscellaneous: 80 to 85 dB (A)
- Control Room and living quarters at the rig: 50 to 60 dB (A)

2.12.5 Solid & Hazardous Waste

The waste generated from drilling activities are drill cuttings, residual drilling mud and used oil and lubricant. Other waste generated from the well pad sites are municipal waste. Overall, the expected solid and liquid waste generation from onshore well drilling along with options for treatment, storage and disposal are described in ***Table 2.13.***

Table 2.13 Waste Generation from Onshore Well Drilling

S.N.	Nature of Waste	Quantity	Treatment/ Temporary Storage	Disposal
1	Drill cuttings containing oil	250 m^3 / well	Temporary storage in HDPE lined impervious pits within well pad sites	APPCB approved common hazardous waste treatment, storage and disposal facility (CHWTSDF)
2	Residual drilling mud	200 m^3 /well		
3	Used lubricating/waste oil	10 m^3/ well	Dedicated paved area for storage	
4	Food waste	25 kg /day	Temporary storage before daily transfer to the Ravva Terminal	Will be composted in-house or sent to piggeries
5	Non-combustible waste (i.e. metallic residues, glass)	20 kg/ day	Temporary storage in dedicated bins	Recycling vendors
6	Packaging wastes	1000 kg/ well		
7	Left over chemicals and materials	250 kg/ well	Temporary storage in bins in secured stores	Disposal through supplier vendor
8	Cement, grit, & painting waste	500 kg/ well	Temporary storage in bins	APPCB approved CHWTSDF
9	Wash wastewater	5m^3/ day/ well	Primary treatment in modular ETP at well pad before transfer through tankers to Ravva Terminal ETP	ETP at Ravva Terminal for final treatment and disposal through existing marine outfall.
10	Sewage	4.5m^3/day/ well	Primary treatment in modular STP at campsite and well pads before transfer through tankers to Ravva Terminal STP	STP at Ravva Terminal for use of treated sewage in land application
11	Biomedical wastes	Minor quantity	Collected in specific bins	APPCB approved vendors

Disposal of wastes will be as per prior approval of APPCB. Waste drill cutting washing fluid will be collected in a gravity tank of 10 m^3 capacity provided with agitation system. The Tank is provided with oil recovery system by pumping out oil. The wash water will be recirculated within the mud.

The separated drill cuttings will be disposed in the APPCB approved CHWTSDF site or to the cement industry for co-processing.

Vedanta Limited (Cairn Oil & Gas) has taken up membership of Coastal Waste Management Project, Vizag, AP for disposal of hazardous wastes generated from its existing operations and the same will be used for disposal of hazardous wastes generated from the proposed drilling of onshore wells.

Disposal Offshore Drilling waste

During the operation of the offshore drilling rig, liquid waste streams / products are generated. These wastes are stored, handled and disposed in compliance to the applicable Indian regulation (Indian discharge requirement) and also as per the requirements of MARPOL convention . The major liquid, solid waste discharges anticipated due to drilling operations include spent drilling mud and drill cuttings. All the major waste streams from drilling operations grouped under different categories.

Domestic wastewater from kitchen, shower, toilets and laundry area on board drilling rig will be approximately 30 m^3/day. Domestic wastewater will be treated in on board Sewage treatment plant (STP) for physico–chemical and biological treatment through extended aeration system before offshore discharge of treated sewage complying with Indian discharge requirements and MARPOL convention. Bilge water consisting of rainwater/seawater containing diesel and oil will be 10m^3/well. Bilge water will be collected into a sludge tank and then to a water/oil separator on board drilling rig before offshore disposal with less than 15 mg/l of oil and grease content.

For the proposed development production, exploratory/appraisal drilling a maximum of 85 m^3/day of water will be used in the drilling rig, out of which 45 m^3/day is fresh water and 40 m^3/day of seawater for both drilling and domestic use. Fresh water will be supplied by sea and stored onboard the rig. The balance water requirement will be met through seawater, which will be lifted from the rig location. Part of the fresh water is also made on board rig using water makers on the rig.

The quantity of water required for preparation of WBM is around 478 m^3 per day, while SBM is 159 m^3 per day. Water will be taken through supply vessels for drilling operation. Being in the deltaic region, water availability is considered adequate in the region. For offshore drilling, fresh water will be sourced from commercial suppliers near the Port of entry. Seawater will be lifted from the sea near the rig location. Water requirement of the onshore wells will be met through bore wells located within the onshore Ravva Terminal.

Overall, the expected solid and liquid waste generation from offshore well drilling along with options for treatment, storage and disposal are described in ***Table 2.14.***

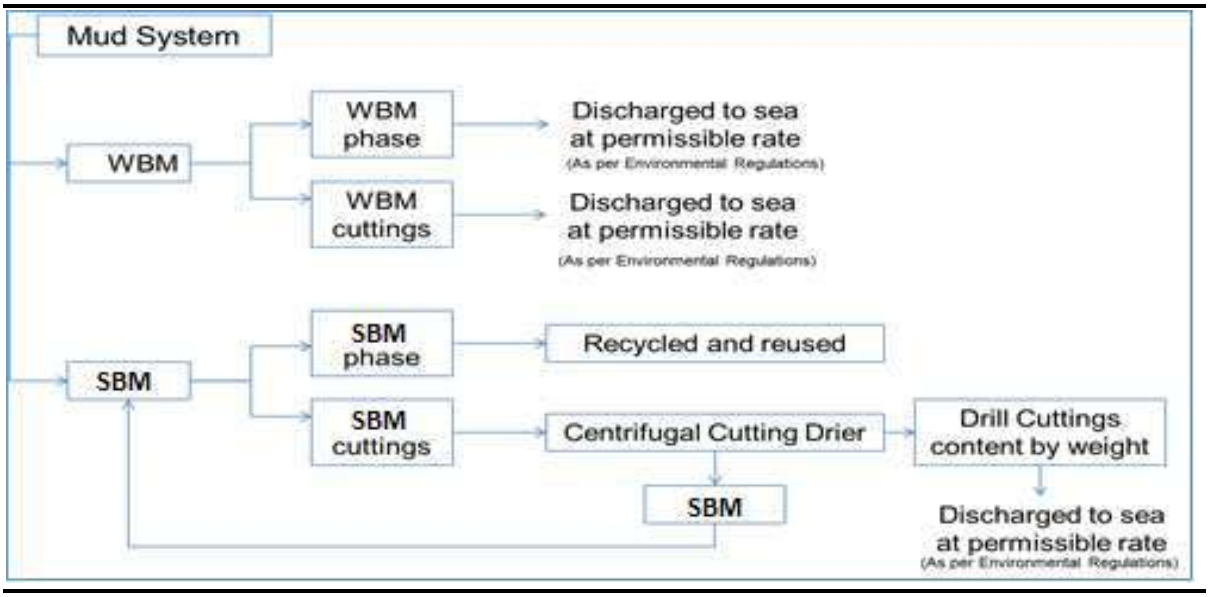
Table 2.14 Waste Generation from Offshore Well Drilling

S.N.	Nature of Waste	Quantity	Treatment/ Temporary Storage	Disposal
1	Drill cuttings	220 m^3 / well	Treated in shale shakers and centrifuges to separate mud from cuttings.	Drill cuttings and WBM will be intermittently disposed offshore at a rate of 50 bbl/hour/well. Oil content if <10 g/kg in drill cutting will be met before offshore disposal. SBM will be collected for re-use in next drilling operation
2	Residual drilling mud	150 m^3 / well		
3	Domestic wastewater (kitchen shower, toilet & laundry)	30 m^3/day	Treated in an on-board STP	To be discharged offshore as per APPCB and MARPOL requirements beyond 3 nm from shore.
4	Bilge water	10 m^3 / well	Treated on board for oil and grease content of < 15 ppm.	To be discharged offshore as per APPCB and MARPOL requirements beyond 3 nm from shore.
5	Wash water and deck drainage	200 m^3 / well		
6	Cooling water	200 m^3/hour	Seawater cooling water is passed through oil- water separator.	Seawater with < 15 ppm oil content for offshore disposal.
7	Packaging materials, paper, plastic, tin, glass etc	~500 kg/well	Segregate and store in on-board storage facility	Disposal at nearby port.
8	Food waste	20-25 kg/ day	Food waste will be macerated to less than 25 mm particle size and	Discharged offshore beyond 3 NM from shore
9	Oily rags	100 kg / well	Temporary storage on board rig	Disposal to onshore APPCB approved CHWTSDF
10	Waste & used oil	5 m^3 / well	Temporary storage on board rig	Disposal to onshore APPCB approved CHWTSDF
11	Biomedical wastes	Minor quantity	Collected in specific bins	Disposal through APPCB approved vendor.

Waste Disposal for Offshore Drilling Activity

Drill cuttings will be discharged off-shore into sea intermittently in accordance with MoEFCC guideline.

Figure 2.20 Waste Disposal Plan – Offshore –weight



Source: Vedanta Ltd (Cairn Oil & Gas)

Vedanta Limited (Cairn Oil & Gas) has taken up membership of Coastal Waste Management Project, Vizag, AP for disposal of hazardous wastes generated from its existing operations and the same will be used for disposal of hazardous wastes generated from the proposed drilling of offshore wells

2.13 CHANGES IN PRODUCTION PROFILE AND ADEQUACY ASSESSMENT OF EXISTING INFRASTRUCTURE AT RAVVA TERMINAL

Implementation of the proposed project will result in incremental changes in current production profiles, however the production capacities will remain within the already approved capacities of 50,000 BOPD of crude oil and 2.32 MMSCMD of gas. No additional requirement power, potable water and fuel requirement and volume of wastes will be generated than the approved capacities of the Ravva Field. ***Table 2.15*** provides an indication on the changes anticipated and adequacy assessment of existing infrastructure. The additional facilities to be developed at Ravva Terminal will include the following:

a) Unloading Bay (including weigh bridge) for hydrocarbon collected from well pads through trucks for initial two years.
b) Pipeline corridor of ~8 km length from well pads to Ravva Terminal upon commercial viability of the production from well pads.

Table 2.15 Adequacy Analysis of Ravva Field vis-à-vis Proposed Ravva Dev. Program

S.N.	Parameter	Units	Installed Capacity	Approved Capacity	Present Avg. Production	Expected Capacity post Proposed Development	Remarks
1	Plant fluid handling capacity	Barrels of Fluid per day	90,000	90,000	70,000	90,000	Total fluid handling capacity of the plant is the primary determining factor for crude, gas and produced water production. The total fluid handling capacity is adequate to cater for changes in production profile due to the proposed development. Due to aging of the field it is anticipated that the existing production levels will drop and incremental increase will suffice the production to present levels.
2	Crude production	Barrels of Oil per day	As per fluid characteristics	50,000	15,000	35,000 up to the approved capacity	
3	Associated and non-associated gas production	MMSCFD	As per fluid characteristics	81.96 (2.32 MMSCMD)	51.0	65.5	
4	Produced water generation	Barrels of water per day	As per fluid characteristics		55,000	55,000 #	
5	Power generation	MW	10	10	5	Up to 10	No change anticipated. Will be within the available 10 MW power generation capacity
6	Fuel consumption (natural gas)	MMSCFD	4.0	Not described	4.0	4.0	No change anticipated

S.N.	Parameter	Units	Installed Capacity	Approved Capacity	Present Avg. Production	Expected Capacity post Proposed Development	Remarks
7	Water consumption (bore wells)	m^3/day	6 bore wells	10,413	9,500	18,285	Additional requirement of ~7872 m^3/day ground water extraction is anticipated. Permission for extraction of additional 7872 m^3/day ground water will be obtained from Ground Water Authority.
8	Borewell Water for Injection	m^3/day	Not described	Not described	9,170 0	17,042	Additional requirement of 7872 m3/day is anticipated.
9	Domestic consumption	m3/day	140.0	Not described	140.0	140.0	No change anticipated
10	Produced water re-injection	Barrels of water per day	90,000	90,000	36,000	50,000 #	No change in approved capacity anticipated
11	Effluent generation & treatment	m^3/day	3,000	3,000	1,563	3,000	No change in approved capacity anticipated

Note: MMSCFD = million standard cubic feet per day; 1 standard cubic feet = 0.028317 standard cubic meter; MMSCMD = million standard cubic meter per day # or as per the fluid characteristics

3 DESCRIPTION OF THE ENVIRONMENT

3.1 INTRODUCTION

This section describes environmental baseline conditions prevailing in the study area pertaining to PKGM-1 Block located on the East Coast of India in the Bay of Bengal with to potential impacts likely to arise from the Project activities. Following are the sources of the information collected:

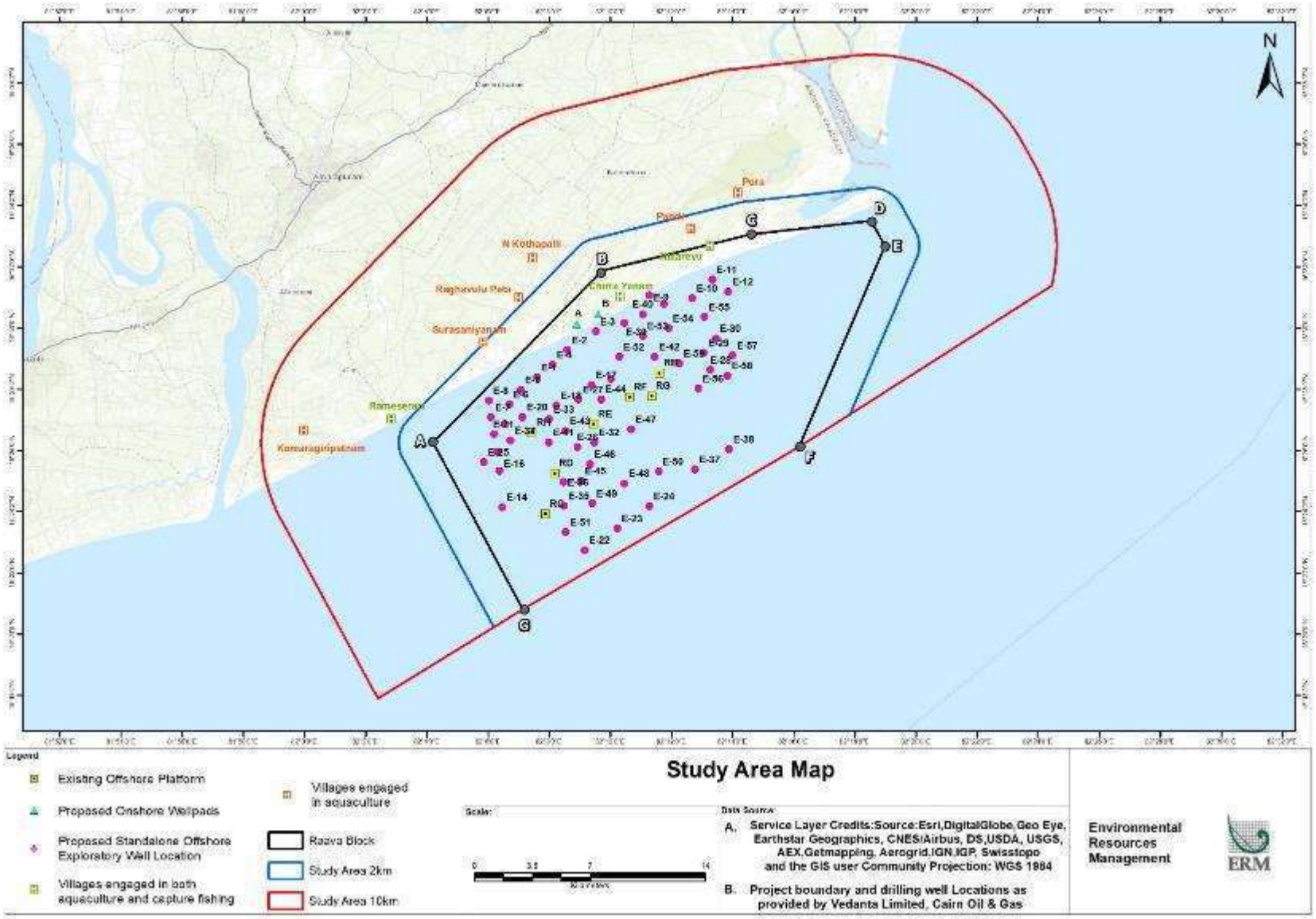
- Reconnaissance and field surveys and investigations including ecological and socio-economic surveys during January to March of 2018;
- Primary environmental monitoring in the onshore area surrounding the PKGM-1 Block mostly during the winter season (Jan – Feb 2018) and then subsequently for a month during the pre-monsoon season (March 2018) by Vimta Labs, Hyderabad as part of the present EIA Study (as included in ***Annex 15 to Annex 18 of EIA Volume 2)***;
- Marine monitoring around the offshore installations of Ravva Field in Bay of Bengal during April 2018 by by Vimta Labs, Hyderabad as part of the present EIA Study;
- Environmental monitoring around the offshore installations of Ravva Field in Bay of Bengal (Phase III) during November 2017 for Vedanta Ltd (Cairn Oil & Gas) by Marine Biological Laboratory, Department of Zoology, Andhra University, Waltair, Visakhapatnam (as included in ***Annex 1 – Volume 2 of EIA)***.
- The literature review on available secondary information and studies conducted previously for the oil and gas developmental activities in the Block by Vedanta Ltd (Cairn Oil & Gas);
- Consultations with local regulatory agencies; and
- Study team's own experience.

3.2 STUDY AREA

The PKGM-1 block is located along the East Coast of India in the East Godavari District of Andhra Pradesh. The block lies in the area between Latitudes: 16° 20′ 44.8″ N to 16° 33′ 26.6″ N and Longitudes: 82° 04′ 17.3″ E to 82° 19′ 04.3″ E. The East Godavari District is a coastal district, bounded on the North by Visakhapatnam District and the State of Orissa, on the East and the South by the Bay of Bengal and on the West by Khammam and West Godavari Districts.

A 10 km radial zone around the apex points of the block (G-A-B-C-D-E-F) has been considered as the study area of the EIA study to ascertain presence of sensitivities/ sensitive receptors in this region. For the marine region south of the apex points F-G, the study area boundary has been limited to the block boundary. The study area for this EIA study is represented in ***Figure 3.1***. It is to be noted that for the socioeconomic studies a radial zone of 2 Km around the block boundary has been considered which is also represented in ***Figure 3.1***.

Figure 3.1 Study Area Map



3.3 GEOGRAPHY & GEOMORPHOLOGY

The coastal area along PKGM-1 Block is dominated by the large delta of Godavari River with prominent geomorphic features comprising of flood plain terraces, river mouth bars, lagoons, ancient beach ridges, old tidal flats, mud flats, mangrove swamps and spits. The onshore topography is relatively low lying.

The East Godavari District predominantly consists of recent and tertiary alluvium, red soils, black soils, Achaean gneiss, sandstone and laterites. Two types of alluvium occur in this region - coastal and riverine.

The coastal alluvium occurs mainly in the coastal region varying in width between 10 and 20 km. Riverine alluvium occurs in the lower courses of the valleys, and in the deltaic regions, the composition and textures of the alluvium vary with the geological nature of the catchment area.

3.3.1 Godavari Delta

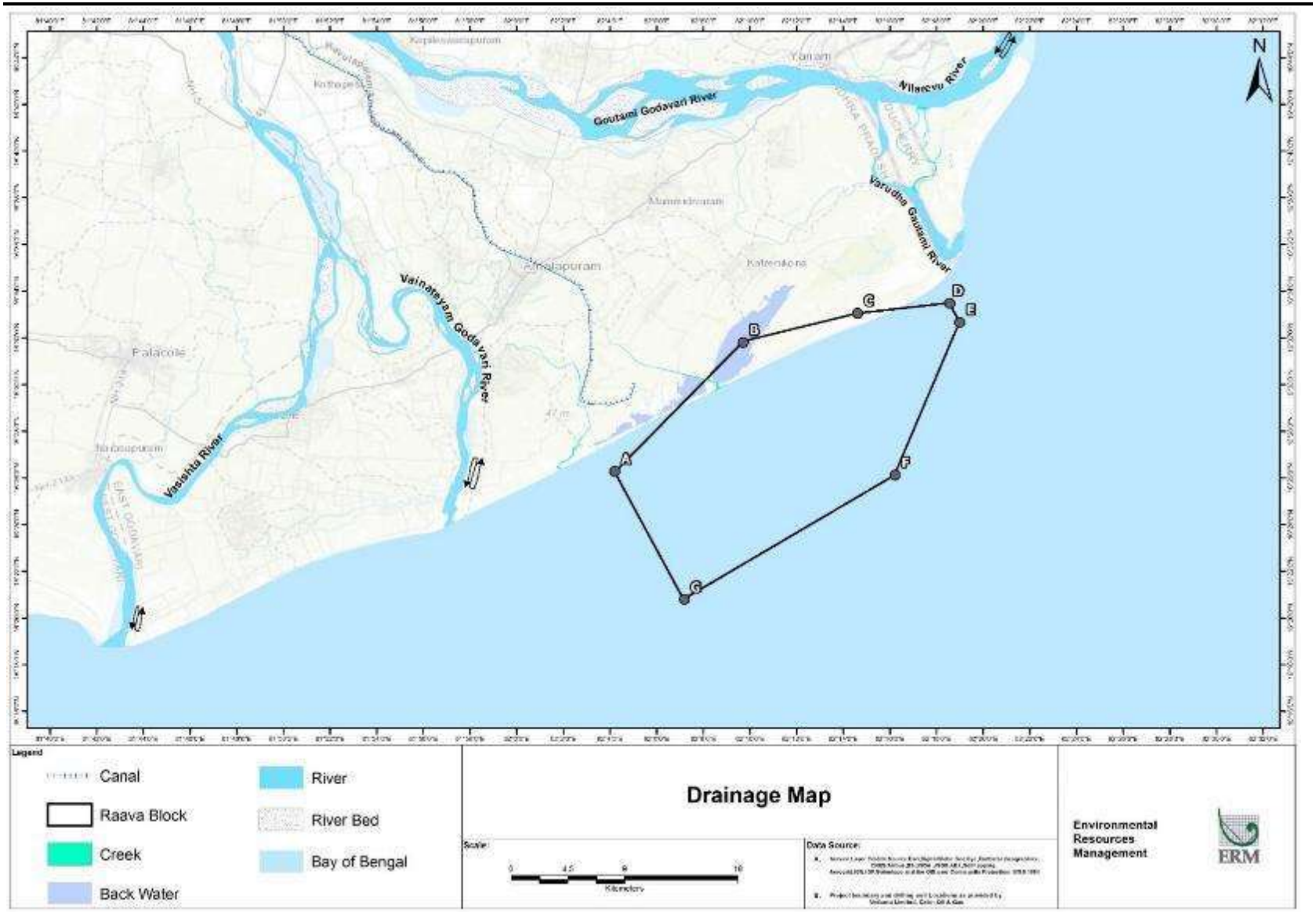
The PKGM-1 area lies offshore from the Godavari Delta. The Godavari River flowing approximately 1,480 km in an east-south-easterly direction forms delta. The apex point of the delta of Godavari River begins at Yanam and ends at Antarvedi in East Godavari District. The river branches at Dowleswaram into two distributaries i.e. eastern branch of Gautami Godavari and western branch of Vasishta Godavari. Between the two lies the Godavari Central Delta.

The Gautami Godavari branches into Nilarevu and Varudha Gautami Rivers. Estuary of Vrudha Gautami River is located at ~17.3 km the northeast of the existing RB Platform in the PKGM-1 Block. Nilarevu, a northern distributary of Gautami Godavari, is located at about 20 km northeast of the PKGM-1 Block. From the Gautami Godavari, there exist smaller branches, i.e. Coringa (also called Corangi) and Gaderu Rivers meandering with strong influence of tides. Coringa River extension of Gautami Godavari River flows through Yanam before it drains into the Bay of Bengal forming an estuary at more than 30km north of the nearest RB Platform in PKGM-1 Block.

Kakinada Bay occurs at 45 km north of the Ravva Terminal, and has a shallow (<5 m) sandbar-built water bay on the east-coast of India. The erosion of sand along Godavari Delta and its redistribution contributed to accretion of sandspits, which resulted in formation of Hope Island (a sandbar of approximately 21 km running north-south) and Sacraomento Shoal in the region.

The Vasishta Godavari branches near Gannavaram as Vasistha Godavari and Vainateyam Godavari. Vainateyam Godavari River is located at 19 km west from nearest RC Platform in PKGM-1 Block while Vasishta Godavari drains near Narsapur and Antarvedi at approximately 45 km to the west from the nearest RC Platform. The drainage pattern in the study area is presented in **Figure 3.2**.

Figure 3.2 Drainage Patter in the Study Area



The drainage pattern of Godavari River (eastern and western branches) is also governed by a network of canals. These includes:

- Samalkota Canal;
- Kakinada Canal;
- Tulyabhaga Drain;
- Mandapeta Canal;
- Coringa Canal;
- Injaram Canal;
- Teki Drain; and
- Godavari Eastern Bank Canal.
- Gannavaram Canal;
- Amalapuram Canal;
- Bank Canal; and
- Kunavaram Drain

The Ganavaram, Amalapuram and Bank Canals are major irrigation canals in providing irrigational support to the agricultural fields and aquaculture ponds in the central and southern delta regions.

3.4 GEOLOGY

Godavari deltaic area consists of four parallel beach ridges located far beyond the present coastline. Much of the coastal plain is composed of Holocene –Pleistocene (Quaternary) sediments. The Quaternary sediments occupying along the coastal tract and inland river valleys include thick blankets of alluvium, gravel and colluvial deposits, beach sand, kankar, soils of various types and laterite. The quaternary sediments are laid down in four major depositional environments, viz., fluvial, fluvio-marine, marine and aeolian. The fluvial deposits can be seen along Godavari River. These are in the form of floodplain (clays and silty clay), levee (silt) point and channel bar (sand), channel fill (sand and gravel) and palaeochannel (silt-sand-gravel) deposits.

The coastal tract is characterized by two narrow continuous palaeo-beach ridges, interrupted by prograding delta of Godavari. These palaeo beaches (sandy) are prominent in the area. Deposits of beach (sand), tidal flat (clay) lagoon (dark grey clay), mangrove swamps (clay with peat) and spits and bars (sand) are more prevalent in the delta. Godavari River started discharging large amounts of sediments into the Bay of Bengal thus initiating the delta building processes during the Quaternary. The upper deltaic sediments are essentially fluvial while those in the lower delta region are fluviomarine. In the Godavari Delta five strandlines indicating five stages in the progradation of the delta are reported. There is evidence of uplift even during the Quaternary and the process of physical and chemical weathering, and deposition continued to operate and modify present day physiography.

Three prominent lineament trends have been identified in Krishna-Godavari Deltas, viz., NE-SW, ENE-WSW and NW-SE. These lineaments are inferred to be pre-Quaternary comprising primordial weak zones that are subsequently reactivated by neotectonic movements. The NE-SW and ENE- WSW trends are rift related. A major NE-SW trending lineament from the west of Mogalturu to the south of Amalapuram is interpreted to have caused a major shift in the distributaries of the Godavari River.

3.5 HYDROGEOLOGY

Groundwater occurs under water table conditions and confined conditions. As per Vedanta Ltd (Cairn Oil & Gas) sponsored CSIR-NGRI (National Geophysical Research Institute, Hyderabad) study[1], there is no change in groundwater water levels from 2006 to 2016. Infact, groundwater levels are rising towards groundwater surface at few locations due to closing of existing wells. The observed average groundwater levels of the central Godavari delta shallow aquifer during phase I (2006-2008) to phase II (2014-2016) was ranging from 2.03 m bgl in June 2006 and it is 2.0 m bgl June 2016. The water levels in the post monsoon that is November 2006 is 0.8 m bgl and in the December 2016 it is 1.29 m bgl. Overall, this long term water level monitoring indicating that there is no water level depletion in the shallow wells in the area. However, very slight rise in water levels were also noticed.

Regional topography is varying from 2 to 7 m (amsl) and Ravva onshore terminal is located at an elevation of about 2 m (amsl). The depth to groundwater level in general is varying from 3 to 4 m and near canals and drains it was reported < 2 m. Groundwater flow direction in the area is tending towards Bay of Bengal from the Amalapuram in the all seasons from 2006 to 2016.

The average groundwater levels in the Ravva wells range from 9.34 m bgl in June 2006 and it is 16.91 m bgl in June 2016. The observed groundwater levels are indicating decline in groundwater levels in the Ravva wells. But there is no impact on shallow wells that may be due to impermeable barrier between shallow and deeper aquifer systems in the area.

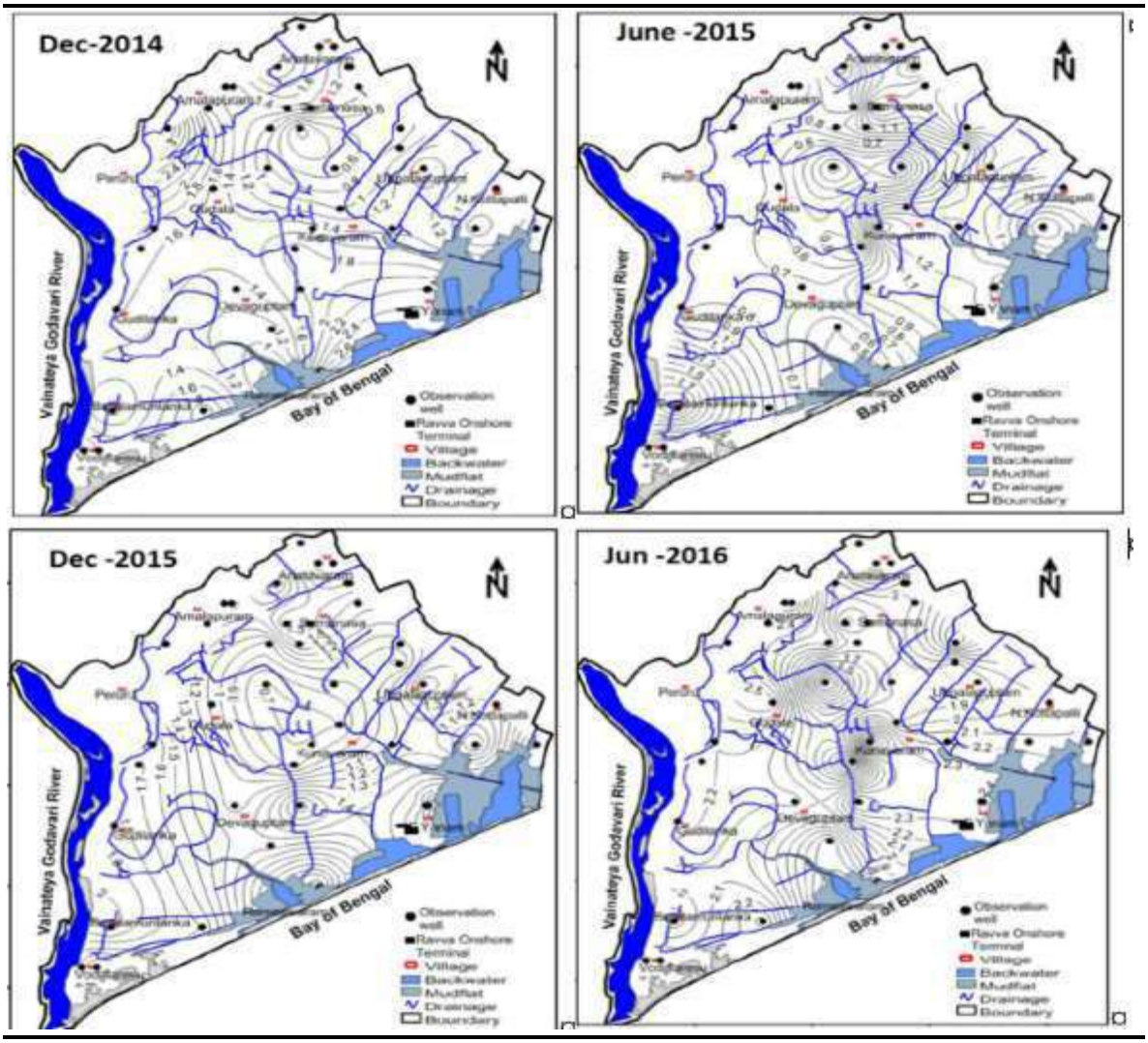
The Electrical Resistivity Tomography (ERT) studies carried out by NGRI at the Ravva terminal along the wells indicated high resistivity (> 4 Ohm.m) for coarse grained sands and low resistivity around the wells, which is possibily due to upconing from groundwater pumping. The resistivity cross section clearly shows that salinity is coming towards the land from bottom and it is not from lateral/sea direction. The ERT images in the coast indicated that there is no seawater intrusion in the area, it is also showed back water mixing with groundwater with low resistivity values.

There exists a network of canals which are providing perennial irrigation as well as drinking water needs in the surrounding area. The canals are contributing for groundwater recharge and improving quality of groundwater in the area. As per the NGRI report, Kunavaram Dain is acting as a natural hydrological barrier and is contributing significantly to the groundwater flow towards the Ravva onshore Terminal. Godavari irrigation canal network is well spread out in the area and provides perennial irrigation to the paddy crop. Irrigation drainage in the area flows to the Bay of Bengal through three important drains, viz., Vilastippa Drain, Kunavaram Drain and Pikaleru Drain. Kunavaram and Pikaleru Drains are passing close to the onshore Ravva Terminal. The areas surrounding the Ravva Terminal receive Godavari flood water almost every alternate year. The area is a flat alluvial terrain and ground elevations vary from 2 m to 6 m (amsl) with some depressions representing the tidal flats, which receive

[1] *Cairn sponsored study on "Assessment of Groundwater Quality around Ravva On-Shore Terminal, Central Godavari Delta, East Godavari District, A.P" by CSIR-National Geophysical Research Institute (CSIR-NGRI), Hyderabad (Phase I Study carried out during 2006 - 2008 and Phase II Study carried out 2014 – 2106).*

seawater during high tidal fluctuations. Refer to ***Figure 3.3*** for the ground water level countours in the study area in terms of metres below ground level (mbgl) as presented in the NGRI Study.

Figure 3.3 Ground Water Level Countours (m bgl) in Study Area



Source: National Geophysical Research Institute (CSIR-NGRI), Hyderabad

3.5.1 Land Subsidence

The issue of land subsidence in Krishna - Godavari (KG) Basin has been raised through a Writ Petition No. 13341/08 filed by Krishna Godavari Deltala Parirakshana Samithi, Bhimavaram, West Godavari District in Andhra Pradesh & Others Vs Union of India & Others. As per the directive of the Hon'ble High Court of Andhra Pradesh, MoEFCC constituted a sub-committee with defined Terms of Reference. The MoEFCC expert sub-committee report of 2009 on Land Subsidence in KG Basin indicated that there is no evidence of land-subsidence in the region.

Ravva Field is operative in the area in the offshore region for last 20 years and no distortion or land subsidence has been reported by Vedanta Ltd (Cairn Oil & Gas) on the infrastructures including platforms, pipelines, boat-landing points and landfall-point (located onshore close to the shoreline). Vedanta Ltd (Cairn Oil & Gas) has been injecting water back to maintain reservoir pressure for last so many years as per the best industry

practice. Also hydrocarbon reservoirs sub-surface areal extent is far away from shoreline and it is controlled by sub-surface faults running parallel to shoreline.

Vedanta Ltd (Cairn Oil & Gas) sponsored a study by Department of Mining Engineering,

IIT (BHU) Varanasi on 'subsidence due to extraction of oil and natural gas from PKGM-1 Block area'. IIT (BHU) studied land subsidence near the Block at regular interval between Oct 2014 to April 2016. Repetitive precision digital leveling and geodetic grade DGPS survey at 20 stations along shoreline and two offshore platforms was carried to understand the subsidence in coastal area near the Ravva oil field (PKGM-1 Block).

The observation of land subsidence (in order of centimeters) near seashore of Ravva oil field is higher than the offshore platforms located just above the oil reservoir. In case source of subsidence is oil and gas extraction, then subsidence on the platforms should be of highest value in magnitude and lesser at other places as one move away from the platform (as the platform is vertically above the oil wells). The progressive peak subsidence values are itself very low. Hence, the study concluded that subsidence near to sea shore will be insignificant due to extraction of soil and natural gas at offshore. In general the study made the following key findings:

- The geometry of oil reservoir indicates that the maximum influence zone of subsidence will be 0.75 km from the reservoir whereas Ravva sea shore is located 6 km away from oil wells offshore platforms. The impact of extraction of oil and natural gas in terms of subsidence is not likely to reach the sea shore as it is 6 km away from the oil wells.
- The progressive subsidence near to reservoir should be of higher magnitude compared to station away from it. This trend is not observed in progressive subsidence movement. Therefore, one may conclude that the progressive subsidence is due to some other reason and not due to extraction of oil and natural gas in PKGM-1 block.
- Subsidence observation at survey stations established near onshore show that there is progressive subsidence with a maximum of 0.099 m and minimum of 0.006 m in 2014-2016.
- The maximum progressive subsidence observation at the survey stations established on the platform 0.086m and 0.059m show that there is change in elevation level of platforms.

3.6 CLIMATE & METEOROLOGY

The climate of the region under study is tropical, maritime and seasonal in character. Air temperature and humidity are high throughout the year. Pressure gradients are weak. The climate is greatly influenced by the southwest and northeast monsoons. There are following four seasons each characterised by a different set of weather conditions.

- Summer (Pre-monsoon) : March to May
- Southwest Monsoon : June to September
- Post Monsoon (Northeast monsoon) : October to December
- Winter season : January to February

The pre monsoon (March to May) and post monsoon seasons (October to December) are the transition periods and are characterised by occurrence of cyclonic storms having active storms during the latter periods. The Southwest monsoon is characterised by strong and persistent wind and rough sea conditions. Northeast monsoon is characterised as fair weather season with light, variable winds and usually calms sea conditions.

Micrometeorological data was recorded during study period from January to March 2018. In addition long term climatological data was also referred to develop a comprehensive understanding of the climate and meteorology of the region.

Diurnal sea breezes modified by monsoonal winds dominate the winds in the Kakinada area. Winds are generally stronger during hours of afternoon than those of night and morning when the thermal circulation is best developed.

3.6.1 Regional Meteorological Conditions

Climatological Table of 30 years (of 1961 to 1990) of IMD for Kakinada Station was referred to assess long-term meteorological conditions prevailing in the region.

Wind Speed and Direction

Monthly average wind distribution ranged from 6.0 km/hour in March to 10.5 km in November. Predominant wind directions were mostly from NE and SW in the morning hours and SE and SW during the evening times.

Ambient Temperature

The mean highest temperature of 41.9 ^{o}C is reported for June while mean lowest temperature of 17.0 ^{o}C is reported for the months of January and December.

Atmospheric Pressure

The variations in pressure are very small and are in the order of 3 mb to 5 mb, with the lowest of 998.7 hPa in the month of June and the highest of 1015.4 hPa in the months of January.

Relative Humidity

The average relative humidity values varied from the lowest of 59% in the months of April and June to the highest of 82% in the months of August and September. The humidity is relatively higher in the morning hours than the evening hours. The morning and evening humidity values did not show any significant or sudden changes (variations are in range of 3% to 15%).

Rainfall

The rainfall in the region is mainly during the two-monsoon periods i.e SW monsoon (June to September) and the NE monsoon (October to December). The annual average rainfall in the area is about 1175.9 mm with considerable variations from year to year. More than 90% of the rainfall is recorded during the months of June to November. Occasional rains are also observed in the non-monsoon months.

Visibility

Visibility in Kakinada and adjacent areas is generally good during almost all the seasons. The monthly average of visibility indicated that the visibility is more than 4 km most of the time.

There are a few occasions when the visibility was less than 4 km. The visibility in the evening hours is more than the morning hours. Barring these few instances, visibility is either between 4 km and 10 km or more than 10 km for most of the time.

Weather Phenomena

The weather phenomena like thunder storms, fog and dust storms is observed for a very limited period. Incidences of fog were observed mainly in the months of January and February. Incidences of dust storms were observed for short periods of 0.1 to 0.2 days in the months of April, May and June. Thunders occur more predominantly during the monsoon months. The reported occurrence of hail and squall is practically nil in the region.

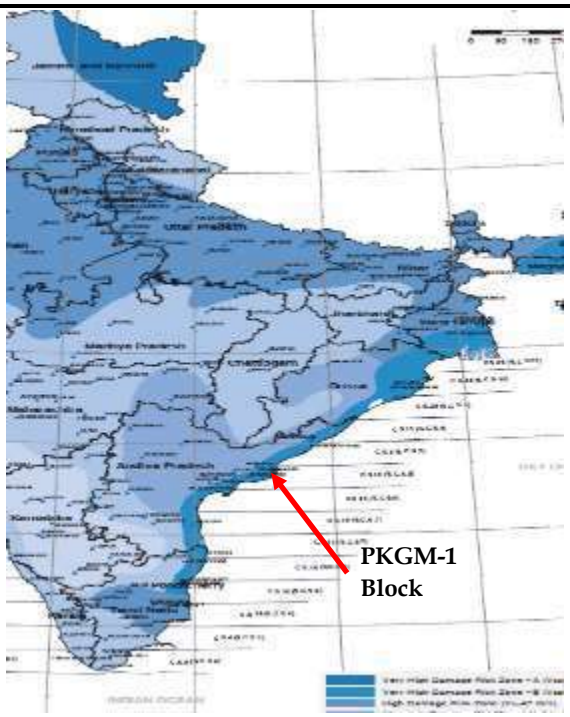
Occurrence of storms and depressions in the Bay of Bengal is relatively higher compared to Arabian Sea. Andhra Pradesh coast is the most vulnerable to the cyclone activity. Most of the cyclones occur in the post monsoon (i.e. Northeast monsoon) months of October and November with few in the months of May and September. As per Climatological Profile of India (Met Monograph No. Environment Meteorology-01/2010), post-monsoon season of October to December is the principal cyclonic season over the North Indian Ocean, followed by the pre-monsoon season of March to May.

Table 3.1 Cyclones observed over Bay of Bengal in last 110 years (1900 to 2009)

Intensity Level of Cyclones	Cyclones Frequency												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
D+CS+SCS	17	5	7	29	81	100	133	168	142	170	152	77	1081
CS+SCS	7	2	5	22	55	32	36	24	31	78	111	46	449
SCS	2	1	2	13	38	3	7	3	13	36	63	21	202

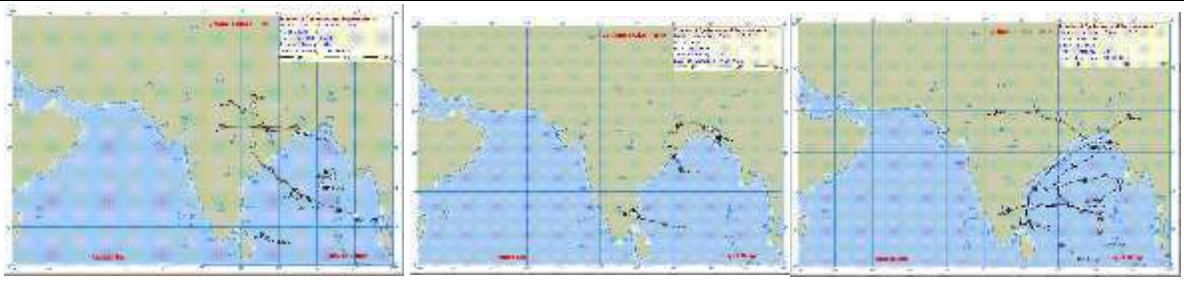
Source: Extracted from Table 12 page 65 of IMD's Climatological Profile of India (Met Monograph No. Environment Meteorology-01/2010); Note: D=Depression (52-61kmph); CS=Cyclonic Storm (62-87 kmph); SCS=Severe Cyclonic Storm (88-117 kmph).

Figure 3.4 Wind and Cyclone Hazard Map



Source: Building Materials and Technology Promotion Council, Vulnerability Atlas

Figure 3.5 Tracks of Storms/Depressions in Bay of Bengal – 2014, 2015 and 2016



Source: Tracks of Cyclones and Depression, India Meteorological Department.

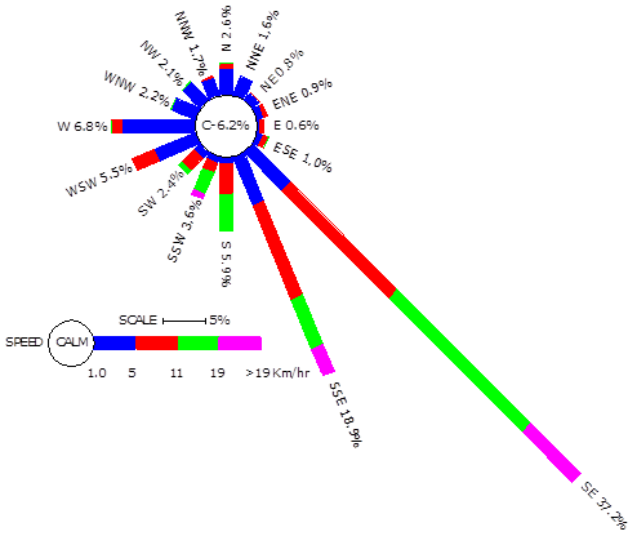
3.6.2 *Micro-meteorological Data Recorded at Surasaniyanam Village*

A Central Monitoring Station (CMS) equipped with continuous monitoring equipment was installed on top of a residential building opposite primary health center in at Surasaniyanam village at a height of about 10.0 m above ground level to record 24 hrs wind speed, direction, relative humidity, temperature, rainfall and cloud cover by Vimta Labs (refer to ***Annex 15 of Volume 2 EIA***). The micro-meteorological monitoring was carried out from 6th January to 31st March 2018 mostly during the winter season (Jan-Feb 2018) and then subsequently for a month during the pre-monsoon season (March 2018). The station was located in a way that it is free from any obstructions and as per the standard norms laid down by Bureau of Indian Standards (IS: 8829) and IMD. Data was collected every hour continuously during the study period. Cloud cover was recorded by visual observation. Rainfall was monitored by rain gauge. The location of the micro-meteorological monitoring station is presented in ***Figure 3.7.***

Wind Direction and Speed

During the monitored winter season, first predominant wind direction prevailed from SE direction with 37.2% of occurrence time while second predominant wind direction prevailed from SSE direction with 18.9% of occurrence time. Predominant wind speed varied from 1.0 to 19.0 kmph with 6.2% of calm conditions. Wind roses as per meteorology monitored during the study period are given in ***Figure 3.6.*** The monthly wind rose diagrams compiled for the 2016 are presented in ***Figure 3.8.***

Figure 3.6 Wind rose of January to March 2018



Source: Environment Monitoring during Jan-Mar, 2018; Note: Wind Direction (blowing from)

Figure 3.7 Ambient Air Quality & Micro Meteorological Monitoring Stations

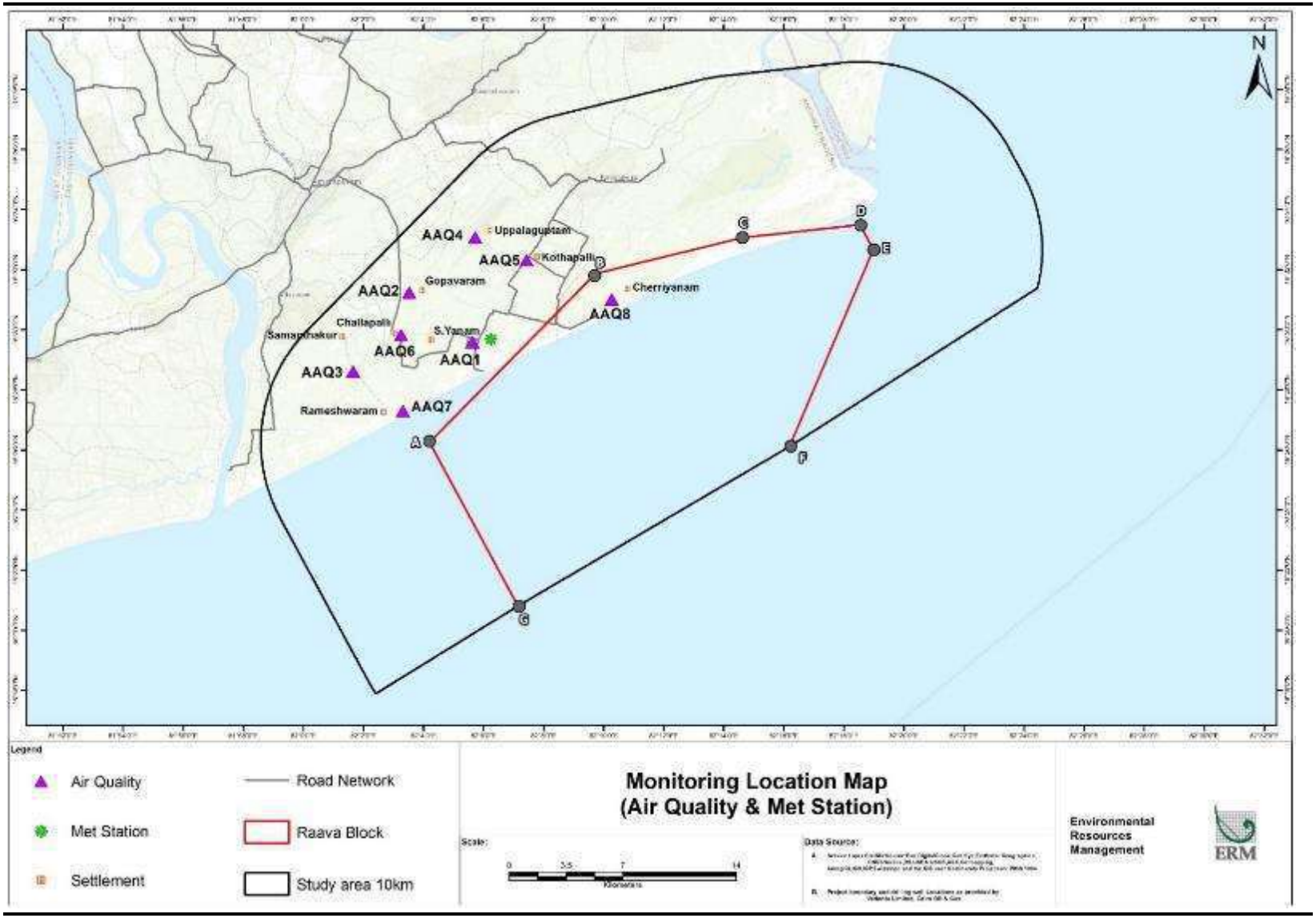
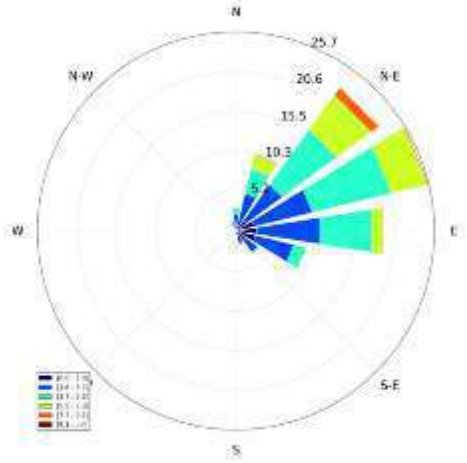
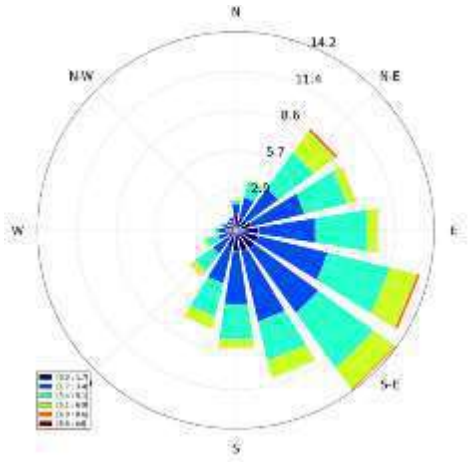


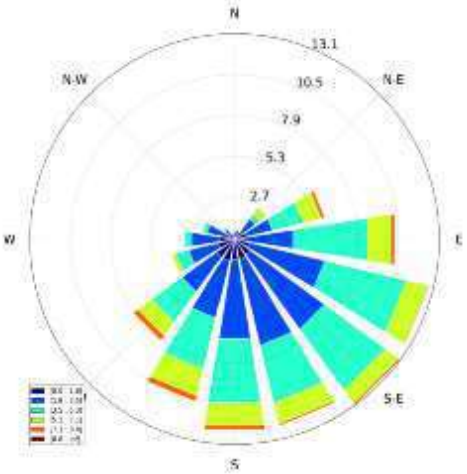
Figure 3.8 Wind roses for January – December 2016



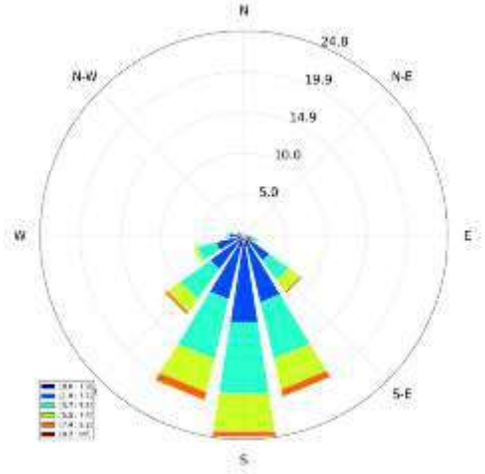
January



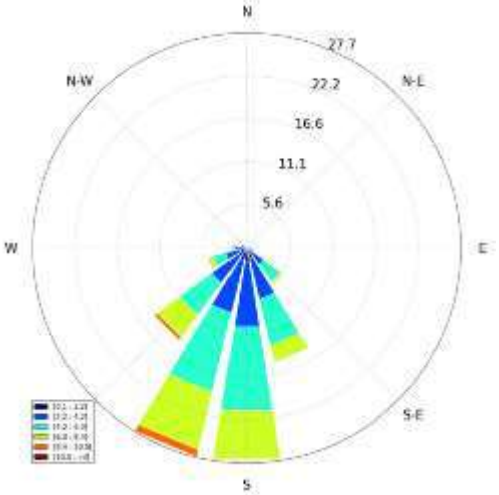
February



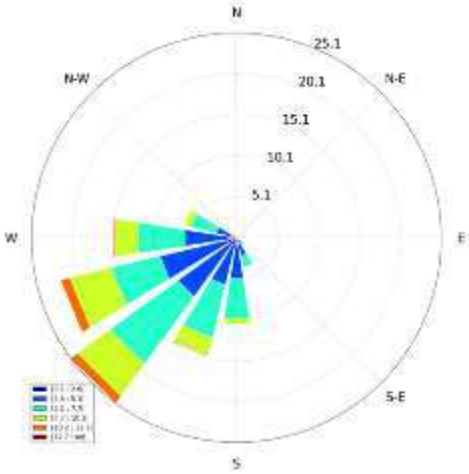
March



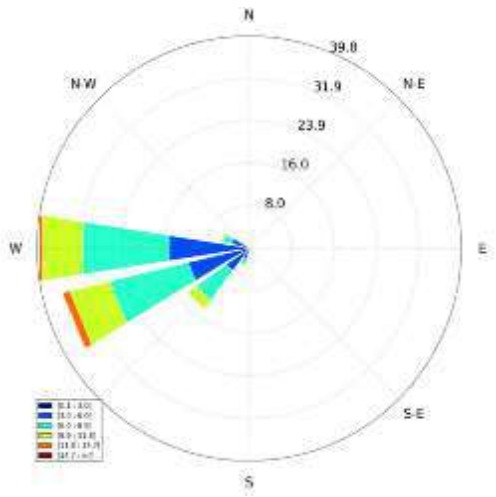
April



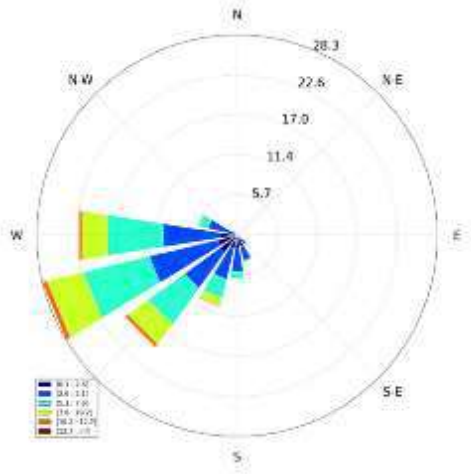
May



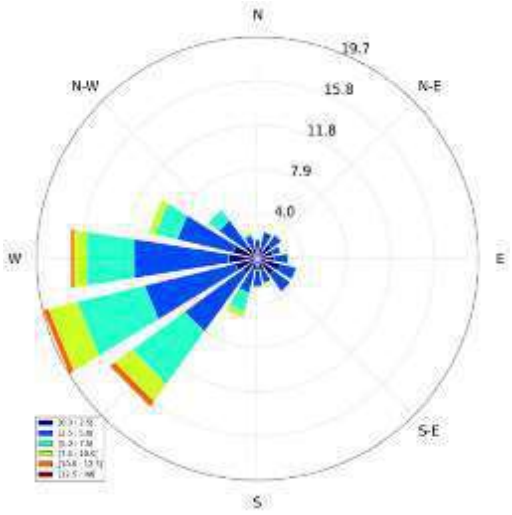
June



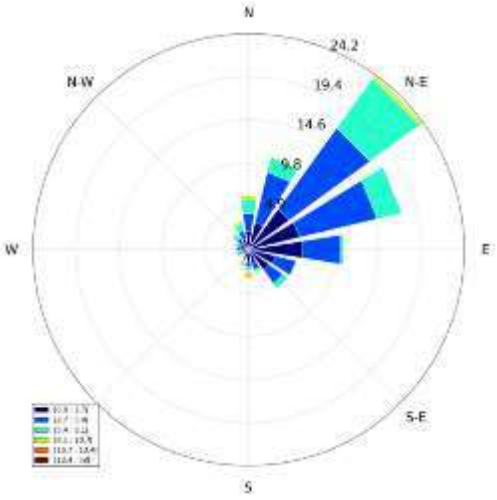
July



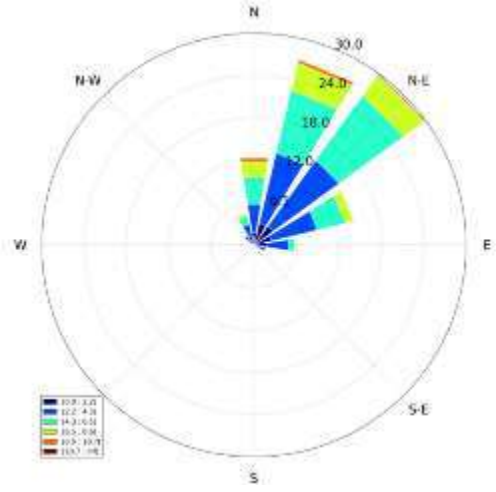
August



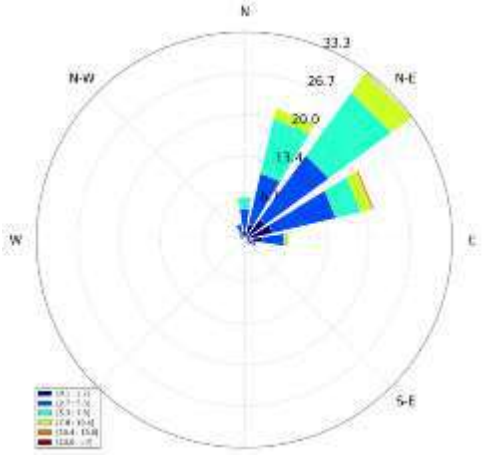
September



October



November



December

Source: Monitoring by Vedanta Ltd (Cairn Oil & Gas) at S.Yanam, 2016

Ambient Temperature & Relative Humidity

Ambient temperature measurements ranged from 18°C during January to 35°C during March. Relative Humidity measurements ranged from 25% to 96%. Maximum humidity was observed

during the month of January. Month wise summary of ambient temperature and relative humidity recorded during the study period are presented in ***Table 3.2.***

Table 3.2 Summary of Meteorological Observations

Period	Temperature (^{0}C)		Relative Humidity (%)	
	Min	Max	Min	Max
January, 2018	18.0	31.0	35	96
February, 2018	19.0	33.0	29	92
March, 2018	21.5	35.0	25	89

Source: Environment Monitoring during Jan-Mar, 2018

Rainfall & Cloud Cover

A rainfall of 7.5 mm was recorded in month of March during the monitoring period. Cloud cover was observed from light to strong i.e. 0/8 to 8/8 cover (1 to 8 oktas). Most of the time, sky was cloudy. Average cloud cover in the month of January, February and March is 4/8, 3/8 and 3/8 respectively.

3.7 AMBIENT AIR QUALITY

Ambient Air Quality Monitoring (AAQM) was carried out was carried out from 6 January to 31 March 2018 mostly during the winter season (Jan-Feb 2018) and then subsequently for a month during the pre-monsoon season (March 2018) at a frequency of twice a week at eight locations NABL and MoEFCC approved lab,Vimta Labs, Hyderabad (refer to ***Annex 16 of EIA Volume 2***). The air samples were analysed as per standard methods specified by Central Pollution Control Board (CPCB), IS: 5184 and American Public Health Association (APHA). The monitored parameters, sampling frequency their minimum detection limits and analytical method adopted are given in ***Table 3.3.***

Table 3.3 Sampling Frequency, Detection Limits & Analytical Method

SN	Parameters	Sampling Frequency	Analytical Method	Technical Protocol	Detectable Limit
1	Particulate Matter (PM_{10})	24 hourly X Twice a Week X 3 months	Respirable dust sampler /high volume sampling (Gravimetric)	IS-5182 (Part-XXIII)	5.0 µg/m^3
2	Particulate Matter ($PM_{2.5}$)	24 hourly X Twice a Week X 3 months		CPCB Guidelines	5.0 µg/m^3
3	Sulphur dioxide (SO_2)	24 hourly X Twice a Week X 3 months	Modified West and Gaeke Method	IS-5182 (Part-II)	4.0 µg/m^3
4	Oxides of Nitrogen (NOx)	24 hourly X Twice a Week X 3 months	Jacob & Hochheiser Method	IS-5182 (Part-VI)	10.0 µg/m^3
5	Hydrogen Sulphide (H_2S)	24 hourly X Twice a Week x 3 months	Spectrophotometric method	IS-5182 (Part-VII)	1.0 µg/m^3
6	Total VOCs	24 hourly X Twice a Week x 3 months	Gas Chromatography	USEPA 17	0.1 ppm
7	Ammonia (NH_3)	24 hourly X Twice a Week x 3 months	Indophenol Blue method	-	20.0 µg/m^3
8	Lead (Pb)	24 hourly X Twice a Week x 3 months	AAS / ICP-MS method after sampling EPM filter paper	IS-5182 (Part-XXII)	0.001

SN	Parameters	Sampling Frequency	Analytical Method	Technical Protocol	Detectable Limit
9	Arsenic(As)	24 hourly X Twice a Week x 3 months		IS-5182	0.001
10	Nickel (Ni)	24 hourly X Twice a Week x 3 months		IS-5182	0.001
11	Benzene (C_6H_6)	24 hourly X Twice a Week x 3 months	Gas Chromatography	IS-5182 (Part-XI)	1.0 µg/m^3
12	Benzo(a) pyrene (BAP)	24 hourly X Twice a Week x 3 months	Solvent extraction followed by GC MS	IS-5182 (Part-XII)	0.1 ng/m^3
13	Carbon Monoxide(CO)	8 hourly over 24 hours X Twice a week x 3 months	Gas Chromato-graphy Method	IS-5182 (Part-X)	50 µg/m^3
14	Hydrocarbons	8 hourly over 24 hours X Twice a week x 3 months	Gas Chromato-graphy	USEPA 17	0.1 ppm
15	Ozone (O_3)	8 hourly over 24 hours X Twice a week x 3 months	Spectrophotometric method	IS-5182 (Part-IX)	2.0 mg/m^3

Source: Environment Monitoring during Jan-Mar, 2018

The ambient air monitoring stations are described in ***Table 3.4*** and their location shown in ***Figure 3.7.***

Table 3.4 Details of Ambient Air Monitoring Stations

Station Code	Name of the station	GPS Location	Distance & Direction wrt Ravva Terminal
AAQ1	Surasaniyanam Village	16°29'33.78"N; 82° 05'49.56"E	0.8 km to NE
AAQ2	Gopavaram Village	16°31'14.64"N; 82° 03'31.86"E	5.3 km to NW
AAQ3	Samanthakur Village	16°28'37.14"N; 82° 01'39.72"E	5.6 km to W
AAQ4	Uppalaguptam Village	16°33'04.44"N; 82° 05'43.26"E	6.8 km to N
AAQ5	Kottapalli Village	16°32'19.20"N; 82° 07'26.22"E	6.1 km to NE
AAQ6	Challapalli Village	16°29'49.32"N; 82° 03'15.54"E	3.8 km to W
AAQ7	Rameshwaram Village	16°27'18.24"N; 82° 03'19.02"E	6.2 km to SW
AAQ8	Cherriyanam Village	16°31'00.78"N; 82°10'16.50"E	9.1 km to NE

Source: Environment Monitoring during Jan-Mar, 2018

Photographs of the ambient air quality monitoring program conducted during the EIA Study are presented in ***Figure 3.9.***

Figure 3.9 Photographs of Ambient Air Quality Monitoring

AAQ1 - Surasaniyanam Village

AAQ2 - Gopavaram Village

AAQ3 - Samanthakurru Village

AAQ4 - Uppalaguptam Village

AAQ5 - Nimmakayala Kottapalli Village

AAQ6 - Challapalli Village

AAQ7 – Rameswaram Village

AAQ8 - ChirayanamVillage

AAQ results as monitored during 6 January to 31 March 2018 at various locations is presented in ***Table 3.5***.

Table 3.5 Ambient Air Quality

Parameters	Unit		Monitoring Locations							
			AQ1	**AQ2**	**AQ3**	**AQ4**	**AQ5**	**AQ6**	**AQ7**	**AQ8**
$PM_{2.5}$: 24 Hourly	µg/m³	**NAAQS (24 Hrs.)**	**60**	**60**	**60**	**60**	**60**	**60**	**60**	**60**
		Maximum	24.5	23.9	23.5	24.8	23.5	25.7	22.6	21.6
		Minimum	20.8	20.3	18.4	20.7	19.6	22.4	18.4	18.5
		Average	22.8	21.8	21.3	22.6	21.2	24.1	20.3	19.8
		98 percentile	24.5	23.9	23.4	24.5	23.5	25.7	22.5	21.6
PM_{10}: 24 Hourly	µg/m³	**NAAQS (24 Hrs.)**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
		Maximum	55.4	54.7	52.4	54.4	53.1	56.3	49.4	47.1
		Minimum	49.2	48.8	46.8	49.2	47.5	49.5	45.6	43.6
		Average	51.5	51.4	49.4	51.6	50.5	52.4	47.4	45.2

Parameters	Unit		Monitoring Locations							
			AQ1	AQ2	AQ3	AQ4	AQ5	AQ6	AQ7	AQ8
		98 percentile	55.3	54.5	52.4	54.3	53.1	56.2	49.3	47.1
SO_2: 24 Hourly	µg/m³	**NAAQS (24 Hrs.)**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**
		Maximum	14.6	13.2	12.5	13.1	12.8	14.8	12.2	11.6
		Minimum	11.5	10.8	9.7	10.3	9.6	11.4	8.7	9.4
		Average	12.7	12.1	11.2	11.8	11.3	12.5	10.3	10.6
		98 percentile	14.4	13.1	12.5	13.1	12.7	14.5	12.1	11.6
NO_x: 24 Hourly	µg/m³	**NAAQS (24 Hrs.)**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**
		Maximum	16.5	15.3	14.5	15.3	14.7	16.7	14.5	14.2
		Minimum	13.2	12.4	11.3	12.8	11.3	13.7	10.5	11.7
		Average	14.4	13.8	13	14	13.1	14.9	12.4	13
		98 percentile	16.4	15.2	14.4	15.3	14.6	16.5	14.3	14.2
CO: 8 hourly	µg/m³	**NAAQS (8 Hrs.)**	**2000**	**2000**	**2000**	**2000**	**2000**	**2000**	**2000**	**2000**
		Maximum	255	232	223	243	226	268	238	224
		Minimum	171	169	166	172	160	191	153	151
		Average	209	201	198	210	200	220	198	192
		98 percentile	253	231	223	242	225	261	235	223
Methane Hydrocarbons (MC) : 8 hourly	ppm	**NAAQS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
		Maximum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		Minimum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		Average	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		98 percentile	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Non-Methane Hydrocarbons (NHMC) : 8 hourly	ppm	**NAAQS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
		Maximum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		Minimum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		Average	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		98 percentile	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ozone (O_3): 8 hourly	mg/m³	**NAAQS (8 Hrs.)**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
		Maximum	13.5	13.2	12.7	13.7	12.5	14.2	12.3	12.6
		Minimum	8.8	7.5	7.2	8.2	6.8	9.4	6.8	8.2
		Average	11.3	10.8	10.3	11	9.9	11.8	9.7	10.6
		98 percentile	13.4	13.2	12.6	13.5	12.4	14.1	12.2	12.5
Ammonia (as NH_3): 24 hrs	µg/m³	**NAAQS (24 Hrs.)**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**
		Maximum	<20	<20	<20	<20	<20	<20	<20	<20
		Minimum	<20	<20	<20	<20	<20	<20	<20	<20
		Average	<20	<20	<20	<20	<20	<20	<20	<20
		98 percentile	<20	<20	<20	<20	<20	<20	<20	<20
Lead (as Pb): 24 hrs	µg/m³	**NAAQS (24 Hrs.)**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
		Maximum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		Minimum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		Average	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		98 percentile	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic (as As): 24 hrs	ng/m³	**NAAQS Annual**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**
		Maximum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		Minimum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		Average	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		98 percentile	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (as Ni): 24 hrs	ng/m³	**NAAQS Annual**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**
		Maximum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		Minimum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		Average	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
		98 percentile	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
H_2S: 24 hrs	µg/m³	**NAAQS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
		Maximum	1.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
		Minimum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
		Average	1.4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

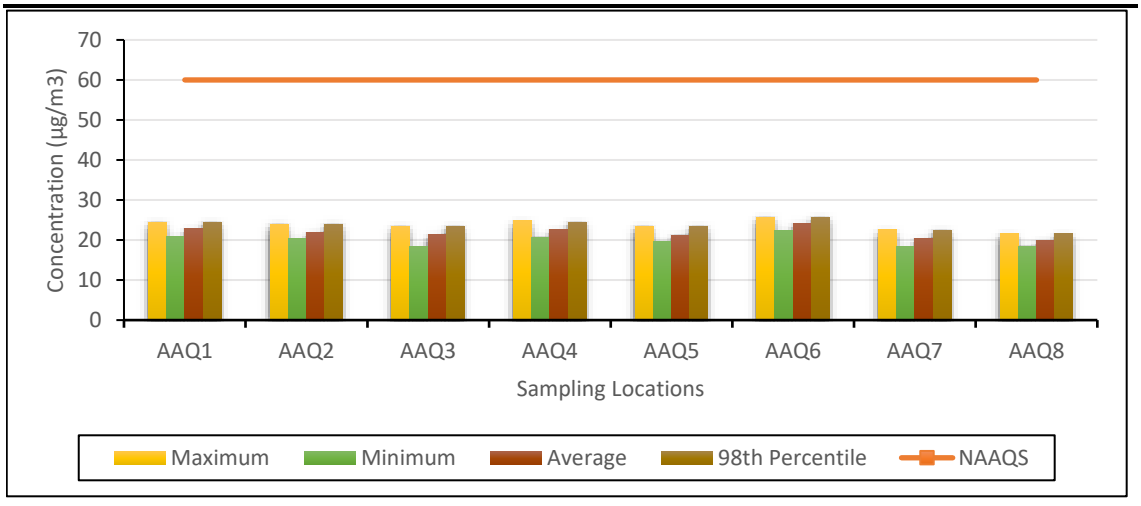
Parameters	Unit		Monitoring Locations							
			AQ1	AQ2	AQ3	AQ4	AQ5	AQ6	AQ7	AQ8
		98 percentile	1.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total VOC's: 24 hrs	ppm	**NAAQS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
		Maximum	0.18	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		Minimum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		Average	0.14	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		98 percentile	0.18	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzene: 24 hrs	µg/m³	**NAAQS Annual**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
		Maximum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		Minimum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		Average	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		98 percentile	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Banzo(a) pyrene	ng/m³	**NAAQS Annual**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
		Maximum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		Minimum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		Average	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		98 percentile	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Note : NAAQS = Revised National Ambient Air Quality Standard as notified on 16 Nov 2009;
NS = Standard not specified; Source: Environment Monitoring during Jan-Mar, 2018

a) Particulate Matter ($PM_{2.5}$)

The $PM_{2.5}$ concentration observed during the period ranged from 18.4 µg/m³ to 25.7 µg/m³. Maximum concentration was recorded at AAQ-6 (Chalapalli village). Average concentration values at all the 8 monitoring stations ranged from 19.8 µg/m³ to 24.1 µg/m³ while 98 percentile values ranged from 21.6 µg/m³ to 25.7 µg/m³. The 98 percentile $PM_{2.5}$ values were observed less than the prescribed NAAQS of 60µg/m³ for $PM_{2.5}$ at all locations. The graphical representation of $PM_{2.5}$ concentration in the study area is shown in ***Figure 3.10***.

Figure 3.10 $PM_{2.5}$ Concentrations in Study Area



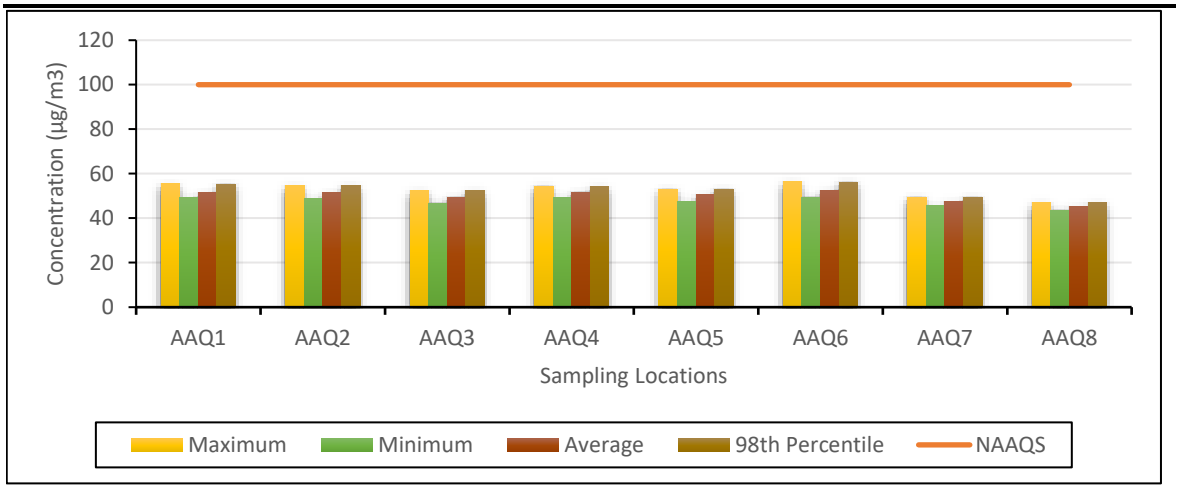
Source: Environment Monitoring during Jan-Mar, 2018

b) Particulate Matter (PM_{10})

The PM_{10} concentration ranged from 43.6µg/m³ to 56.3µg/m³. AAQ-6 (Chalapalli village) recorded the maximum concentration while AAQ- 8 (Cherriyanam) recorded the minimum concentration. Average concentration values ranged from 45.2 µg/m³ to 52.4 µg/m³ while 98 percentile values ranged from 47.1 µg/m³ to 56.2 µg/m³. The PM_{10} values (98 percentile) were

observed less than the prescribed 24 hourly NAAQS of 100 µg/m³ at all locations. The graphical representation of PM_{10} concentration in the study area is shown in ***Figure 3.11.***

Figure 3.11 PM_{10} Concentrations in Study Area

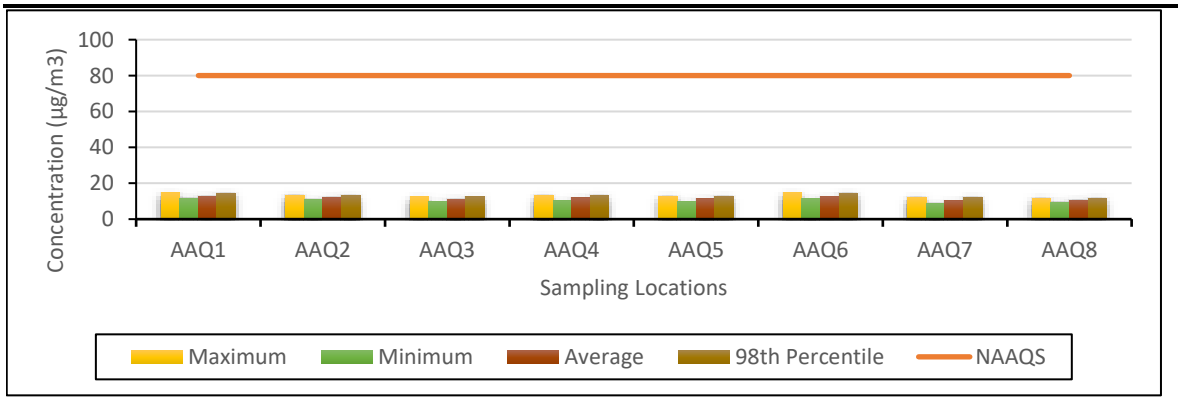


Source: Environment Monitoring during Jan-Mar, 2018

c) Sulphur dioxide (SO_2)

The SO_2 concentration observed during the period ranged from 8.7 µg/m³ to 14.8 µg/m³. AAQ-6 (Chalapalli village) recorded the maximum concentration of while AAQ-7 (Rameswaram village) recorded the minimum concentration. Average concentration values ranged from 10.3 µg/m³ to 12.7 µg/m³ while 98 percentile values ranged from 11.6 µg/m³ to 14.5 µg/m³. The 98 percentile SO_2 values were observed less than the prescribed 24 hourly NAAQS of 80 µg/m³ at all locations. The graphical representation of SO_2 concentration in the study area is shown in ***Figure 3.12***.

Figure 3.12 SO_2 Concentrations in Study Area



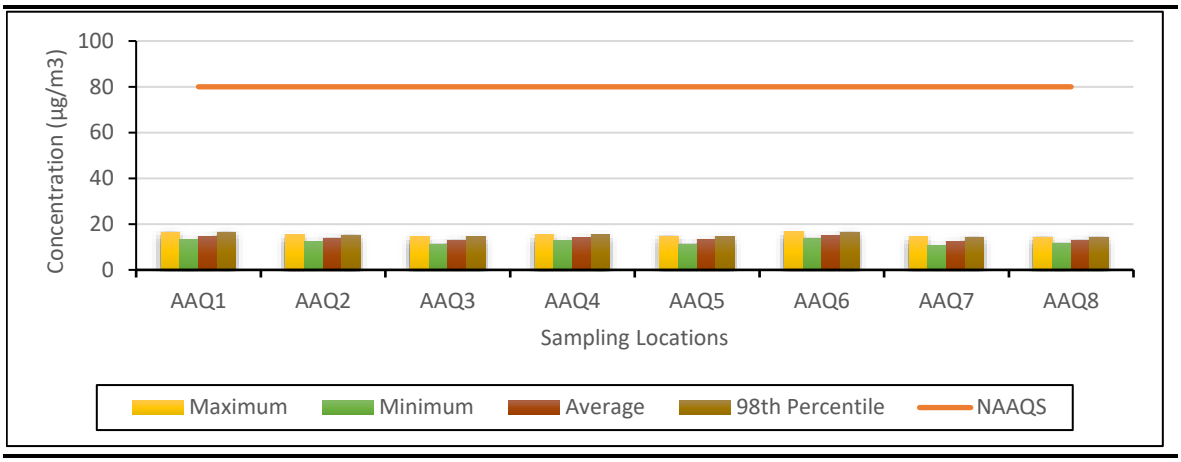
Source: Environment Monitoring during Jan-Mar, 2018

d) Oxides of Nitrogen (NOx)

The NOx concentration observed during the period ranged from 10.5 µg/m³ to 16.7 µg/m³. AAQ-6 (Chalapalli village) recorded the maximum concentration while AAQ-7 (Rameswaram village) recorded the minimum concentration. Average concentration values ranged from 12.4 µg/m³ to 14.9 µg/m³ while 98 percentile values ranged from 14.2 µg/m³ to 16.5 µg/m³. The

98 percentile NOx values were observed less than the prescribed 24 hourly NAAQS of 80 µg/m³ at all locations. The graphical representation of NOx concentration in the study area is shown in ***Figure 3.13***.

Figure 3.13 Oxides of Nitrogen Concentrations in Study Area

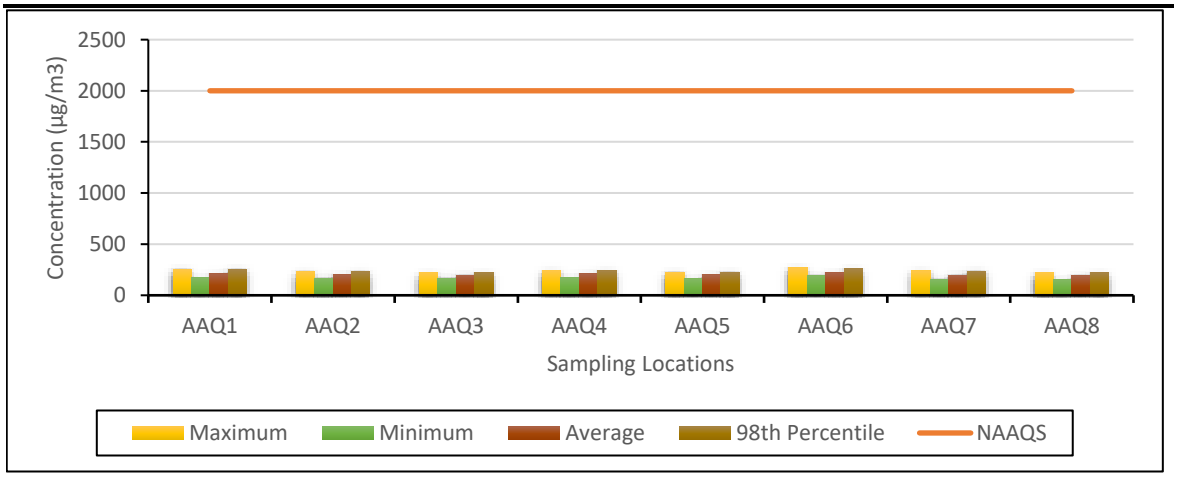


Source: Environment Monitoring during Jan-Mar, 2018

e) Carbon Monoxide (CO)

The CO concentration observed during the period ranged from 151 µg/m³ to 268 µg/m³ at AAQ-6. The maximum and minimum values of CO were recorded at Chalapalli and Cherriyanam Village respectively. Average concentration values ranged from 192 µg/m³ to 220 µg/m³ while 98 percentile values ranged from 223 µg/m³ to 261 µg/m³. The 98 percentile CO values were observed less than the prescribed 8 hourly NAAQS of 2000 µg/m³ at all locations. The graphical representation of CO concentration in the study area is shown in ***Figure 3.14***.

Figure 3.14 Carbon Monoxide Concentrations in the Study Area



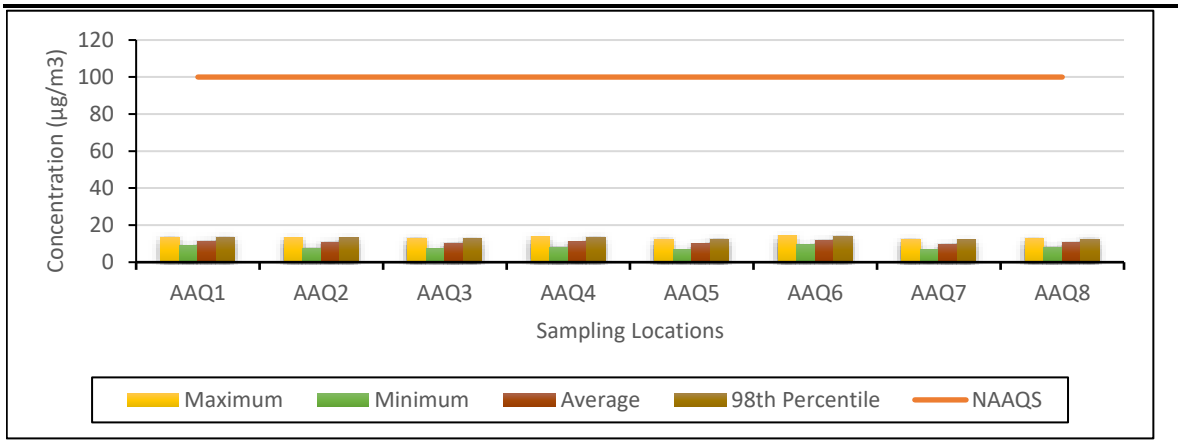
Source: Environment Monitoring during Jan-Mar, 2018

f) Ozone (O_3)

The Ozone concentration observed during the period ranged from 6.8 µg/m³ to 14.2 µg/m³. AAQ-6 (Chalapalli villge) recorded the maximum concentration while AAQ-7 (Rameswaram) and AAQ-5 (Kothapalli village) recorded the minimum concentration. Average concentration values ranged from 9.7 µg/m³ to 11.8 µg/m³ while 98 percentile values ranged from 12.2

µg/m³ to 14.1 µg/m³. The graphical representation of the concentration is shown in ***Figure 3.15***.

Figure 3.15 Ozone Concentrations in Study Area



Source: Environment Monitoring during Jan-Mar, 2018

g) Methane and Non Methane Hydrocarbon

Concentration of Methane Hydrocarbon and non Methane Hydrocarbon at all the eight monitoring locations were observed below corresponding detection limits of 0.1 ppm.

h) Volatile Compounds (VOCs)

Concentration of VOCs at all the eight monitoring locations were observed below corresponding detection limits of 0.1 ppm however only one instance VOC's concentration level was detected as 0.18 in AAQ-1 (S.Yanam village)

i) Ammonia (NH_3) & Hydrogen Sulphide H_2S

Concentration of NH_3 and H_2S at all the eight monitoring locations were observed below corresponding detection limits of 20 µg/m³ and 1.0 µg/m³ respectively however only one instance H_2S concentration level was detected as 0.16 in AAQ-1 (S.Yanam village).

j) Lead (Pb) & Arsenic (As) & Nickle (Ni)

Concentration of Pb, As and Ni at all the eight monitoring locations were observed below corresponding detection limits of 0.001 µg/m³.

k) Benzene & Benjo(a)pyrene (BaP)

Concentration of benzene and BaP at all the eight monitoring locations were observed below corresponding detection limits of 0.01 µg/m³.

3.8 AMBIENT NOISE QUALITY

Sound Pressure Levels (SPL) measurements were recorded at eight locations. The readings were recorded for every hour for 24 hours using noise samplers. The day noise levels have been monitored during 6 am to 10 pm and night noise levels during 10 pm to 6 am at all the 8 locations covered in the study area as given in ***Table 3.6.*** The noise monitoring locations are shown in ***Figure 3.16.***

Table 3.6 Description of Noise Sampling Locations

Code	Location	GPS Location	Distance & Direction (wrt Ravva Terminal)
N1	Outside Ravva Terminal - Near Anjaneyswamy Temple	16°29′45.90″N; 82°05′30.90″E	0.6 km to N
N2	Living Quarter (LQ)	16°29′40.86″N; 82°05′43.38″E	0.5 km to NE
N3	Surasaniyanam Village	16°27′18.00′′N; 82°05′37.74′′E	0.8 km to NE
N4	S.Yanam Beach – Cyclone Shelter	16°28′40.38′′N′ 82°06′06.12′′E	1.2 km to SE
N5	Challapalli Village	16°29′49.14′′N; 82°03′15.54′′E	3.8 km to W
N6	Gopavaram Village	16°31′14.46′′N; 82°03′30.60′′E	5.3 km to NW
N7	Gachakayala Pora Village	16°31′12.70′′N; 82°08′26.80′′E	6.1 km to NE
N8	Cherriyanam Village	16°31′00.66′′N; 82°10′16.50′′E	3.3 km to NW

Source: Environment Monitoring during Jan-Mar, 2018

Day Time Noise Levels in Residential Area

The daytime noise levels at the residential location ranged from 50.0 to 53.5 dB (A). It is observed that the day time noise levels at residential locations are within the prescribed limit of 55 dB (A).

Night Time Noise Levels in Residential Area

The night time noise levels at the residential locations during working day ranged from 40.1 to 43.5 dB (A). It is observed that the night time noise levels at residential locations are not exceeding the prescribed limit of 45 dB (A).

Day Time Noise Levels in Commercial Area

The daytime noise levels recorded at the commercial location is 59.4 dB (A). It is observed that the day time noise levels at commercial locations are within the prescribed limit of 65 dB (A).

Night Time Noise Levels in Commercial Area

The nighttime noise levels recorded at the commercial location is 53.8 dB (A). It is observed that the day time noise levels at commercial locations are within the prescribed limit of 55 dB (A). The recorded noise levels in the study area are summarised in ***Table 3.7***.

Figure 3.16 Ambient Noise Monitoring and Traffic Survey Locations

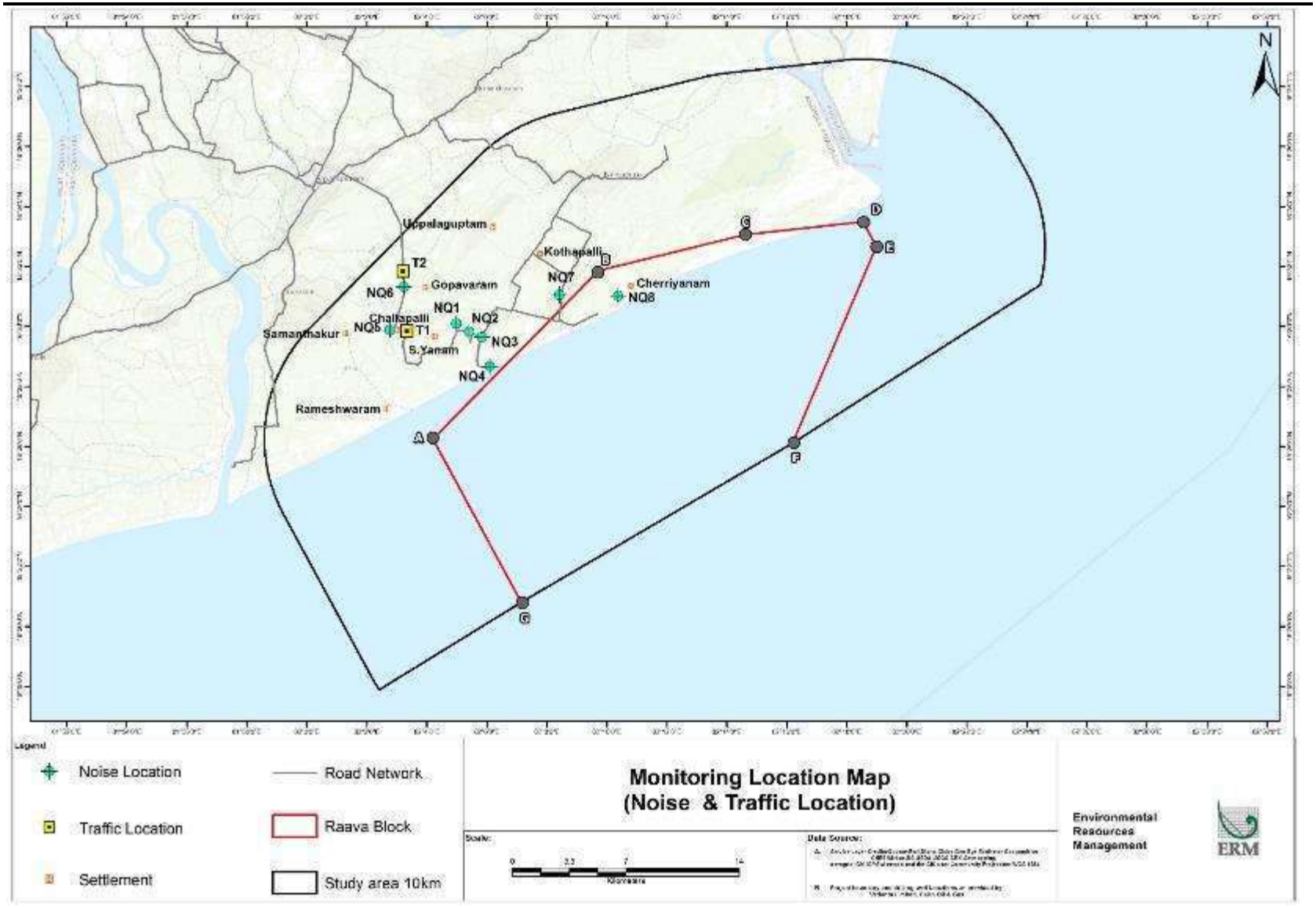


Table 3.7 Noise Level in the Study Area

Code	Location	Type of Area	Date of Sampling	L_{eq} (24 Hours)	Leq (day)	Leq (night)	Standard Leq (day)	Standard Leq (night)
N1	Outside Ravva Terminal (Near Anjaneyswamy Temple)	Commercial Area	24 Mar 2018	53.8	59.4	50.7	65	55
N2	Living Quarters (LQ)	Residential Area	28 Mar 2018	46.6	52.2	43.5	55	45
N3	S.Yanam Village	Residential Area	30 Mar 2018	45.8	51.5	40.1	55	45
N4	S.Yanam Beach – Cyclone Shelter	Residential Area	26 Mar 2018	45.5	51.2	42.1	55	45
N5	Challapalli Village	Residential Area	22 Mar 2018	48.3	53.5	43.8	55	45
N6	Gopavaram Village	Residential Area	21 Mar 2018	47.6	53.2	43.5	55	45
N7	Gachakayala Pora Village	Residential Area	23 Mar 2018	44.5	50.3	41.3	55	45
N8	Cherriyanam Village	Residential Area	27 Mar 2018	44.4	50.0	40.8	55	45

Source: Environment Monitoring during Jan-Mar, 2018

The hourly equivalent noise levels are presented in ***Annex 17 of EIA Volume 2.***

3.9 ROAD TRAFFIC SURVEY

Road traffic surveys were carried out at two locations viz. Chalapalli village and Kunavaram village for 24 hours once during study period to characterize type, category and number of vehicles plying on the roads joining the Ravva Terminal. Passenger car unit (PCU) equivalent vehicles recorded in Chalapalli village were 1741 during working day and 1316 during non-working day whereas in Kunavaram village, the PCUs were observed as 2010 during working day and 1625 during nonworking day as per description given in ***Table 3.8.*** The detailed traffic survey results are presented in ***Annex 18 of EIA Volume 2.***

Table 3.8 Observed Traffic Density

Date	Location	Traffic Direction	2/3W	4 - W	LMV	Buses / Lorries	MAV	Total Vehicles	Total PCUs
26 Mar 2018	Challapalli Village *[16°29'51.06" N; 82°03' 20.28" E]*	Amalapuram to S.Yanam	378	73	61	66	87	1432	1741
		S.Yanam to Amalapuram	408	88	73	68	130		
24 Mar 2018		Amalapuram to S.Yanam	295	59	43	49	62	1106	1316
		S.Yanam to Amalapuram	329	60	59	53	97		
22 Mar 2018	Kunavaram Village *[16°31'50.58" N; 82°03' 12.60" E]*	Amalapuram to Chalapalli	716	123	94	85	113	2020	2010
		Chalapalli to Amalapuram	608	81	72	53	75		
31 Mar 2018		Amalapuram to Chalapalli	606	101	77	68	84	1686	1625
		Chalapalli to Amalapuram	524	66	60	42	58		

Note: PCU = passenger car units (PCU) as per conversion factors stipulated by Indian Road Congress; LMV: Light Motor Vehicle and MAV: Multi Axle Vehicle;
Source: Environment Monitoring during Jan-Mar, 2018

As per IRC standards, the roads are two lane roads having maximum capacity of 15,000 PCU/day. The above traffic survey shows roads leading to the Ravva Terminal are above the available design capacity during working days.

3.10 GROUND & SURFACE WATER RESOURCE & QUALITY

Ground water and surface water resources within 10 km radius from Ravva Terminal have been studied for assessing the water environment.

Samples of ground water and surface water were examined for physico-chemical, heavy metals and bacteriological parameters as per procedures specified in 'Standard Methods for the Examination of Water and Wastewater' published by American Public Health Association (APHA). Four samples of groundwater and four samples of surface water were collected as per their locations given in ***Table 3.9 &*** **Figure 3.18.**

Table 3.9 Details of Ground and Surface Water Sampling Locations

S.N	Code	Sampling Location	Geographical Location	Source
Groundwater				
1	GW1	Living Quarters (LQ)	16°29.681′ N; 82°05.723′ E	Treated Water
2	GW2	Uppalaguptam Village	16°33.144′ N; 82°05.623′ E	Treated Water
3	GW3	Challapalli Village	16°29.600′ N; 82°03.272′ E	Tube Well
4	GW4	Samanthakur Village	16°28.523′ N; 82°02.248′ E	Dug Well
Surface Water				
1	SW1	Challapalli Canal	16°29.978′ N; 82°02.927′ E	Canal
2	SW2	Back water near Cherriyanam	16°30.111′ N; 82°08.600′ E	Backwater
3	SW3	S.Yanam Creek	16°30.637′ N; 82°06.335′ E	Creek
4	SW4	Back Water near S.Yanam Beach	16°28.550′ N; 82°05.776′ E	Backwater

Source: Environment Monitoring during Jan-Mar, 2018

Photographs of the surface and ground water monitoring conducted during the EIA Study are presented in ***Figure 3.18.***

3.10.1 Groundwater Quality

Most of the villages in the project area have hand pumps and dug wells, the residents of these villages make use of this untreated water for domestic uses. Due to high TDS concentration in groundwater owing to proximity to marine areas, groundwater is treated before drinking. The observed groundwater quality of the area is as per detail given in ***Table 3.10.***

Figure 3.17 Photographs of Surface and Ground Water Quality Monitoring

SW1 – Challapalli Cannal

SW2-Backwater Near Cherriyanam

SW3- S.Yanam Creek

SW3- Backwaters near S.Yanam Beach

GW1 – Vedanta Ltd (Cairn Oil & Gas) Living Quarters

GW2 – Uppalaguptam Village

GW3 - Challapalli Village

GW4 – Samanthakur Village

Analysis of Onsite Parameters for Water Samples

Figure 3.18 Water and Soil Sampling Locations

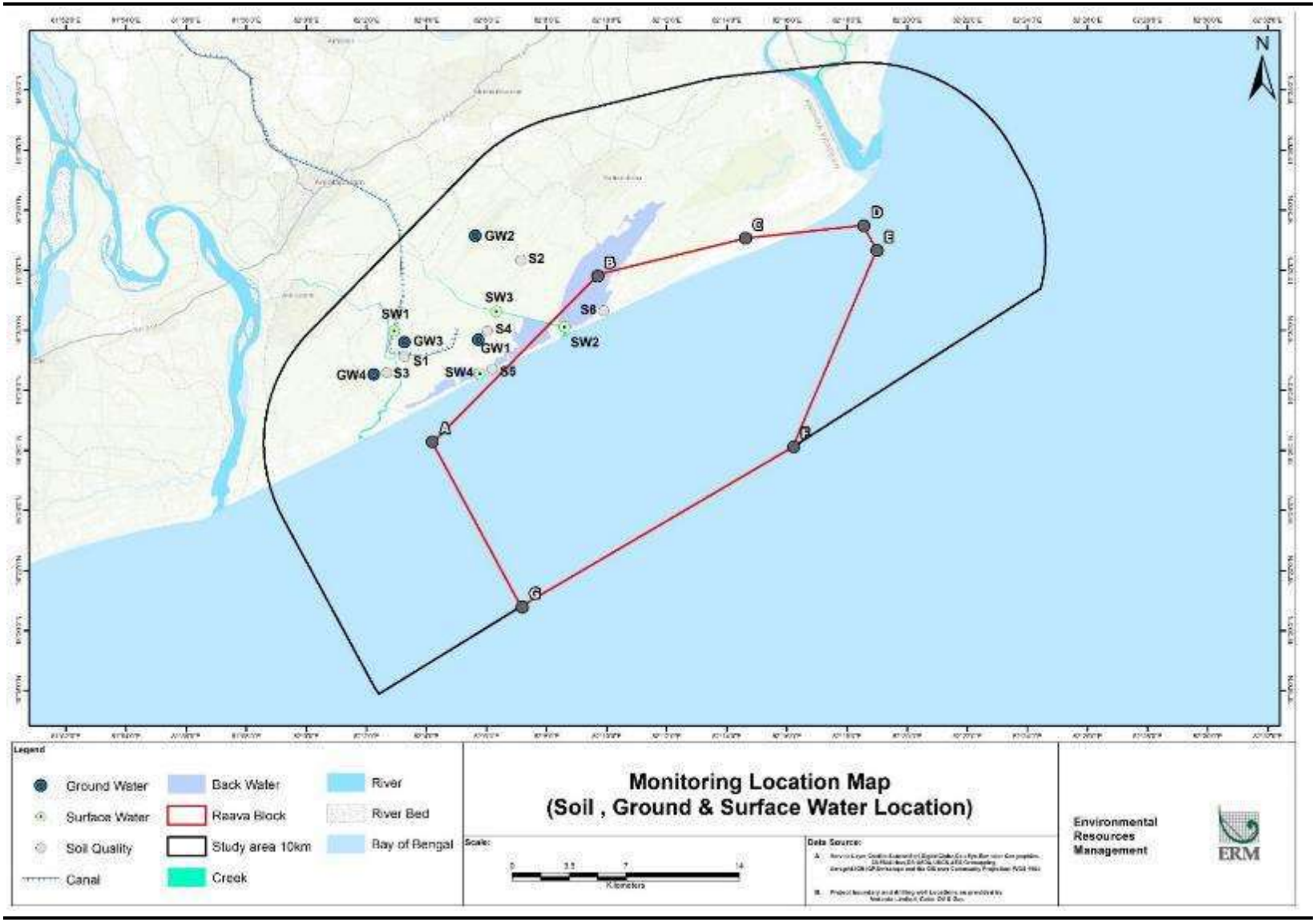


Table 3.10 Ground Water Quality during the Study Period

SN.	Parameter	Unit	GW1	GW2	GW3	GW4	IS: 10500 Limit	
							Acceptable Limit	Permissible Limit
1	pH		7.3	7.2	7.1	7.4	6.5-8.5	
2	Colour	Hazen	1	1	2	2	5	15
3	Taste		Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	
4	Odour		Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	
5	Conductivity	µs/cm	645	640	3310	7730	NS	
6	Turbidity	NTU	1	2	3	3	1	5
7	Total Dissolved Solids	mg/l	412	397	2174	5334	500	2000
8	Total Hardness	mg/l	165.2	196.8	571.4	1086.4	200	600
9	Total Alkalinity	mg/l	65.0	205	815	790	200	600
10	Calcium	mg/l	35.4	51.3	81.1	134.5	75	200
11	Magnesium	mg/l	18.6	16.7	89.6	182.3	30	100
12	Free residual Chlorine	mg/l	<0.2	<0.2	<0.2	<0.2	0.2	1
13	Boron	mg/l	0.26	0.13	0.24	0.51	0.5	1
14	Chlorides	mg/l	178.8	101.6	525.8	1857.7	250	1000
15	Sulphates	mg/l	3.6	16.5	44.7	65.5	200	400
16	Fluorides	mg/l	0.2	0.3	0.5	0.7	1.0	1.5
17	Nitrates	mg/l	3.9	2.4	10.7	11.2	45	NR
18	Sodium	mg/l	72.4	54.6	395.7	1254.2	NS	NS
18	Potassium	mg/l	1.3	3.8	174.4	35.6	NS	NS
20	Phenolic Compounds	mg/l	<0.001	<0.001	<0.001	<0.001	0.001	0.002
21	Cyanides	mg/l	<0.02	<0.02	<0.02	<0.02	0.5	NR
22	Anionic Detergents	mg/l	<0.2	<0.2	<0.2	<0.2	0.2	1.0
23	Mineral Oil	mg/l	<0.01	<0.01	<0.01	<0.01	0.5	NR
24	Cadmium	mg/l	<0.001	<0.001	<0.001	<0.001	0.003	NR
25	Total Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01	0.01	0.05
26	Copper	mg/l	<0.01	<0.01	<0.01	<0.01	0.05	1.5
27	Lead	mg/l	<0.01	<0.01	<0.01	<0.01	0.01	NR
28	Manganese	mg/l	<0.01	0.02	0.03	0.02	0.1	0.3
39	Iron	mg/l	0.04	0.29	0.02	0.09	0.3	NR
30	Total Chromium	mg/l	<0.01	<0.01	<0.01	<0.01	0.05	NR
31	Selenium	mg/l	<0.01	<0.01	<0.01	<0.01	0.01	NR
32	Zinc	mg/l	<0.01	<0.01	0.09	0.01	5	15
33	Aluminium	mg/l	<0.01	<0.01	<0.01	<0.01	0.03	0.2
34	Mercury	mg/l	<0.001	<0.001	<0.001	<0.001	0.001	NR
35	Pesticides	mg/l	Absent	Absent	Absent	Absent	Absent	
36	E. Coli	MPN / 100ml	Absent	Absent	Absent	Absent	Absent	
37	Total Coliforms	MPN / 100ml	<2	<2	<2	<2	Absent	

Source: Environment Monitoring during Jan-Mar, 201

Following are the summary observations on ground water quality:

- pH of the groundwater samples ranged from 7.1 to 7.4 which is within specified acceptable range of IS:10500 (6.5-8.5);
- Total Dissolved Solids ranged from 412 to 5334 mg/l which is within specified permissible standards of IS: 10500 except for the water samples collected from Challapalli and Samanthakur villages. Higher levels of TDS at these groundwater samples was probably due to ingress of saline marine water in ground water at the coastal areas.
- Turbidity in all groundwater samples ranged from 1 to 3 NTU which is within acceptable IS:10500 limit of 5 NTU;
- Total alkalinity ranged from 65 to 815 mg/litre which is within specified permissible limit of IS:10500 except for the water samples collected from Challapalli and Samanthakur villages;
- Fluoride content ranged from 0.2 to 0.7 mg/l which is within acceptable IS:10500 limit of 1.0 mg/l;
- Nitrate content ranged from 2.4 to 11.2 mg/l which is within acceptable IS: 10500 limit of 45 mg/l;
- Chlorides content ranged from 101.6 mg/l to 1857.7 mg/l which is within the permissible IS:10500 limit of 1000 mg/l except for the water samples collected from Challapalli and Samanthakur villages;
- Sulphates content ranged from 3.6 mg/l to 65.5 mg/l;
- Metals: iron ranged from 0.04 mg/l to 0.29 mg/l, manganese ranged from <0.01 to 0.03 mg/l while zinc were ranged from <0.01 mg/l to 0.09 mg/l; other metals like aluminium (<0.01 mg/l), mercury(<0.01 mg/l), total chromium(<0.01 mg/l), cadmium(<0.001 mg/l), copper(<0.01 mg/l), selenium(<0.01 mg/l), lead(<0.01 mg/l) were found to be below detection limits for all the samples and in compliance to the respective acceptable limits of IS:10500 .
- Arsenic contents of the groundwater samples were found to be <0.01 mg/l and in compliance to the acceptable limits of IS:10500.
- Phenolic compounds, cyanides, anionic detergents and mineral oil contents of the groundwater samples were found to be below detection limits for all the samples and in compliance to the respective acceptable limits of IS:10500.
- Coliforms: Total coliform contents of the groundwater samples were found to be <2 MPN/100 ml and E. coli was absent in all the groundwater samples. The results were in compliance to the limits of IS:10500.

In summary, the water samples collected from Challapalli Village and Samanthakur Village showed higher levels of chloride, TDS, total alkalinity, total hardness probably due to the saltwater intrusion at the aquifer. The water samples collected from the Vedanta Ltd (Cairn Oil & Gas) Living Quarters and Uppalaguptam village showed the levels of chloride, TDS, total alkalinity, total hardness in compliance to the permissible limits of IS:10500. All the samples, however, did not reveal presence of any metallic or biological contaminants.

3.10.2 Surface Water Quality

Surface water quality was assessed by collecting and analysing samples from canal and backwater creeks. The results of the samples collected from the selected locations have been discussed below with respect to CPCB's surface water classification and also compared to IS

7967-1976 (reaffirmed 2009) as provided in ***Annex 9 of EIA Volume 2.*** The observed surface water quality of the area is as per details given in **Table 3.11.**

Table 3.11 Surface Water Quality during the Study Period

SN.	Parameter	Unit	SW1	SW2	SW3	SW4
1	pH		7.3	7.5	7.2	8.2
2	Temperature	^{0}C	31	30	32	31
3	Turbidity	NTU	8	12	10	13
4	Electrical Conductivity	µs/cm	670	50300	22100	44700
5	Total Suspended Solids	mg/l	17	21	27	35
6	Total Dissolved Solids@180^{0}C	mg/l	425	38687	15785	32634
7	Total Hardness (as $CaCO_3$)	mg/l	201	3584	2192	3277
8	Total Alkalinity	mg/l	80	120	150	135
9	Salinity	%	0.3	29	13	27
10	Chlorides (as Cl)	mg/l	159.3	16366	7256	15324
11	Sulphates (as SO_4)	mg/l	26.2	2519	614	1987
12	Nitrates (as NO_3)	mg/l	2.6	2.8	4.4	2.3
13	Fluorides (as F)	mg/l	0.4	1.4	0.9	1.8
14	Sodium as Na	mg/l	46.3	9452	3945	8597
15	Potassium as K	mg/l	25.9	348	210	344
16	Total Nitrogen	mg/l	<0.1	<0.1	<0.1	<0.1
17	Total Phosphorus	mg/l	0.04	0.02	0.26	0.07
18	DO	mg/l	5.8	6.2	5.6	6.1
19	BOD	mg/l	<3	<3	<3	<3
20	Phenolic Compounds (as C_6H_6oH)	mg/l	<0.01	<0.01	<0.01	<0.01
21	Oil & Grease	mg/l	<1.0	<1.0	<1.0	<1.0
22	Total Arsenic (as As)	mg/l	<0.01	<0.01	<0.01	<0.01
23	Cadmium (as Cd)	mg/l	<0.001	<0.001	<0.001	<0.001
24	Mercury (as Hg)	mg/l	<0.001	<0.001	<0.001	<0.001
25	Nickel (as Ni)	mg/l	<0.01	<0.01	<0.01	<0.01
26	Manganese (as Mn)	mg/l	0.12	0.34	0.63	0.21
27	Chromium (as Cr^{+6})	mg/l	<0.05	<0.05	<0.05	<0.05
28	Lead (as Pb)	mg/l	<0.01	<0.01	<0.01	<0.01
29	Iron (as Fe)	mg/l	0.47	0.54	0.62	1.06
30	Copper (as Cu)	mg/l	<0.01	<0.01	<0.01	0.01
31	Zinc (as Zn)	mg/l	<0.01	<0.01	<0.01	<0.01
32	Selenium (as Se)	mg/l	<0.01	<0.01	<0.01	<0.01
33	Total Coliforms	MPN / 100ml	49	33	52	240
34	Faecal coliform	MPN / 100ml	<1.8	<1.8	<1.8	<1.8

Source: Environment Monitoring during Jan-Mar, 2018

Following observations can be made from the above table:

- pH of the surface water samples varied between 7.3-8.2;
- Dissolved oxygen (DO) content of the water samples varied between 5.6-6.1 mg/l. Lowest DO was observed for the sample collected from S. Yanam creek and the highest DO was obtained for the sample collected from backwater near S.Yanam Beach;
- Biochemical Oxygen demand (BOD) of all samples were found to be <3.0 mg/l.
- TDS of the surface water samples varied between 425-38687 mg/l. Sample collected from Challapalli canal showed lower TDS value (425 mg/l) compared to the samples collected from the back ater near Cherriyanam (38687 mg/l), S.Yanam Creek (15785 mg/l) and backwater near S.Yanam Beach (32634 mg/l);
- Chloride contents of the coastal water samples varied between 159.3-16366 mg/l;

- Sulphate contents of the coastal water samples varied between 26.2-2519 mg/l.
- Fe content of the surface water samples varied between 0.47-1.06 mg/l.
- Concentration of total arsenic at the surface water samples were found to be <0.01 mg/l.
- Concentration of heavy metals viz. Cu, Cd, Pb, Hg, Ni, Se, Zn and hexavalent chromium were found to be below detection limits.
- Oil and grease content (<1.0 mg/l) and phenolic compounds (<0.01 mg/l) for all surface water samples were found to be below detection limits;
- Concentration of total coliform in the water samples ranged between 33-240 MPN/100 ml. Highest value of 240 MPN/100 ml was recorded for Backwater near S.Yanam Beach sample, while the lowest value was recorded for Challapalli canal. *E. coli* was not detected from (<1.8 MPN/100 ml) for all the samples

Surface water from the canals, creeks and backwater areas is used for washing and catching fish. The surface water quality reveal that the water conforms to CPCB Class "B "(Outdoor Bathing Organized) and Class "D" (propagation of wildlife and fisheries) Water Quality Criteria.

When compared to IS 7967-1976 (reaffirmed 2009) the surface water samples collected were found to be in compliance to the Tolerance limits for Bathing, Recreation, Shell Fish and Commercial Fish Culture, and Salt Manufacture and also tolerance limit of Harbour Water as mentioned in ***Annex 9 of EIA Volume 2.***

3.11 SOIL QUALITY

Six soil samples were collected in 5 to 10 km from the Ravva On-shore Terminal during winter 2018. The soil sampling locations are shown in ***Figure 3.18.***

Table 3.12 Soil Sampling Locations

Code	Location	GPS Co-ordinates	Distance & Direction wrt Ravva Terminal	Present Land use
S1	Chellapalli Village	16°29'20.88"N; 82° 03'13.68"E	4 km to W	Agriculture
S2	Kotapalli Village	16°32'20.10"N; 82° 07'08.70"E	6 km to NE	Agriculture
S3	Samanthakuru Village	16°28'36.30"N; 82° 02'27.06"E	6.3 km to W	Agriculture
S4	S.Yanam Village	16°29'59.10"N; 82° 06'01.62"E	1.8 km to NE	Agriculture
S5	S.Yanam Beach	16°28'42.78"N; 82°06'11.10"E	1.2 km to SE	Beach
S6	Cherriyanam Village	16°30'39.30"N; 82° 09'54.30"E	9.1 km to NE	Scrub Land

Source: Environment Monitoring during Jan-Mar, 2018

Photographs of the soil sampling during the EIA Study are presented in ***Figure 3.19.***

Figure 3.19 Photographs of Soil Sampling

S1 – Challapalli Village

S2-Kottapalli Village

S3- Samanthakur Village

S4 - S.Yanam Village

S5 – S.Yanam Beach

S6 - Cherriyanam Village

The observed soil quality of the area is as per details given in **Table 3.13.**

Table 3.13 Soil Analysis Results

SN	Test Parameters	UOM	S1	S2	S3	S4	S5	S6
1	Particle Size Distribution	mm	0.001	0.002	<0.001	0.8	1.4	1.0
2	Texture	--	Clay	Clay	Clay	Sand loam	Sandy	Sandy loam
3	Sand	%	12	10	13	76	85	74
4	Clay	%	78	81	75	11	10	12
5	Silt	%	10	9	12	13	5	14
6	% Moisture	%	28	31	34	22	18	15
7	Alkalinity	mg/Kg	650	750	450	200	100	250
8	Acidity	mg/Kg	250	350	200	150	150	150
9	Specific gravity	--	3.85	4.10	2.95	2.80	2.65	2.95

SN	Test Parameters	UOM	S1	S2	S3	S4	S5	S6
10	Bulk density	gm/cc	1.2	1.1	1.1	1.0	1.0	1.0
11	Porosity	%	54	52	50	58	51	56
12	Permeability	Cm/h	0.07	0.18	0.10	3.7	5.2	3.6
13	Infiltration Capacity	mm/h	3.6	4.2	3.9	24.3	37.2	27.7
14	pH (1:5 aq. extract)	--	7.5	7.4	6.9	7.5	6.5	6.1
15	Conductivity (1:5 Aq.extract)	µS/cm	495	982	668	2350	321	489
16	Cation exchange capacity	meq/100	17.6	23.8	29.3	12.0	2.9	5.3
17	Sodium Absorption Ratio (SAR)	--	7.04	6.9	13.2	12.2	3.8	8.1
18	Available Nitrogen as N	mg/Kg	136.1	179.1	142.8	39.9	24.6	29.8
19	Available Phosphorus as P_2O_5	mg/Kg	92.7	145.2	139.9	12.6	22.2	18.6
20	Exchangeable Calcium as Ca	mg/Kg	540	499	720	180	140	138
21	Exchangeable Magnesium as Mg	mg/Kg	522	910	595	182	36	48
22	Chloride as Cl	mg/Kg	850	283	2671	3118	708	1417
23	Sulphate as SO_4	mg/Kg	1120	454	1811	662	435	548
24	Carbonate	mg/Kg	Nil	Nil	Nil	Nil	Nil	Nil
25	Boron	mg/Kg	110.6	90.3	26.5	99.3	10.8	25.6
26	Sodium exchangeable	mg/Kg	2139	2530	4426	2182	442	969
27	Arsenic as As	mg/Kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
28	Mercury as Hg	mg/Kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
29	Cadmium as Cd	mg/Kg	0.10	<0.1	<0.1	0.2	0.90	1.60
30	Chromium as Cr^{+6}	mg/Kg	7.48	5.95	5.92	5.00	2.07	4.23
31	Lead as Pb	mg/Kg	6.29	7.60	4.79	8.99	7.09	17.60
32	Copper as Cu	mg/Kg	7.21	7.47	9.95	15.19	7.89	4.34
33	Iron as Fe	%	4.27	4.98	5.84	1.30	0.50	1.31
34	Zinc as Zn	mg/Kg	120.6	128.1	124.7	75.4	53.3	54.8
35	Selenium as Se	mg/Kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Source: Environment Monitoring during Jan-Mar, 2018

Following observations have been made on the results shown in the above Table:

- pH of the soil in the study area ranged from 6.1 to 7.5. As per Handbook of Agriculture published by Indian Council of Agricultural Research, New Delhi, 2015, soil sample collected from S5 and S6 are slightly acidic whereas sample collected from S1, S2 and S4 are slightly alkaline in nature and soil sample collected from S3 are neutral in nature;
- The texture of all the soil samples was observed as 'clay' in S1, S2 and S3 whereas texture was 'sandy loam' in S4 and S6 and 'sandy' in S5. Electrical conductivity was observed to be in the range of 321 µS/cm to 2350 µS/cm;
- Sodium Absorption Ratio (SAR) values ranged from 3.8 to 13.2;
- Cation exchange capacity values ranged from 2.9 meq/100 g to 29.3 meq/100 g;
- Arsenic value in all sample are <0.1 mg/kg while the Lead values in the samples ranged from 4.79-17.60 mg/Kg;
- Cadmium values ranged from <0.1 mg/kg to 1.6 mg/kg while the Chromium values in all samples ranged from 2.07 mg/kg to 7.48 mg/kg;
- Copper values ranged from 4.34 mg/kg to 15.19 mg/kg;
- Zinc values ranged from 53.3mg/kg to 128.1 mg/kg;
- Selenium values in all sample are <0.1and;
- Iron values ranged from 0.50% to 5.84%.

The relevant Soil Remediation Intervention Values (Dutch standards) are presented in ***Table 3.14***.

India does not have any specific concentration based soil contamination standards. In absence of any existing standards for safe heavy metals contents, Dutch standards have been

considered for the purpose of analysis. The observed values for metals namely Zinc, Arsenic, Cadmium, Copper, Lead and Mercury (inorganic) are much below the soil remediation intervention values specified in Soil Remediation Circular 2009.

Table 3.14 Soil Remediation Intervention Values as per Dutch Standards

Parameter	Intervention Values (mg/kg dry matter)
Zinc	720
Arsenic	76
Lead	530
Cadmium	13
Copper	190
Mercury (inorganic)	36

Source: Soil Remediation Circular 2009, Minister of Housing, Spatial Planning and Environment, Netherlands. Note: Concentrations are shown for standard soil (10% organic matter and 25% clay)

3.12 OCEANOGRAPHY DETAILS

Currents in the Bay of Bengal are complex and are principally driven by the meteorological conditions associated with the monsoons. They are also influenced by smaller density driven gyres and local wind conditions.

The tidal range in the Bay is generally low (in the order of 0.5 m) resulting in tidal currents rarely exceeding 1 knot (1.8 km/hour). In the western part of the Bay, currents essentially run parallel to the coast, with a diurnal onshore offshore wind-driven component. The impact of winds on water movement in the Bay is significant. The pattern of monsoon winds is reflected in that residual currents generally set to the northeast during summer months and to the southwest in winter.

Tropical storms, which traverse the area during October and November, may have a significant short-term impact on water movements, generating localised currents in excess of 2 knots (3.6 km/hour).

3.12.1 Bathymetry

The sea floor of the Bay of Bengal shows a broad U shaped basin open at its southern end. The continental shelf adjacent to the Godavari River delta is narrow, with the continental slope starting at 90-m depth contour. Water depths across PKGM-1 Block shelve very gently away from the coast with 10 m depth contour lying approximately 10 km from shore. Beyond this, water depths increase more rapidly with water depth 30m and more. (*Hydrographers Chart, as corrected up to 31 March 2010*)

3.12.2 Tides

The tides along the Andhra Pradesh coast are of mixed semi-diurnal type with unequal tidal amplitudes occurring each day and average maximum tidal range is about one meter. The highest and lowest water levels normally occur at spring tides, which are associated with the full moon and new moon periods. The high tides, which occur during the months of November and December, are found to be unusually high.

The maximum tidal ranges are also high during this period. The tidal ranges during the neap periods are usually low very often less than 50 cm. In general, it is observed that range and duration of the floated tide during the spring are greater. Neap tides, however, did not show any conspicuous variation in tidal ranges. The tides and the tidal currents are oscillatory in nature and are of considerable importance in sediment transport. The sea level is generally low during the monsoon season compared to post and pre-monsoon months. There is also a marked difference in the mean sea level from season to season. The various astronomical tide characteristics with respect to chart datum are as follows:

Table 3.15 Observed Coastal Tidal Constituents (for Kakinada Station)

SN	Harmonic Constants	Amplitude, m	Phase°
1	Principal lunar semidiurnal constituent (M_2)	0.46	248
2	Principal solar semidiurnal constituent (S_2)	0.20	285
3	Luni-solar declinational diurnal constituent (K_1)	0.11	339
4	Lunar declinational diurnal constituent (O_1)	0.04	342
5	Larger Lunar elliptic semidiurnal constituent (N_2)	0.10	239

Source: Vedanta Ltd (Cairn Oil & Gas) ASA Report

Table 3.16 Tidal Levels & Amplitude reported in Bay of Bengal

SN	Tide Levels	Amplitude, m
1	Highest astronomical tide (HAT)	+2.56
2	Mean high water springs (MHWS)	+1.60
3	Mean high water neaps (MHWN)	+1.10
4	Mean low water neap (MLWN)	+0.52
5	Mean low water springs (MLWS)	+0.10
6	Lowest mean astronomical tide (LAT)	-0.05
7	Mean spring range	1.50
8	Mean neap range	0.58

Source: Admiralty Tide Tables, C.McCammon & Wunch JGR, TS Murthy & RF Henry JGR)

3.12.3 Currents

The currents along the coast of Andhra Pradesh consist of tide, wave and wind induced components. The flood currents flow in southerly direction towards the head of Bay. The ebb current flows in northerly direction along the sand pit. Coastal currents change its direction seasonally being northerly from January to July and Southerly from August to December. The flow changes with depth and exhibits very weak vertical shear. As there are open sea currents, their influence is not much unlike tidal currents or the wave induced littoral currents. Current conditions prevailing during an year are given in ***Table 3.17*** and as shown in ***Figure 3.20.***

Table 3.17 Current Conditions

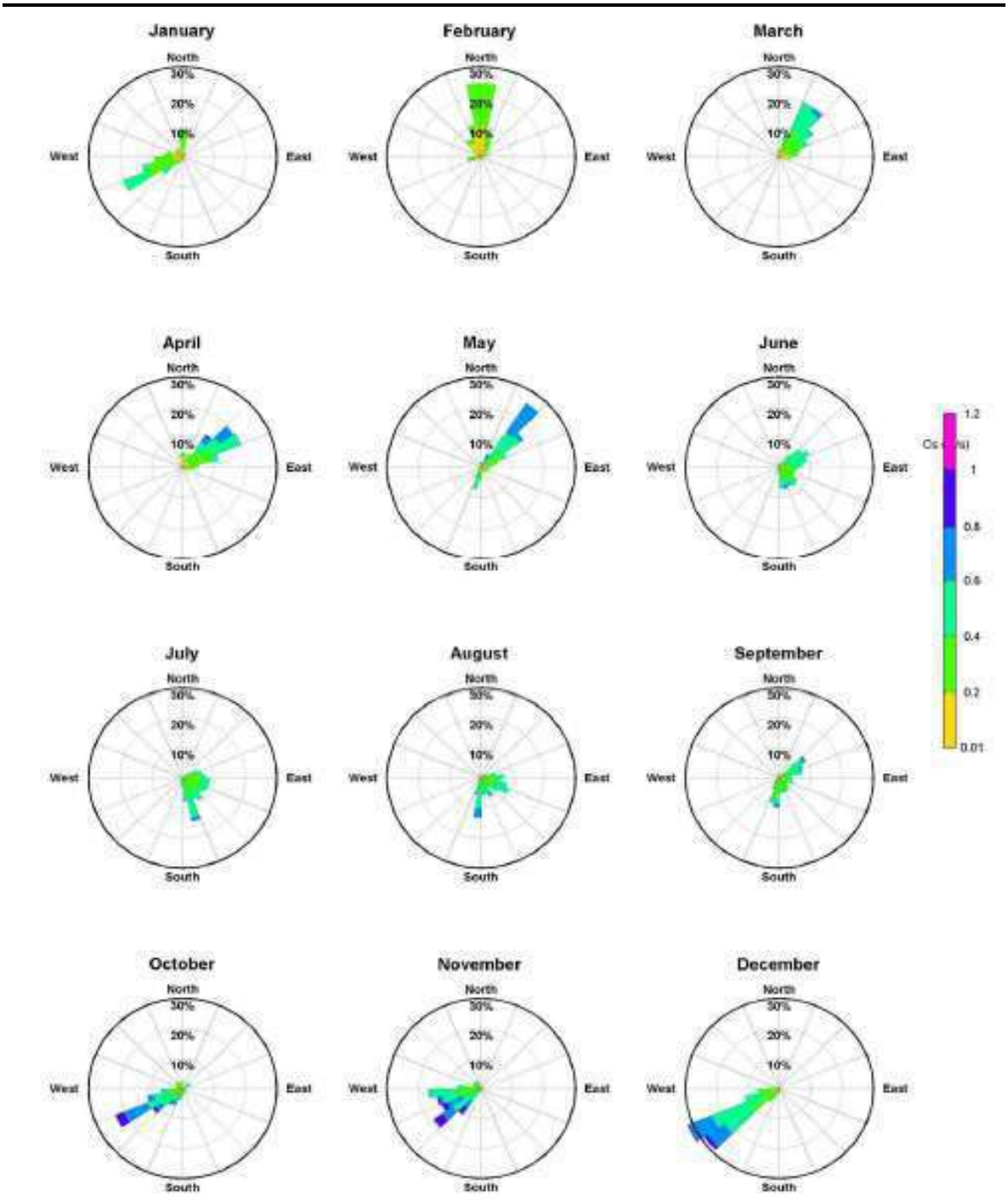
SN	Parameter	May to Sep.	October	Nov - Feb	March – April
1	5th percentile current speed in (m/s)	0.12	0.10	0.08	0.07
2	95th percentile current speed in (m/s)	0.62	0.78	0.71	0.61
3	Main axis current direction (degrees)	180	247.5	247.5	45

Source: Vedanta Ltd (Cairn Oil & Gas), ASA Report

Overall currents are weakest with 0.61 m/sec for 95th percentile in March - April and strongest with 0.78m/sec for 95th percentile in October. The typical current speeds are

approximately 0.3 to 0.4 meters/second during October through March and 0.4 to 0.5 meters/second during April through September in the region.

Figure 3.20 Monthly Current Roses (Currents Flowing Towards) (PKGM-1 Block)



Source: Vedanta Ltd (Cairn Oil & Gas) (from ASA Study)

3.12.4 Waves & Winds

The wave climate and its variations were mainly dependent on the meteorological conditions prevailing in the neighbouring Bay of Bengal. The highest wave activity in the region is coincided with the high seasonal winds of May-November. During the rough weather season waves exceeding heights 2 to 3 m are common. The wave heights are less than 1 m during fair

weather seasons. During the monsoon period more than 50% of the waves are approaching from the Southwest, while during the fair weather seasons 60% of the waves are approaching from the Northwest direction. The waves are usually approaching the coast from SW and NW directions.

Winds during November to February blow from the northeast, at reasonably strong speeds. The wind speed is relatively weak during March and April with directions from the NE and SW. During May to September relatively strong winds blow with a predominant SW direction. During October winds are weak and all directional.

3.13 OFFSHORE ENVIRONMENTAL BASELINE STUDIES

3.13.1 Marine Water Quality

Primary Monitoring Conducted by ERM

ERM engaged Vimta Labs, Hyderabad to conduct marine environmental monitoring in PKGM-1 Block during April 2018 as part of the EIA Study. Fieldwork for collection of marine water and sediment samples, was conducted in the coastal waters of Ravva during 21-22 April, 2018 using a marine vessel *M T Sirius* arranged by Cairn. Eight (8) pre-determined stations were considered for collection of the marine water and sediment samples. Out of these, 7 stations were exclusively selected near the existing offshore platforms while one station was selected near the marine outfall location (extending to ~1km in the sea).

Water samples were collected from the surface, mid depth and bottom of each station using a 5L Van Dorn Water Sampler (PARTEX make) for analyzing major physico-chemical and biological parameters. Plankton net (WP net) was used for collecting plankton samples. A Van Veen grab was operated at all stations for collecting sediments and benthic fauna.

Details on the marine sampling locations is presented in ***Table 3.18*** and also shown in ***Figure 3.21***. Details on the marine water quality sampling and analysis procedures adopted for the study are indicated in ***Table 3.19.***

Table 3.18 Marine Water & Sediment Sampling Locations

SN.	Station No	Latitude (^{0}N)	Longitude (^{0}E)	Nearest Facility	Distance from the Shore (Km)	Water Depth (m)
1	MW1/SD1	16° 28′ 32.21″ N	82° 11′ 51.79″ E	Near Platform RB	4.75	10
2	MW2/SD2	16° 27′ 50.86″ N	82° 11′ 32.35″ E	Near Platform RG	5.75	11
3	MW3/SD3	16° 27′ 54.59″ N	82° 10′ 27.60″ E	Near Platform RF	5.20	10
4	MW4/SD4	16° 26′ 45.18″ N	82° 09′ 39.88″ E	Near Platform RE	5.7	11
5	MW5/SD5	16° 26′ 36.47″ N	82° 07′ 45.42″ E	Near Platform RH	4.5	9.5
6	MW6/SD6	16° 25′ 34.15″ N	82° 08′ 18.38″ E	Near Platform RD	6.8	12
7	MW7/SD7	16° 23′ 54.24″ N	82° 08′ 5.38″ E	Near Platforms RC	9.2	14.5
8	MW8/SD9	16° 28′ 17″ N	82° 06′ 22″ E	Near Marine Outfall	0.75	6

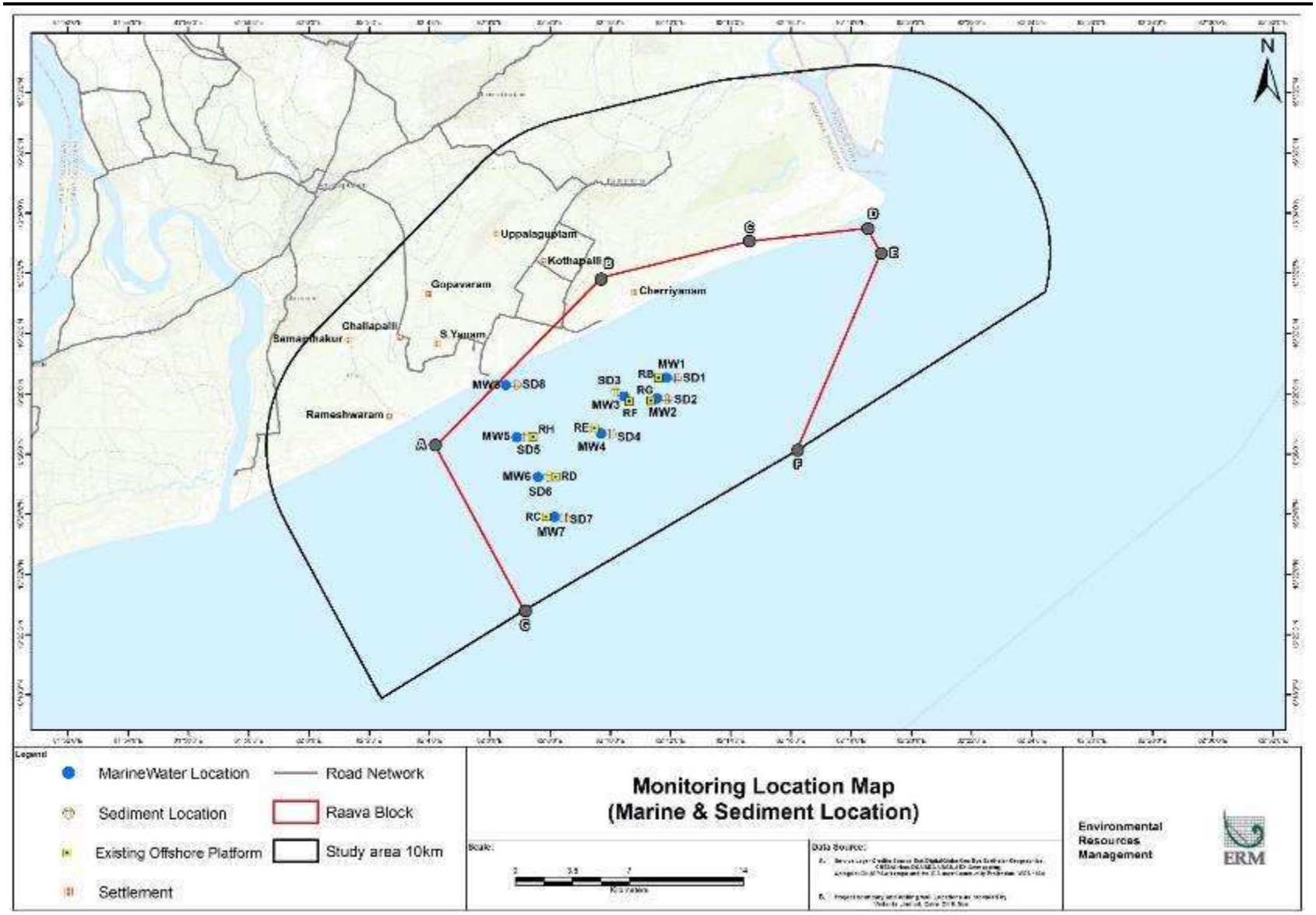
Source: Marine Environmental Monitoring, April 2018

Table 3.19 Marine Water Quality Sampling and Analysis Procedures

SN.	Sample Type	Sample Size	Parameter	Fixation / Preservation Requirements	Storage Container	Reagents Required / Quantity Carried	Max. Holding Time / Storage Time	Methodology / Instrumentation Used	Detection Limit
A.	**Physico-Chemical Parameters**								
1.	Onsite Analysis	100 ml	pH	-	Plastic Bottle	pH Buffers (4.0, 7.0 & 9.2) 100 ml each	Not Applicable	Digisun Electronics pH Electrode and pH Strips (backup)	1.0
2.			Temperature			None		GH Zeal Thermometer	1 ^{0}C
3.			Conductivity			0.01 M KCl Solution		Eutech Instrument	0.1 (µs/cm^2)
4.	Onsite Analysis	300 ml	Dissolved Oxygen	Acidification using 1 ml of MnSO4 and 1 ml of Alkali Azide Solution for DO fixing and then analysis at site (Storage in ice box)	DO Glass Bottle	MgSO4 (100 ml);	300 ml	Dissolved Oxygen	1.0 mg/l
5.	Chemical Analysis	1000 ml	Total Phosphorus	Storage in Ice box	Plastic Bottle	None	7 days	Colorimetric method	0.1 mg/l
6.			Salinity					Argentrometric method	0.5 mg/l
7.			Suspended Solids					Gravimetric method	1.0 mg/l
8.			Silicates					Molybdo silicate method	0.1 mg/l
9.	Dissolved Metals	50 ml	Cadmium	Acidification using 2 drops HNO_3 acid	Plastic (Torsen Tubes)	Concentrated HNO_3 (50 ml)	6 months	ICP Method (Inductive Couple Plasma)	0.003 mg/l
10.			Copper						0.01 mg/l
11.			Chromium						0.01 mg/l
12.			Iron						0.01 mg/l
13.			Manganese						0.01 mg/l
14.			Nickel						0.01 mg/l
15.			Zinc						0.01 mg/l
16.			Lead						0.01 mg/l
17.	Chemical Analysis	1000 ml	Total Nitrogen	4 drops H_2SO_4	Glass Bottle	Concentrated H_2SO_4 (50 ml)	7 days	Digestion and Distillation Method (Kjeldahl Method)	1.0 mg/l
18.			Oil and Grease					N-Hexane Method	1.0 mg/l
B.	**Biological Parameters**								
19.	Plankton Sample	250 ml	Chlorophyll A	2 ml 40% formalin Solution (Storage in ice box)	Plastic Bottle	40% Formalin (200 ml)	7 days	Discrete depth Sampling (Plankton Net)	-
20.			Phytoplankton						-
21.			Zooplankton						-

Source: Marine Environmental Monitoring, April 2018

Figure 3.21 Marine Water and Sediment Sampling Locations



Photographs of the marine water sampling conducted during the EIA Study are presented in ***Figure 3.22.***

Figure 3.22 Photographs of Marine Water Sampling

The observed marine water quality of the area is as per details given in ***Table 3.20.***

Table 3.20 Marine Water Quality during the Study Period

SN.	Parameters	Unit	MW1			MW2			MW3			MW4			MW5			MW6			MW7			MW8		
			Surface	*Middle*	*Bottom*	*Surface*	*Middle*	*Bottom*	*Surface*	*Middle*	*Bottom*	*Surface*	*Middle*	*Bottom*	*Surface*	*Middle*	*Bottom*	*Surface*	*Middle*	*Bottom*	*Surface*	*Middle*	*Bottom*	*Surface*	*Middle*	*Bottom*
1	Temperature	^{0}C	30	--	--	32	--	--	31	--	--	31	--	--	30	--	--	32	--	--	32	--	--	30	--	--
2	Salinity	%	3.20	3.40	3.50	3.30	3.50	3.50	3.60	3.60	3.70	3.50	3.70	3.70	3.70	3.50	3.50	3.50	3.60	3.50	3.80	3.60	3.70	3.70	3.50	3.50
3	Conductivity	µS/cm	50900	50300	52000	51100	51600	49900	52300	52200	52000	50200	51700	51700	51900	53200	51900	51700	52000	51700	51100	51400	52300	52100	52100	52000
4	Suspended Solids	mg/l	12.0	10.0	14.0	10.0	8.0	8.0	11.0	7.0	8.0	10.0	8.0	8.0	12.0	10.0	8.0	10.0	10.0	7.0	12.0	8.0	7.0	9.0	8.0	8.0
5	pH	--	7.7	7.8	7.9	7.9	7.9	7.9	7.9	8.0	8.0	7.9	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.1	8.1	8.1	8.1	8.1
6	Dissolved Oxygen (DO)	mg/l	5.7	5.6	5.4	5.9	5.7	5.5	5.8	5.5	5.4	6.0	5.7	5.6	5.9	5.6	5.4	5.8	5.7	5.6	6.1	5.9	5.7	5.9	5.8	5.6
7	Total Nitrogen	mg/l	0.64	0.48	0.41	0.54	0.51	0.44	0.82	0.78	0.42	0.91	0.67	0.48	0.84	0.71	0.68	0.92	0.88	0.66	0.76	0.61	0.58	0.58	0.50	0.54
8	Total Phosphorus	mg/l	0.07	0.05	0.06	0.06	0.06	0.04	0.07	0.05	0.07	0.08	0.06	0.05	0.07	0.08	0.06	0.08	0.06	0.06	0.07	0.05	0.06	0.05	0.04	0.06
9	Silicates	mg/l	2.6	0.7	0.7	0.5	1.2	0.8	1.3	0.4	0.7	0.3	1.3	0.1	0.7	1.1	0.7	0.6	1.8	1.3	0.7	0.8	0.5	0.4	0.7	0.4
10	Cadmium as Cd	mg/l	<0.01	0.011	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
11	Copper as Cu	mg/l	<0.01	0.013	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
12	Total Chromium as Cr	mg/l	<0.01	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
13	Iron as Fe	mg/l	<0.01	0.079	<0.01	<0.01	0.0270	<0.01	<0.01	0.022	<0.01	<0.01	0.023	0.013	<0.01	0.016	<0.01	0.013	0.01	<0.01	<0.01	<0.01	0.018	<0.01	<0.01	0.017
14	Manganese as Mn	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
15	Nickel as Ni	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16	Zinc as Zn	mg/l	0.022	0.060	0.036	0.036	0.040	0.024	0.026	0.033	0.022	0.022	0.031	0.023	0.007	0.048	0.019	0.023	0.032	0.04	0.025	0.037	0.029	0.027	0.029	0.028
17	Lead as Pb	mg/l	<0.01	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
18	Oil and Grease (from Surface)	mg/l	<1	--	--	<1	--	--	<1	--	--	<1	--	--	<1	--	--	<1	--	--	<1	--	--	<1	--	--

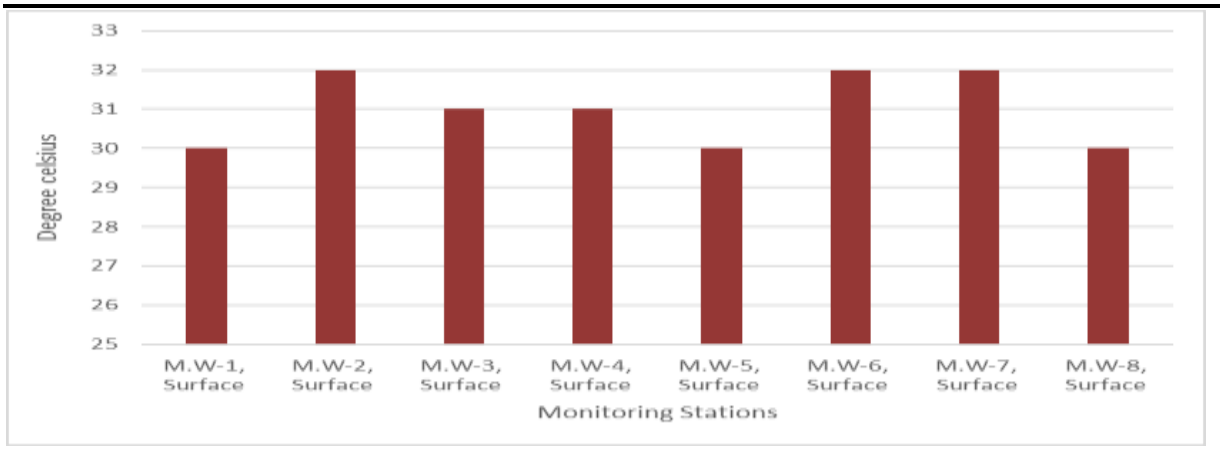
Source: Marine Environmental Monitoring, April 2018

Following are the summary observations on marine water quality:

a) Temperature

Average surface water temperature at the stations were found to be 31.00 ± 0.93°C. Surface water temperature ranged from 30 to 32°C at all the stations. The distribution of surface water temperature in the marine water samples is presented in ***Figure 3.23.***

Figure 3.23 Temperature of the Surface Water Samples

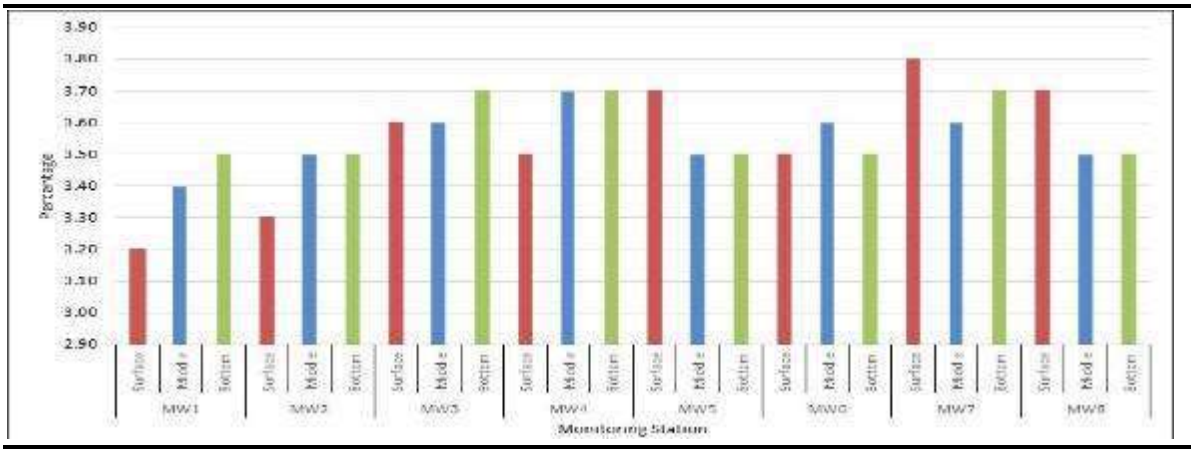


Source: Marine Environmental Monitoring, April 2018

b) Salinity

Average values of salinity in surface water, water at mid depth and bottom water for all the samples were found to be 3.54 ± 0.21%,3.55 ± 0.091% and 3.58 ± 0.10% respectively. Salinity levels of the water samples collected from the bottom were slightly higher compared to the water samples collected at mid depth and surface. Maximum and minimum values of salinity at surface (3.80% and 3.20%), water at mid depth (3.70% and 3.40%) and at bottom (3.70% and 3.50% respectively) show less variance. The distribution of salinity in the marine water samples is presented in ***Figure 3.24***.

Figure 3.24 Distribution of Salinity in the Marine Water Samples

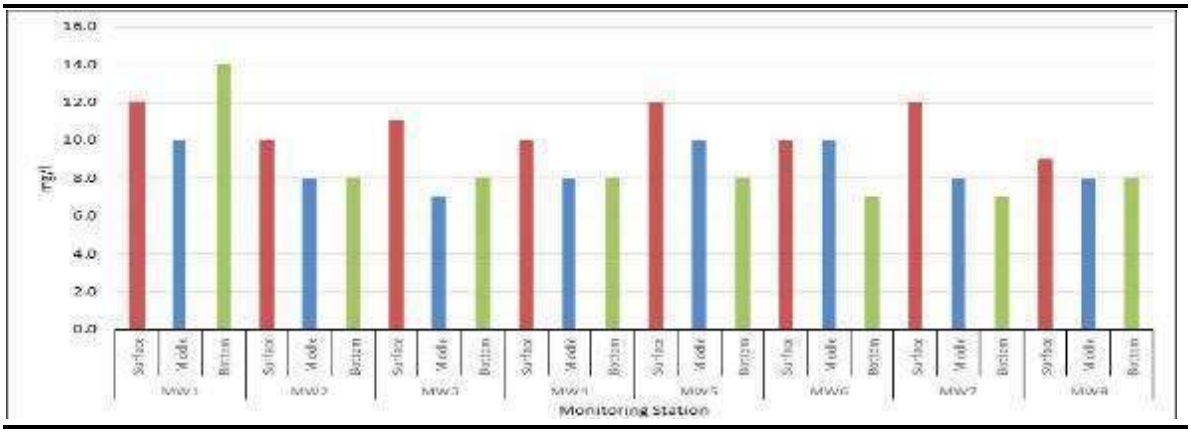


Source: Marine Environmental Monitoring, April 2018

c) Suspended Particulate Matter

Concentration of suspended particulate matter (SPM) at the surface (10.75±1.16 mg/l) was higher compared to the water samples collected from mid depth (8.63±1.19 mg/l) and bottom (8.5.±2.27mg/l). SPM varied from 9 mg/l to 12 mg/l in the surface, 7 mg/l to 10 mg/l at mid depth and 7 mg/l to 14 mg/l at the bottom. The distribution of the SPM in the marine water samples is presented in ***Figure 3.25***.

Figure 3.25 Distribution of Suspended Particulate Matter in the Marine Water Samples

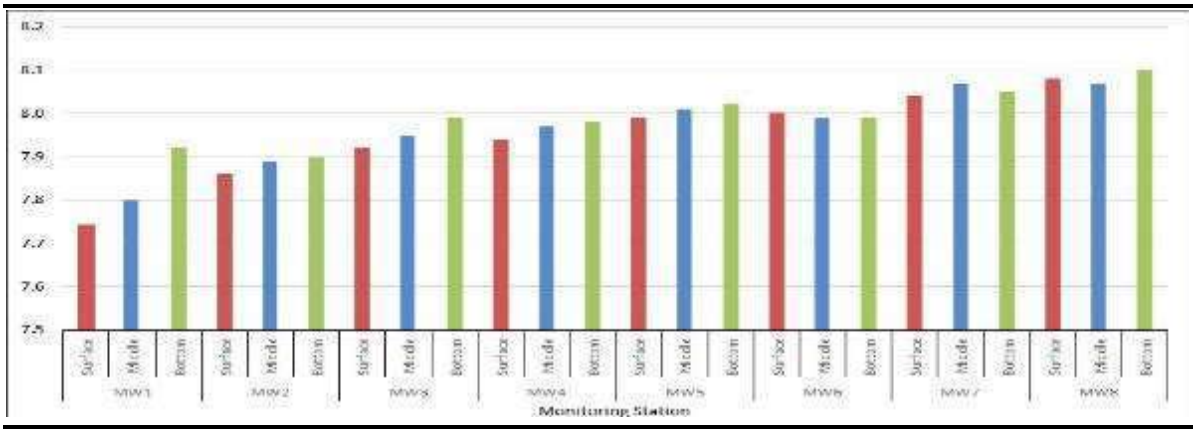


Source: Marine Environmental Monitoring, April 2018

d) pH

In the surface water samples, pH varied from 7.74 to 8.08; at mid depth pH varied between 7.80 to 8.07 and in the bottom, it ranged between 7.90 and 8.10. Much variation of pH was not observed between the surface, mid depth and bottom water samples. The distribution of pH in the marine water samples is presented in ***Figure 3.26***.

Figure 3.26 Distribution of pH in the Marine Water Samples

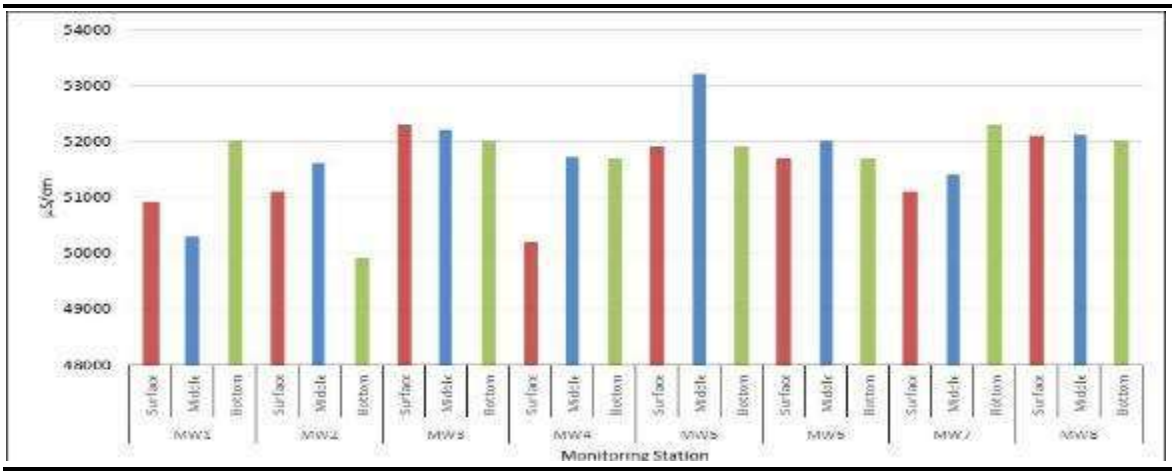


Source: Marine Environmental Monitoring, April 2018

e) Conductivity

Average value of conductivity at the surface water samples (51412.50±707.99 µS/cm) was higher compared to the water samples collected from mid depth (51812.50±820.17 µS/cm) and bottom (51687.50±747.26 µS/cm). Conductivity varied between 50200-52300 µS/cm at the surface, 50300-53200 µS/cm at mid depth and 49900-52300 µS/cm at bottom. The distribution of the conductivity in the marine water samples is presented in ***Figure 3.27***.

Figure 3.27 Distribution of Conductivity in the Marine Water Samples

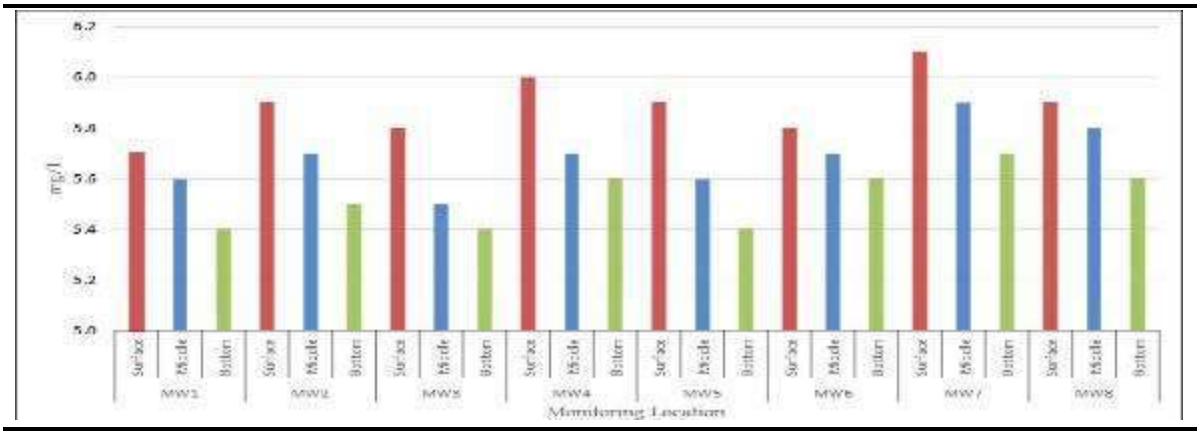


Source: Marine Environmental Monitoring, April 2018

f) Dissolved Oxygen

Compared to bottom waters (average 5.53± 0.12 mg/l), Dissolved Oxygen (DO) concentration at the water samples collected from mid depths (average 5.69± 0.12 mg/l) was higher. Average DO concentration (5.89± 0.12 mg/l) was highest at the samples collected from the surface water. Concentration of DO ranged from 5.70-6.10 mg/l in the surface, 5.50-5.90 mg/l at mid depth and 5.40-5.70 mg/l in the bottom waters. Distribution of dissolved oxygen in the marine water samples is shown in ***Figure 3.28.***

Figure 3.28 Distribution of Dissolved Oxygen in the Marine Water Samples



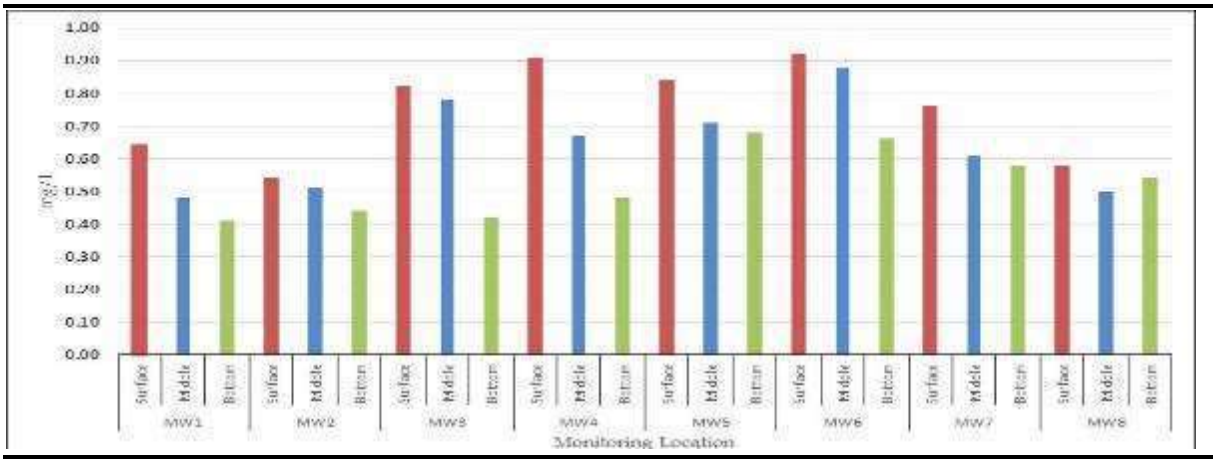
Source: Marine Environmental Monitoring, April 2018

g) Inorganic Nutrients

i. Total Nitrogen

Total nitrogen concentrations were higher at the surface (0.75 ± 0.15 mg/l) compared to the mid depth (0.64 ± 0.14 mg/l) and bottom samples (0.53 ± 0.11 mg/l). Total nitrogen concentration at the surface ranged between 0.54-0.92 mg/l, at mid depth it ranged between 0.48-0.88 mg/l and at the bottom, it ranged between 0.41-0.68 mg/l. Distribution of total nitrogen in the marine water samples is shown in ***Figure 3.29.***

Figure 3.29 Distribution of Total Nitrogen in the Marine Water Samples

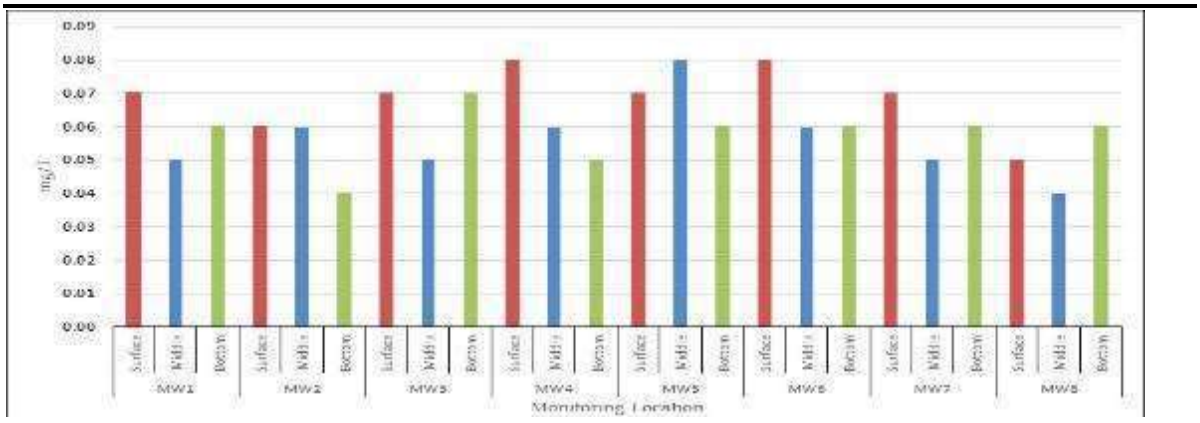


Source: Marine Environmental Monitoring, April 2018

ii. Total Phosphorous

Similar to that of total nitrogen concentrations, total phosphorous concentrations were higher at the surface (0.07 ± 0.01 mg/l) compared to the mid depth (0.06 ± 0.01 mg/l) and bottom samples (0.06 ± 0.01 mg/l). Total phosphorous concentration at the surface ranged between 0.05-0.08 mg/l at mid depth it ranged between 0.04-0.088 mg/l and at the bottom, it ranged between 0.04-0.07 mg/l. Distribution of total phosphorous in the marine water samples is shown in ***Figure 3.30.***

Figure 3.30 Distribution of Total Phosphorous in the Marine Water Samples

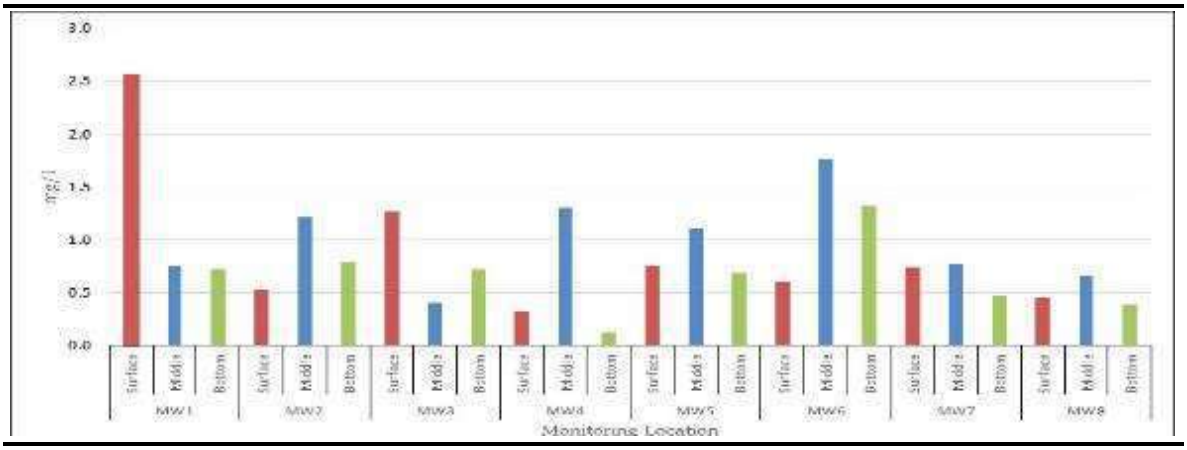


Source: Marine Environmental Monitoring, April 2018

iii. Silicate (SiO4)

Silicate concentrations were higher at the mid depth (1.00 ± 0.43 mg/l) compared to the surface (0.90 ± 0.73 mg/l) and bottom samples (0.65 ± 0.35 mg/l). Silicate concentration at the surface ranged between 0.32-2.56 mg/l, at mid depth it ranged between 0.41-1.77 mg/l and at the bottom, it ranged between 0.13-1.32 mg/l. Distribution of silicate in the marine water samples is shown in ***Figure 3.31.***

Figure 3.31 Distribution of Silicate in the Marine Water Samples



Source: Marine Environmental Monitoring, April 2018

h) Oil & Grease

Oil and grease content in all the surface water samples were found to be <1 mg/l.

i) Metals

Important metals in the water samples (surface, mid depth & bottom) analyzed were Cadmium (Cd), Copper (Cu), Total Chromium, Iron, Manganese (Mn), Nickel, Zinc and Lead.

Cadmium
Apart from the sample collected from mid depth of MW-1 (Cd concentration of 0.011 mg/l) cadmium levels at all the monitoring locations were found to be <0.01 mg/l.

Copper
Apart from the sample collected from mid depth of MW-1 (Cu concentration of 0.013 mg/l) copper levels at all the monitoring locations were found to be <0.01 mg/l.

Total Chromium
Apart from the sample collected from mid depth of MW-1 (total chromium concentration of 0.010 mg/l) total chromium concentrations at all the monitoring locations were found to be <0.01 mg/l.

Lead
Apart from the sample collected from mid depth of MW-1 (lead concentration of 0.010 mg/l) lead concentrations at all the monitoring locations were found to be <0.01 mg/l.

Manganese and Nickel
Manganese and nickel concentrations at all the stations were found to be <0.01 mg/l.

Iron
Iron contents of the most of stations at different depths were found to be below 0.01 mg/l. Few samples revealed iron concentrations ranging between 0.016-0.079 mg/l. Highest concentration of iron was recorded at mid depth of MW-1.

Zinc

Average zinc concentrations in the surface water, water at mid depth and bottom samples varied between 0.024 ± 0.008 mg/l, 0.039 ± 0.011 mg/l and 0.028 ± 0.007 mg/l respectively. Zinc concentrations in surface water ranged between 0.007-0.036 mg/l; in water samples collected from mid depth it varied between 0.029-0.060 mg/l and in the bottom water samples it varied between 0.019-0.040 mg/l.

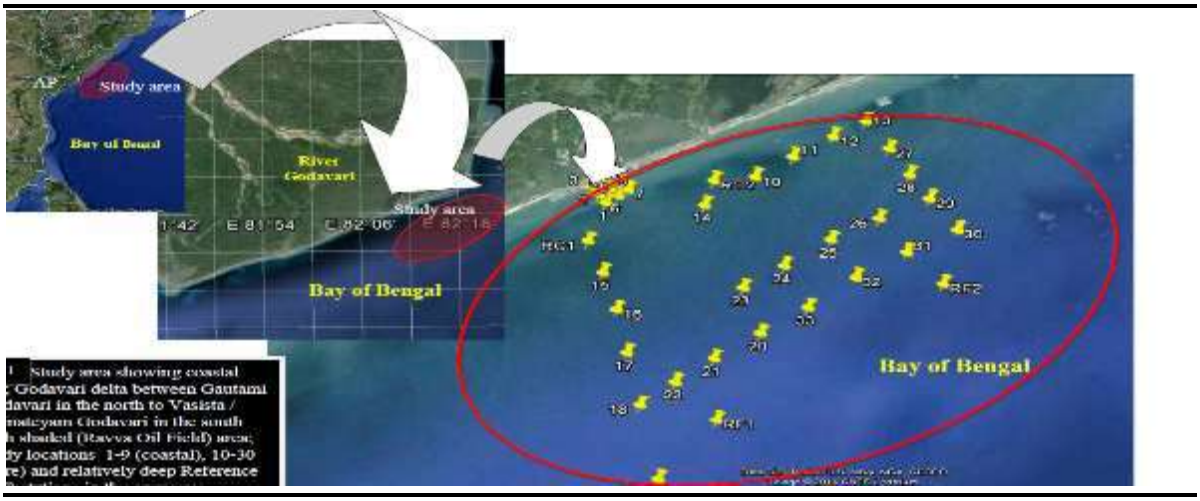
Inference

In general, the marine water samples collected from surface, mid depth and bottom of the samples did not reveal much variation in terms of concentrations of physicochemical parameters. The water samples collected from different locations did not reveal presence of high concentration of metals and most of the samples reveal metal and oil and grease contents below detectable limits. The water sample collected from mid depth of MW-1 reveal presence of metals Cadmium, Copper, Lead and Total Chromium, however, the levels detected were very low.

Study Conducted by Andhra University, 2017

Andhra University undertook marine water and sediment quality survey in the Ravva Block for Vedanta Ltd (Cairn Oil & Gas) during 8-12 November 2017 representing the post-monsoon conditions when seawater salinity is expected to be low in general. The investigation was held at 37 stations which represented a wide spectrum of habitats such as shore- ward (locations 1-9), the core area (10-33) and four Reference points (RC1, RC2, RF1 and RF2) of which the last two are in deep water (depth 26-43m), maintaining a gradation of depths (5.2m and 43m) overall. The investigation involved monitoring biological attributes (phytoplankton, zooplankton, macrobenthos, and fisheries) along with conventional water quality characteristics at locations closer coast (0.5 km from the shore) and up to ~17km in the sea. The observations were made for 5 days (8-12 November 2017) during daylight hrs when the sea state was comparatively stable; wind direction predominantly northeast and the prevailing current southerly. The study area with sampling locations is shown in ***Figure 3.32***. The co-ordinates of sampling locations are provided in ***Table 3.21.***

Figure 3.32 Monitoring Locations around Offshore Installations in PKGM-1 Block



Source: Marine Study by Department of Zoology, Andhra University, 2017 for Vedanta Ltd (Cairn Oil & Gas)

Table 3.21 Co-ordinates of Seawater/Sediment/Biological Sample Collection Stations

S.N.	Station No	Latitude (^{0}N)	Longitude (^{0}E)	Depth (m)
1.	1	16^{0}27'38.4"	82^{0}06'13.1"	8.10
2.	2	16^{0}27'52.5"	82^{0}06'06.0"	7.40
3.	3	16^{0}28'06.6"	82^{0}06'01.8"	6.10
4.	4	16^{0}28'17.6"	82^{0}06'13.5"	5.30
5.	5	16^{0}28'02.0"	82^{0}06'24.2"	6.50
6.	6	16^{0}27'50.2"	82^{0}06'35.1"	7.40
7.	7	16^{0}28'01.9"	82^{0}06'49.2"	7.00
8.	8	16^{0}28'12.8"	82^{0}06'37.5"	6.50
9.	9	16^{0}28'22.7"	82^{0}06'25.4"	5.20
10.	10	16^{0}28'23.4"	82^{0}09'39.6"	8.80
11.	11	16^{0}28'57.4"	82^{0}10'30.1"	8.70
12.	12	16^{0}29'32.9"	82^{0}11'22.6"	8.20
13.	13	16^{0}29'59.1"	82^{0}12'07.1"	7.80
14.	14	16^{0}27'36.0"	82^{0}08'27.6"	9.50
15.	15	16^{0}25'39.6"	82^{0}06'15.5"	10.10
16.	16	16^{0}24'35.2"	82^{0}06'32.9"	11.30
17.	17	16^{0}23'19.2"	82^{0}06'45.6"	12.30
18.	18	16^{0}21'51.7"	82^{0}07'04.2"	18.70
19.	19	16^{0}19'43.8"	82^{0}07'29.0"	34.50
20.	20	16^{0}23'54.4"	82^{0}09'43.0"	16.30
21.	21	16^{0}23'09.1"	82^{0}08'46.7"	16.00
22.	22	16^{0}22'30.0"	82^{0}07'51.0"	16.50
23.	23	16^{0}25'10.1"	82^{0}09'26.1"	12.10
24.	24	16^{0}25'49.4"	82^{0}10'18.0"	11.90
25.	25	16^{0}26'33.8"	82^{0}11'21.3"	12.30
26.	26	16^{0}27'10.1"	82^{0}12'26.2"	12.30
27.	27	16^{0}29'09.8"	82^{0}12'40.0"	9.20
28.	28	16^{0}28'27.5"	82^{0}13'05.4"	10.20
29.	29	16^{0}27'46.0"	82^{0}13'31.7"	12.60
30.	30	16^{0}26'51.9"	82^{0}14'09.7"	17.30
31.	31	16^{0}26'12.5"	82^{0}13'02.6"	16.60
32.	32	16^{0}25'26.9"	82^{0}11'56.3"	16.10
33.	33	16^{0}24'38.3"	82^{0}10'51.3"	16.20
34.	RC1	16^{0}26'32.4"	82^{0}05'54.4"	9.30
35.	RC2	16^{0}28'19.4"	82^{0}08'42.7"	8.80
36.	RF1	16^{0}21'23.0"	82^{0}08'46.3"	26.60
37.	RF2	16^{0}25'16.3"	82^{0}13'47.2"	43.00

Source: Marine Study by Andhra University, 2017 for Vedanta Ltd (Cairn Oil & Gas)

Marine Water Quality

a) Temperature

Water column temperature did not show much variation. Surface temperature seemed to be slightly warmer (av. 27.87 ± 0.48°C), compared to water at mid depth (av. 27.83 ± 0.49°C) and at bottom (av. 27.72 ± 0.51°C). Water temperature ranged from 26.99 to 28.64°C at the surface, 27.00 to 29.20°C at mid depth and 26.13 to 28.58°C in the bottom.

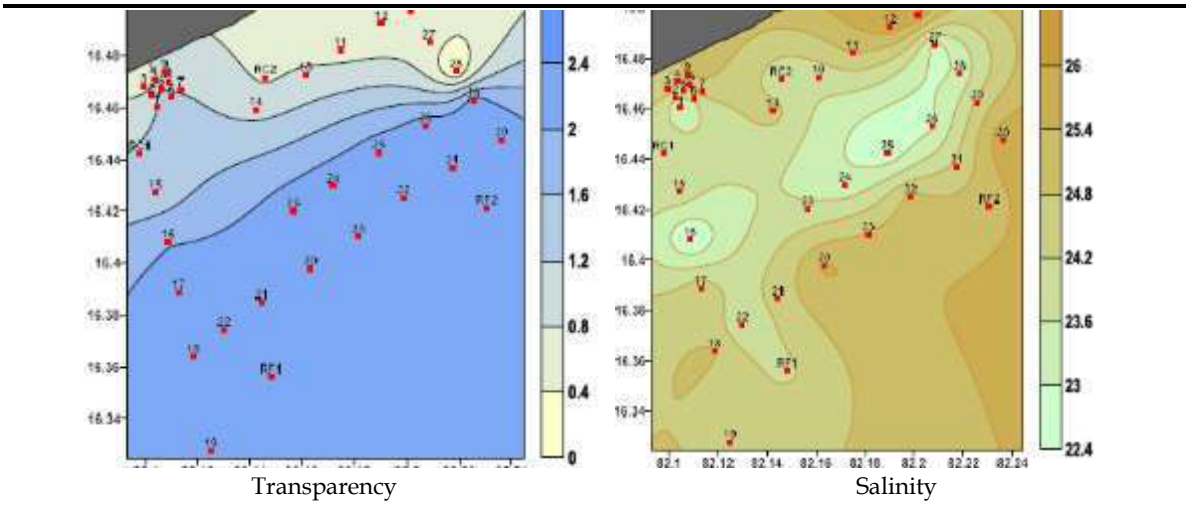
b) Transparency

The Sechhi disk transparency values were found to be (1.54 ± 0.72m). Transparency ranged from 0.2-23 m. Transparency values were comparatively lower near shore and higher distant offshore. The distribution of transparency in the area is shown in ***Figure 3.33.***

c) Salinity

Slightly higher salinity values were recorded from the bottom (av. 24.41 ± 0.93) compared to the surface (av. 24.18 ± 0.91). Salinity ranged 22.29-25.87 at the surface and 22.54-26.51 at the bottom. Lower salinity values were recorded from the stations 16, 25, 26, 28 etc. The distribution of salinity in the area is shown in ***Figure 3.33***.

Figure 3.33 Distribution of Transparency & Salinity at Selected Stations



Source: Marine Study by Andhra University, 2017 for Vedanta Ltd (Cairn Oil & Gas)

d) pH

The pH of the coastal waters did not show much variation b/etween the surface middle and bottom). Even though, a slight increase in pH was apparent in the bottom (av. 8.45) than in the middle and surface (av. 8.44 and 8.44 respectively). In the surface waters, pH varied from 8.41-8.51, at mid depth pH varied between 8.41-8.52 and in the bottom it ranged between 8.42 and 8.52. Distribution of pH in the area is shown in ***Figure 3.34.***

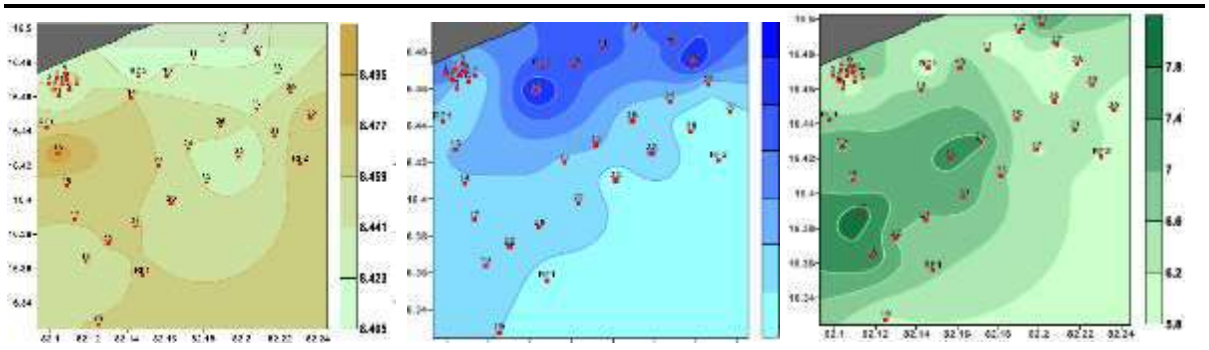
e) Suspended Particulate Matter

Average concentration of suspended particulate matter (SPM) at the surface was recorded as 14.92 ± 4.81 mg/l. SPM ranged between 8.8-27 mg/l. Higher SPM concentrations were recorded at the stations 10, 11, 13, 14, 2728, RC-2, etc. Distribution of SPM in the area is shown in ***Figure 3.34***.

f) Dissolved Oxygen

Compared to bottom waters (av. 6.53± 0.68 mg/l), slightly higher concentration of DO (av. 6.63± 0.58 mg/l) was observed in the near surface waters. Concentration of DO ranged from 5.88 to 8.01 mg/l in the surface and 6.61 to 8.01 mg/l in the bottom waters. A gradual decrease in DO was discernible towards the offshore region except for the monitoring stations 17, 23 and 24. Distribution of dissolved oxygen in the area is shown in ***Figure 3.34.***

Figure 3.34 Distribution of pH, SS & DO at Selected Stations



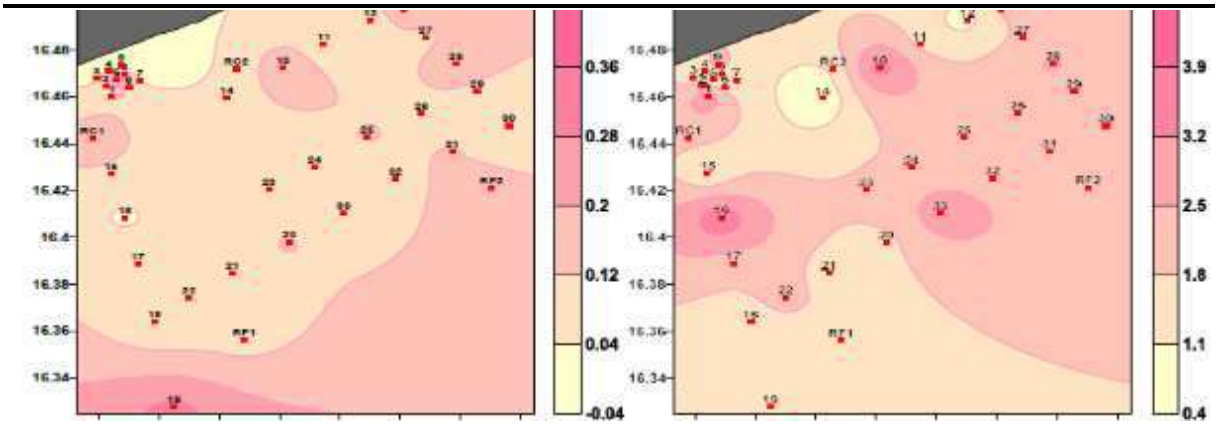
Source: Marine Study by Andhra University, 2017 for Vedanta Ltd (Cairn (Oil & Gas)

g) ***Inorganic Nutrients***

i. Nitrate (NO_3^-) and Nitrite (NO_2^-)

Nitrate concentrations were higher at the bottom (3.62 ± 2.99 µM) compared to the surface (1.87 ± 0.72 µM). Nitrate concentration at the surface ranged between 0.47-3.95 µM and at the bottom, it ranged between 0.13-13.99 µM. Higher nitrate concentrations were recorded at the stations 10, 16 and 33. No particular trend was observed in the distribution of nitrite in the surface and bottom waters. Nitrite concentrations were slightly higher at the bottom (0.13 ± 0.12 µM) compared to the surface (0.1 ± 0.07 µM). Nitrite concentration at the surface ranged between 0.0-0.37 µM and at the bottom, it ranged between 0.0-0.71 µM. Highest nitrite concentrations were recorded at the station 19. Distribution of nitrate and nitrite in the area is shown in ***Figure 3.35.***

Figure 3.35 Distribution of Nitrate at the Selected Stations

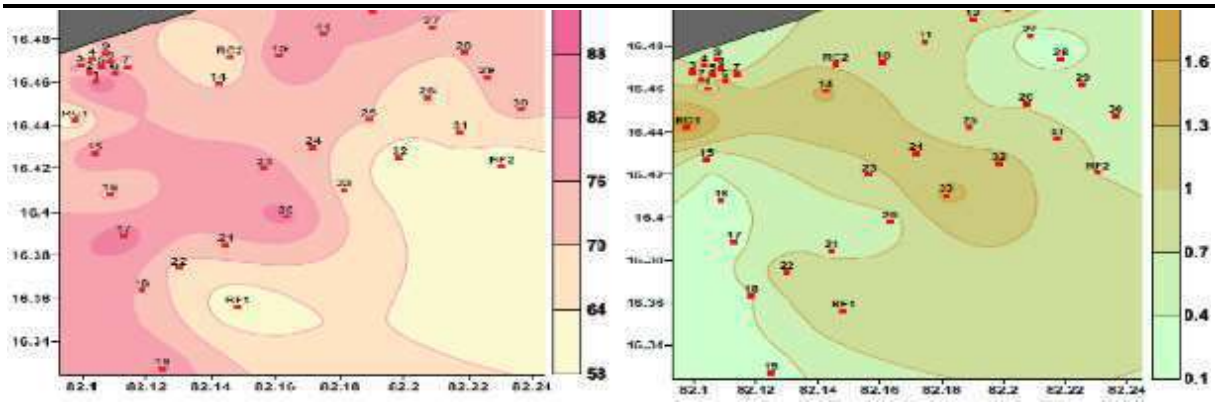


Source: Marine Study by Andhra University, 2017 for Vedanta Ltd (Cairn Oil & Gas)

ii. Total Nitrogen and Ammonia

Total nitrogen and ammonia contents were higher at the surface water (72.66 ± 7.77 µM and (0.78 ± 0.34 µM respectively) compared to the bottom (66.44 ± 10.6 µM and 0.51 ± 0.16 µM respectively). Total nitrogen content ranged between 59.1-88.19 µM at the surface and 44.09-92.28 µM at the bottom. Ammonia concentration ranged between 0.25-1.81 µM at the surface and 0.25-0.94 µM at the bottom. Distribution of Total nitrogen and ammonia in the area is shown in ***Figure 3.35***.

Figure 3.36 Distribution of Total Nitrogen & Ammonia at Selected Stations



Total Nitrogen Ammonia Nitrate

Source: Marine Study by Andhra University, 2017 for Vedanta Ltd (Cairn Oil & Gas)

iii. Phosphate (PO4-) and Total Phosphorous

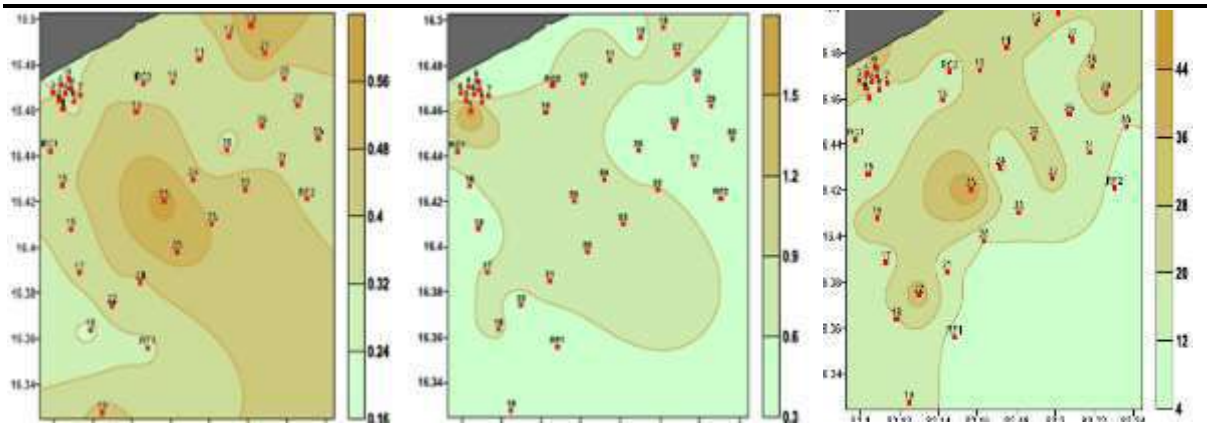
Average Dissolved inorganic phosphate (PO4-) values were higher at the bottom (0.78 ± 0.28 µM) compared to the surface (0.37 ± 0.10 µM). Dissolved inorganic phosphate concentration at the surface ranged between 0.6-0.17 µM and at the bottom, it ranged between 0.3-1.33 µM. Higher phosphate concentrations were recorded at the stations 13, 19, 20, 23 and 27.

Similar to that of Dissolved inorganic phosphate, the total phosphorous (TP) values were also values were higher at the bottom (1.04 ± 0.27 µM) compared to the surface (0.64 ± 0.22 µM). TP concentration at the surface ranged between 0.31-1.71 µM and at the bottom, it ranged between 0.57-1.58 µM. Highest TP concentration was recorded at station 1. Distribution of dissolved inorganic phosphate and TP in the area is shown in ***Figure 3.37.***

iv. Silicate (SiO_4)

Silicate contents were higher at the surface water (19.24 ± 7.46 µM) compared to the bottom (9.06 ± 5.08 µM). Silicate content ranged between 8.71-44.6 µM at the surface and 3.43-33.51 µM at the bottom. Higher silicate concentrations were recorded at the Stations 22 and 23. Distribution of silicate in the area is shown in ***Figure 3.37.***

Figure 3.37 Distribution of Phosphate, Total Phosphorous & Silicates at Selected Stations



Phosphates Total Phosphorous Silicates

Source: Marine Study by Andhra University, 2017 for Vedanta Ltd (Cairn Oil & Gas)

Summary of physicochemical parameters of marine water is presented in ***Table 3.22***.

Table 3.22 Summary of Physiochemical Properties of Marine Water

Parameter	Unit	Surface Mean	Surface SD	Surface Max.	Surface Min.	Middle Mean	Middle SD	Middle Max.	Middle Min.	Bottom Mean	Bottom SD	Bottom Max.	Bottom Min.
Depth	m	13.16	8.06	42.3	5	-	-	0	0	-	-	0	0
Transparency	m	1.54	0.72	2.23	0	-	-	0	0	-	-	0	0
Water Temperature	°C	27.87	0.48	28.64	26.99	27.83	0.49	29.21	27	27.72	0.51	28.58	26.13
Turbidity	NTU	22.04	22.34	68.6	0	21.31	20.41	65	0	21.94	21.68	63.1	0
SPM	mg/l	14.92	4.81	27	8.8	-	-	0	0	-	-	0	0
pH		8.44	-	8.51	8.41	8.44	-	8.52	8.41	8.45	-	8.52	8.42
Conductivity	ms/cm	37.64	0.70	39.5	36.3	37.71	0.68	39.6	36.5	38.10	1.14	41.9	36.8
Salinity		24.18	0.91	25.87	22.29	-	-	0	0	24.41	0.93	26.51	22.54
Dissolved Oxygen	mg/l	6.63	0.58	8.01	5.88	-	-	0	0	6.53	0.66	8.01	5.61
Nitrite	µM	0.10	0.07	0.37	0	-	-	0	0	0.13	0.12	0.71	0
Nitrate	µM	1.87	0.72	3.95	0.47	-	-	0	0	3.62	2.99	13.99	0.13
Ammonia	µM	0.78	0.34	1.81	0.25	-	-	0	0	0.51	0.16	0.94	0.25
Dissolved Inorganic Nitrogen	µM	2.76	0.78	4.58	1.53	-	-	0	0	4.25	2.98	14.45	0.69
PO_4	µM	0.37	0.10	0.6	0.17	-	-	0	0	0.78	0.28	1.33	0.3
SiO_4	µM	19.24	7.46	44.6	8.71	-	-	0	0	9.06	5.08	33.51	3.43
Total Nitrogen	µM	72.66	7.77	88.19	59.1	-	-	0	0	66.44	10.60	92.28	44.09
Total Phosphorous	µM	0.64	0.22	1.71	0.31	-	-	0	0	1.04	0.27	1.58	0.57
Dissolved Organic Nitrogen	µM	69.90	7.96	84.23	55.92	-	-	0	0	62.19	9.60	87.44	42.75
Dissolved Organic Phosphorous	µM	0.28	0.23	1.37	0.01	-	-	0	0	0.26	0.16	0.72	0.02

Source: Environmental Monitoring around Offshore Installations (Ravva Field), Andhra University, 2017 for Vedanta Ltd (Cairn Oil & Gas); Note: SD: Standard Deviation; Max. : Maximum and Min.: Minimum

3.13.2 Sediment Quality

Primary Monitoring Conducted by ERM

Geochemical and texture analysis were carried out for understanding the characteristics of sediments. Metals such as Cadmium (Cd), Copper (Cu), Chromium (Cr), Iron (Fe), Manganese (Mn), Nickel (Ni), Zinc (Zn), Lead (Pb) were estimated from all the stations. Grain size analyses were accomplished to determine the contribution of various sediment components such as sand, silt and clay. In addition samples of benthos from the sediments were also collected.

As stated earlier ERM engaged Vimta Labs, Hyderabad to conduct marine environmental monitoring in PKGM-1 Block during April 2018 as part of the EIA Study. Eight (8) pre-determined stations were considered for collection of the marine sediment samples. Details on the sediment sampling locations is presented in ***Table 3.18*** and also shown in ***Figure 3.21***. Details on the marine sediment quality sampling and analysis procedures adopted for the study are indicated in ***Table 3.23.***

Table 3.23 Marine Sediment Quality Sampling and Analysis Procedures

SN.	Sample Type	Sample Size	Parameter	Preservation Requirement	Storage Container	Reagents Required	Max. Time of Holding	Methodology / Instrumentation Used	Detection Limit
A.	**Physico-Chemical Parameters**								
1.	Sediment Sample	2 Kg	Texture	Not Applicable	Ziploc Bag (5 kg) double wrapped	Not Applicable	7 days	Sampling performed with help of Van Veen Grab Sampler (Sediment Sampler). The collected sample was stored in Ice Box and sent to Laboratory for Analysis	-
2.			Organic Matter						0.01%
3.			TPH						0.001%
4.			Cadmium						0.003 mg/kg
5.			Copper						0.1mg/kg
6.			Chromium						0.1mg/kg
7.			Iron						0.1mg/kg
8.			Manganese						0.1mg/kg
9.			Nickel						0.1mg/kg
10.			Zinc						0.1mg/kg
11.			Lead						0.1mg/kg
B.	**Biological Parameters**								
12.	Sediment Sample	2 Kg	Benthos	4 ml 40% formalin Solution (Storage in ice box)	Glass Bottle	40% Formalin (200 ml)	7 days	Sampling performed with help of Van Veen Grab Sampler The collected sample was stored in Ice Box and sent to Lab for Analysis	-

Source: Marine Environmental Monitoring, April 2018

Photographs of the marine sediment sampling conducted during the EIA Study are presented in ***Figure 3.38.*** The observed marine sediment quality of the area is as per details given in ***Table 3.42.***

Figure 3.38 Photographs of Marine Sediment Sampling

Source: Marine Environmental Monitoring, April 2018

Table 3.24 Marine Sediment Quality

SN.	Parameters	Unit	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SD8
1.	Texture									
1a.	*Sand*	%	43	42	41	40	38	36	37	35
1b.	*Silt*	%	49	48	51	53	53	49	49	52
1c.	*Clay*	%	8	10	8	7	9	15	14	13
2.	Organic Matter	%	0.84	0.58	1.24	1.16	0.59	1.12	0.50	0.47
3.	TPH	mg/kg	0.41	0.38	0.29	0.41	0.50	0.36	0.43	0.53
4.	Cadmium as Cd	mg/kg	0.19	0.33	0.27	0.41	0.27	0.23	0.45	0.37
5.	Copper as Cu	mg/kg	61.48	73.45	83.21	69.82	79.24	97.32	85.21	68.24
6.	Chromium as Cr	mg/kg	48.23	63.21	54.78	85.24	59.21	74.23	81.24	69.21
7.	Iron as Fe	mg/kg	2.97	3.19	2.83	3.41	3.02	3.29	2.79	3.48
8.	Manganese as Mn	mg/kg	509.8	442.6	832.4	627.4	778.2	805.3	671.4	784.4
9.	Nickel as Ni	mg/kg	59.28	49.23	83.42	71.42	69.45	93.48	74.23	86.24
10.	Zinc as Zn	mg/kg	63.24	57.84	89.32	73.46	81.45	48.12	67.23	75.24
11.	Lead as Pb	mg/kg	5.78	9.43	8.35	6.93	8.02	7.49	8.82	7.08

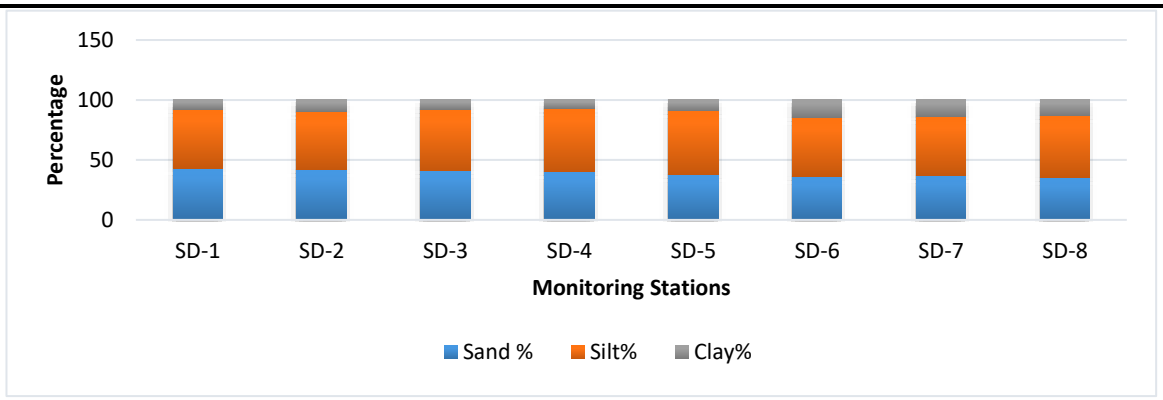
Source: Marine Environmental Monitoring, April 2018

Following are the summary observations on marine sediment quality:

Sediment Texture

The sediment was mainly comprised of sand, silt and clay and their ratio did not varied considerably at the monitoring stations. Along the Ravva block, the silt was the dominant fraction (av. 50.5% varying from 48% to 53%), followed by sand (av. 39.0% varying from 35% to 43%) and clay (av. 10.5% varying from 8% to 15%). Distribution of sand, silt and clay at the monitored locations is presented in ***Figure 3.39.***

Figure 3.39 Sediment Texture at the Monitored Stations

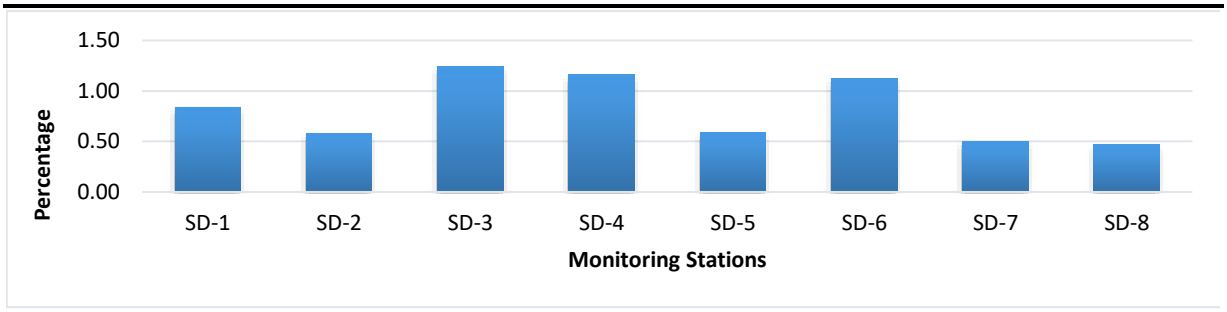


Source: Marine Environmental Monitoring, April 2018

Organic Matter

Average organic matter concentrations at the sediments were found to be 0.81± 0.32%. Organic matter concentration at the stations varied between 0.47% to 1.24%. Highest organic matter concentration was recorded for the station MW-1 and the lowest was recorded from MW-8. Distribution of organic matter at the monitored locations is presented in ***Figure 3.40.***

Figure 3.40 Organic Matter Concentration at the Monitored Stations

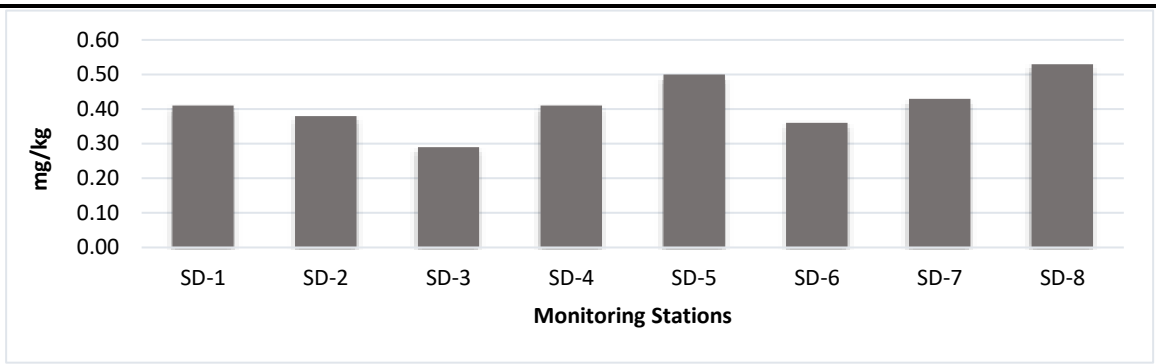


Source: Marine Environmental Monitoring, April 2018

Total Petroleum Hydrocarbons (TPH)

Average TPH concentrations at the sediments were found to be 0.41± 0.08 mg/kg. TPH concentrations at the stations varied between 0.29 mg/kg to 0.53 mg/kg. Highest TPH was recorded for the station MW-8 and the lowest was recorded from MW-3. Distribution of TPH at the monitored locations is presented in ***Figure 3.41.***

Figure 3.41 TPH Concentration at the Monitored Stations



Source: Marine Environmental Monitoring, April 2018

Metals

Cadmium

Average cadmium concentrations at the sediments were found to be 0.32± 0.09 mg/kg. Cadmium concentrations at the stations varied between 0.23 mg/kg to 0.41mg/kg. Cadmium concentration at the sediment were found to be in compliance to the Dutch Intervention value of 13 mg/kg.

Copper

Average copper concentrations at the sediments were found to be 77.25± 11.39 mg/kg. Copper concentrations at the stations varied between 61.48 mg/kg to 97.32 mg/kg. Copper concentration at the sediment were found to be in compliance to the Dutch Intervention value of 190 mg/kg.

Chromium

Average chromium concentrations at the sediments were found to be 66.92± 12.92 mg/kg. Chromium concentrations at the stations varied between 48.23 mg/kg to 85.24 mg/kg.

Lead

Average lead concentrations at the sediments were found to be 7.74± 1.16 mg/kg. Lead concentrations at the stations varied between 5.78 mg/kg to 9.43 mg/kg. Lead concentration at the sediment were found to be in compliance to the Dutch Intervention value of 530 mg/kg.

Zinc

Average zinc concentrations at the sediments were found to be 69.49± 13.21 mg/kg. Zinc concentrations at the stations varied between 48.12 mg/kg to 89.32 mg/kg. Zinc concentration at the sediment were found to be in compliance to the Dutch Intervention value of 720 mg/kg.

Nickel

Average nickel concentrations at the sediments were found to be 73.34± 14.50 mg/kg. Nickel concentrations at the stations varied between 49.23 mg/kg to 93.48 mg/kg. Nickel concentration at the sediment were found to be in compliance to the Dutch Intervention value of 100 mg/kg.

Iron

Average iron concentrations at the sediments were found to be 3.12± 0.26 mg/kg. Iron concentrations at the stations varied between 2.79 mg/kg to 3.48 mg/kg.

Manganese

Average manganese concentrations at the sediments were found to be 681.44± 145.22 mg/kg. Manganese concentrations at the stations varied between 442.60 mg/kg to 832.40 mg/kg.

Conclusion

The sediment samples collected from different locations did not reveal presence of high concentration of metals and all the samples reveal metal contents in compliance to the Dutch Intervention Values. Concentration of TPH was also found to be low at the monitored stations. Thus, the sediment samples did not reveal presence of any metallic or oil pollution in the area.

Study Conducted by Andhra University, 2017

Andhra University conducted analyses of sediment texture and organic matter at all the 37 locations as mentioned in ***Table 3.9.***

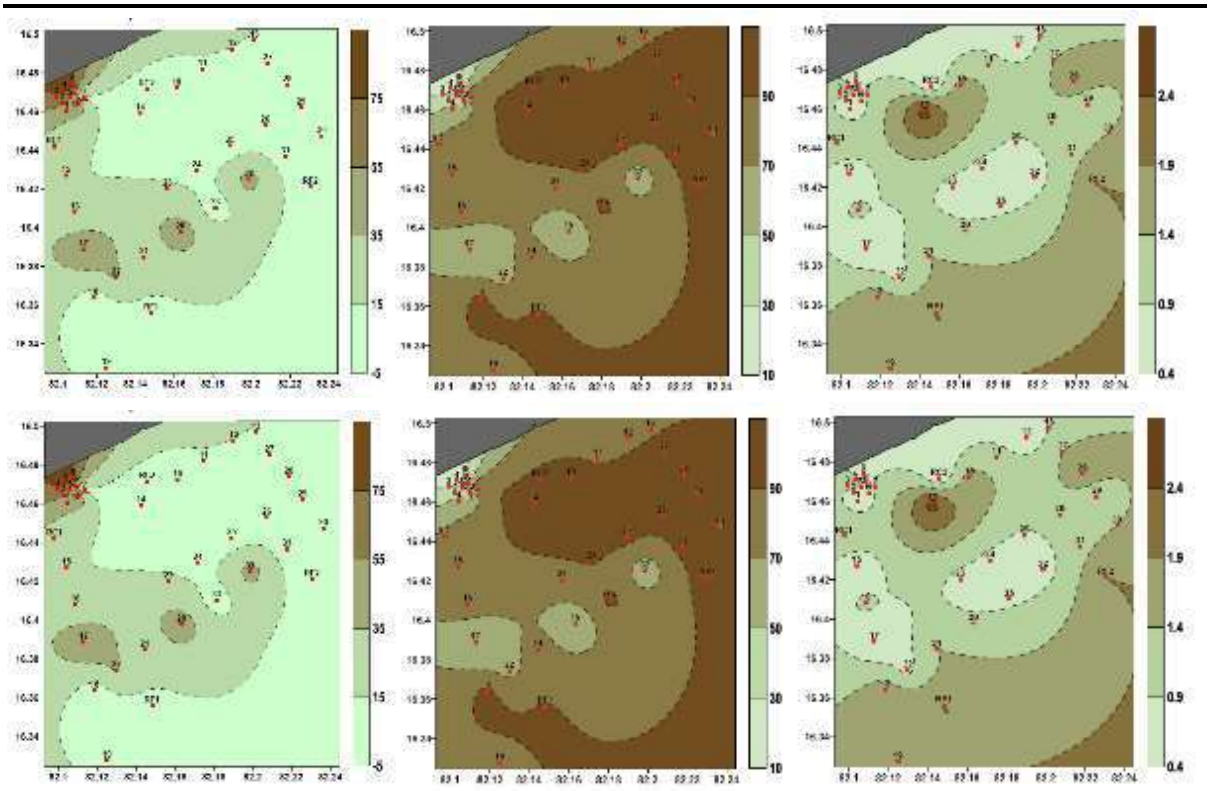
Sediment Quality

Sediment Organic matter was high (mean 1.12±0.44%) for the deeper locations compared to shallow locations (1.05±0.56%). In shallow locations the sediments were predominantly sandy (mean 32.16±30.25%) relative to deeper. Similarly, silt+clay were high at the deeper locations (82.78±16.00%) than shallow locations (67.84±30.25%). The predominant reason for the relatively high mud levels at most places could be related to flows from the nearby Godavari River opening into the sea further south and slightly north of the study area. Summary of sediment quality analyses conducted by Andhra University is presented in ***Table 3.25*** in form of range, mean and standard deviation and observed % values shown in ***Figure 3.42***.

Table 3.25 Summary of Sediment Quality Analyses, Andhra University, 2017

Sediment characteristics		**Shallow**	**Deeper**
Stations investigated		1 to 14, 27, 28, RC2	15 to 26, 29-33, RC1, RF1, RF2
Sand (%)	Range	0.38 to 81.17	0.36 to 51.10
	Mean	32.16	17.22
	SD	±30.25	±16.00
Silt and Clay (%)	Range	18.83-99.62	48.90-99.64
	Mean	67.84	82.78
	SD	±30.25	±16.00
Sediment Organic Matter (%)	Range	0.41-2.65	0.50-1.91
	Mean	1.05	1.12
	SD	±0.56	±0.44

Figure 3.42 Sediment Texture



Source: Marine Study by Andhra University, 2017 for Vedanta Ltd (Cairn Oil & Gas)

3.13.3 Marine Biological Parameters

Primary Monitoring Conducted by ERM

As stated earlier, ERM engaged Vimta Labs, Hyderabad to conduct marine environmental monitoring in PKGM-1 Block during April 2018 as part of the EIA Study. Eight (8) pre-determined stations were considered for collection of the marine sediment samples. Details on the sediment sampling locations is presented in ***Table 3.18*** and also shown in ***Figure 3.21***. The results are presented as following:

Phytoplankton

Observations of phytoplankton characteristics involved quantification of phytoplankton pigments i.e., chlorophyll *a*, (which is generally considered as the proxy of phytoplankton biomass). Besides phytoplankton species, composition and abundance are made to understand the environmental quantity of the area. Water samples were collected from the surface to evaluate the phytoplankton biomass and their community structure.

a) Biomass (chlorophyll-a)

For chlorophyll-a samples collected were immediately kept away from the sunlight wrapped in aluminum foil for the recommended holding time and were kept in the freezer for safe keeping, before laboratory analysis.

For chlorophyll-a measurement, water samples were collected from 10 m, 11m, 11m, 9.5 m, 12m, 14.5 m, 6m (refer ***Table 3.26)***. These depths were selected to cover euphotic zone that is well-ventilated zone for primary production or plankton biomass.

An aliquot of 2 L of seawater is filtered through 0.7 µm pore size Whatman GF/F filters. Prior to filtration of the water sample, 1 ml of 1% $MgCO_3$ suspension is added to the filters as it could prevent acidification of extract and, thereby, prevent the formation of pheophytin. After the filtration, filter papers are dried under suction for 1 to 2 min and carefully transferred to (pre-soaked 90% acetone washed) a screw cap test tubes; thereafter, 10 ml of 90% acetone was added to it. These test tubes are vigorously shaken and covered with aluminium foil to prevent light penetration and kept in the refrigerator for 15 to 20 h. Further, the extract is transferred into pre-cleaned 90% acetone soaked centrifuge tubes and centrifuged at 2400 rpm. The supernatant solution is transferred to another test tube and the solutions made up to 10 ml with 90 % acetone and analyzed for the determination of chlorophyll-a on the spectrophotometer (Shimadzu, Model –UV-1650 PC). The chlorophyll-a concentrations are presented in ***Table 3.26*** and ***Figure 3.43.***

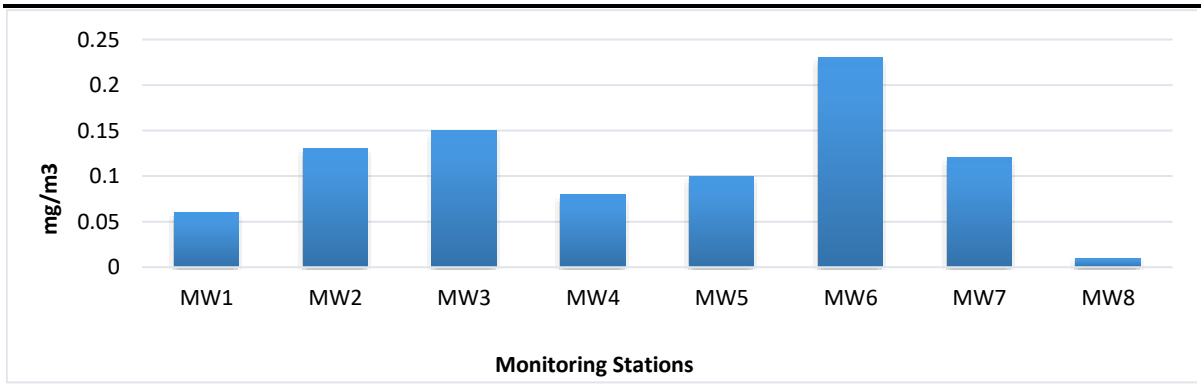
Table 3.26 Chlorophyll-a Diversity in Ravva Offshore Sampling Locations

Sample IDs	Nearest Facility	Distance from the Shore (Km)	Approx. Water Depth (m)	Chlorophyll-a Concentration
MW1	Near Platform RB	4.75 Km	10 m	0.06 mg/m^3
MW2	Near Platform RG	5.75 Km	11 m	0.13 mg/m^3
MW3	Near Platform RF	5.20 Km	10 m	0.15 mg/m^3
MW4	Near Platform RE	5.7 Km	11 m	0.08 mg/m^3
MW5	Near Platform RH	4.5 Km	9.5 m	0.10 mg/m^3
MW6	Near Platform RD	6.8 Km	12.m	0.23 mg/m^3
MW7	Near Platform RC & RA	9.2 Km	14.5 m	0.12 mg/m^3
MW8	Near Marine Outfall	0.75 Km	6 m	0.01 mg/m^3

Source: Marine Environmental Monitoring, April 2018

The Chlorophyll-a concentrations were ranged between 0.01 till 0.23 mg/m^3, highest concentration of Chlorophyll-a were recorded at MW6 (SD6) comprising of 0.23 mg/m^3 and lowest concentration of 0.01 mg/m^3 is recorded at Marine Outfall region at the MW8 station. In general the distribution of Chlorophyll-a concentration was low at all the monitoring locations and represents oligotrophic/less-productive nature of the area.

Figure 3.43 Distribution of Chlorophyll-a & Phytoplanktons Composition at the monitoring stations



Source: Marine Environmental Monitoring, April 2018

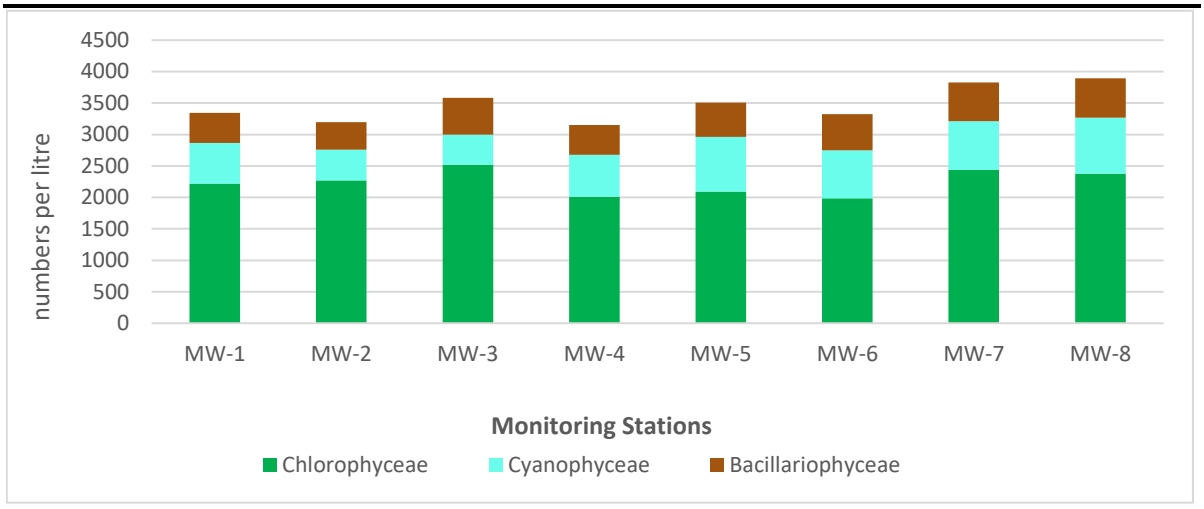
b) Phytoplankton Composition, Abundance and Species Diversity

Plankton net of mesh size of 25 was used for sampling, lugol solution and formaldehyde were added to preserve the samples. Phytoplankton community in the sampling area was mainly comprised of chlorophyceae (average 64%), cyanophyceae (average 20%) and bacillariophyceae (average 16%).

A total of 15 genera of phytoplankton were identified in the study area, including 10 genera of chlorophyceae, 3 general of cyanophyceae and 2 general of bacillariophyceae. Their total abundance ranged from 3149-3896 numbers per litre.

Chlorophyceae genera identified were *Cosmarium* sp., *Chara* sp., *Cladophora* sp., *Chlorilla* sp., *Chlamydomonas* sp., *Volvox* sp., *Hydrodicto* sp., *Spirodictiona* sp., *Spirozyra* sp., *Zygnema* sp. Cyanophyceae general identified were *Spirulina* sp., *Anabaena* sp. and *Nostoc* sp. Bacillariophyceae genera identified were *Pinnularia* sp.and *Navicula* sp.

Figure 3.44 Distribution of Chlorophyll-a & Phytoplanktons Composition at the monitoring stations



Source: Marine Environmental Monitoring, April 2018

Phytoplankton composition at all the stations is presented in ***Figure 3.44*** and genera wise detailed abundance is shown in ***Figure 3.45.***

Table 3.27 Phytoplankton Diversity at the Ravva Offshore Sampling Locations

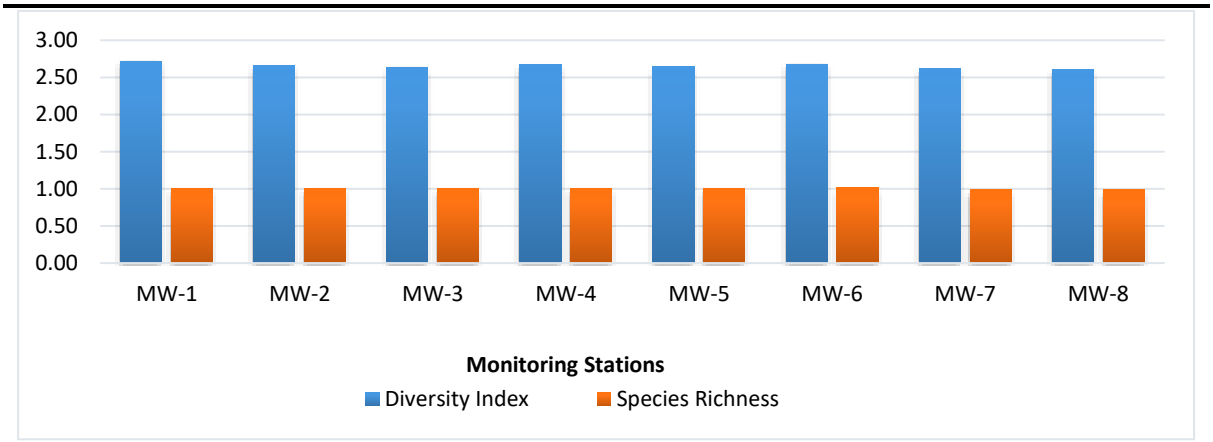
Chlorophyaceae		**MW-1**	**MW-2**	**MW-3**	**MW-4**	**MW-5**	**MW-6**	**MW-7**	**MW-8**
1	*Cosmarium*	199	200	213	-				
2	*Chara*	210	238	232	229	210	238	397	229
3	*Cladophora*	225	*236*	310	211	199	220	213	397
4	*Chlorilla*	238	*242*	248	230	197	218	321	380
5	*Chlamydomonas*	210	*248*	231	239	199	200	219	212
6	*Volvox*	197	*218*	321	252	210	238	243	199
7	*Hydrodicto*	199	*200*	219	212	220	200	258	219
8	*Spirodictiona*	210	*212*	210	217	310	218	283	223
9	*Spirozyra*	220	*232*	312	200	335	200	269	248
10	*Zygenema*	310	*243*	222	221	214	255	233	269
Cyanophyaceae									
1	*Spirulina*	211	-		215	340	210	215	330
2	*Anabaena*	210	*252*	229	219	318	230	239	350

3	*Nostoc*	225	*238*	251	234	213	320	321	212
Bacillariophyaceae									
1	*Pinnularia*	248	*215*	336	225	213	221	229	318
2	*Navicula*	232	*225*	250	245	330	356	390	310
Shannon Wiener Diversity Index for Species Diversity		2.72	2.66	2.64	2.67	2.65	2.68	2.62	2.6
Species Richness		1.00	1.01	1.00	1.01	1.00	1.02	0.99	0.99

Source: Marine Environmental Monitoring, April 2018

Phytoplankton diversity index (*H'*) did not show spatial variation, and ranged between 2.60-2.72. The species richness ranged between 0.99-1.02. Phytoplankton diversity index and species richness presented in ***Figure 3.45.***

Figure 3.45 Phytoplankton Diversity Index (H') and Species Richness



Source: Marine Environmental Monitoring, April 2018

Inference: 15 genera of phytoplankton were identified in the study area, with average composition of 64% Chlorophyceae, 20% Cyanophyceae and 16% Bacillariophyceae. Their total abundance ranged from 3149-3896 numbers per litre. The diversity of phytoplankton did not show much variation among the sampling stations with diversity indices ranging between 2.60-2.72 and species richness ranged between 0.99-1.02 indicating uniform distribution of phytoplankton in the study area.

Zooplankton

Zooplankton, the primary consumers in the marine ecosystem are tiny animals that feed on phytoplankton and micro zooplankton. Zooplankton study includes the assessment of standing stock (biomass), abundance, composition, and community structure. Despite their small size, zooplankton plays an important in the aquatic food.

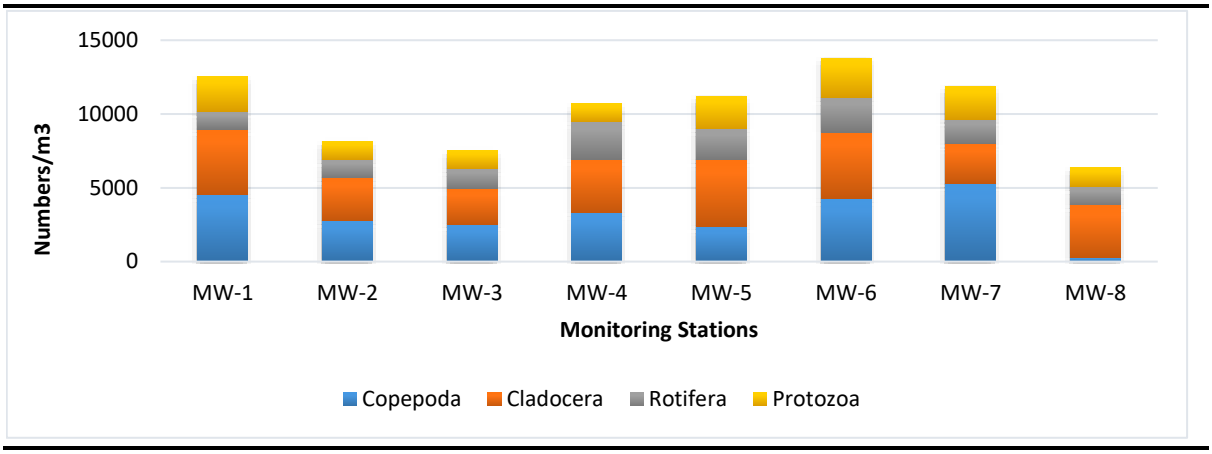
Zooplankton species and abundance comprised of 2 Copepods, 2 Cladocerans, 1 Rotifer and one Protozoa across the sampling locations. Abundance of zooplankton varied from 6365 no/m^3 at MW-8 to 12545 no/m^3 at MW-1. Copepod genera reported were such as *Cyclops* and Nauplius larvae, *Brachionus* sp. was the recorded rotifer species, *Allonella* sp. and *Moina* sp. were the two recorded Cladocerans and *Prinularia* sp. was the only Protozoa recorded. The list of zooplankton recorded is presented in ***Table 3.28*** and species wise detailed abundance is shown ***Figure 3.46.***

Table 3.28 Zooplankton Diversity at the Ravva Offshore Sampling Locations

Zooplankton		MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8
Copepoda									
1	*Cyclops* sp	2229	1238	1222	1229	1210	2138	2633	40
2	*Nauplius larvae*	2297	1550	1310	2113	1199	2120	2670	225
Rotifera									
3	*Brachionus* sp	1199	1218	1325	2522	2110	2338	1613	1220
4	*Allonella* sp	2221	2680	1219	2123	2230	2300	1297	1340
5	*Moina* sp	2230	212	1210	1481	2250	2218	1413	2230
Protozoa									
6	*Prinularia* sp	2369	1243	1222	1221	2214	2677	2258	1310
Shannon Wiener Diversity Index for Species Diversity		1.79	1.71	1.77	1.74	1.76	1.78	1.75	1.23
Species Richness		1.00	0.95	0.99	0.97	0.98	0.99	0.98	0.76

Source: Marine Environmental Monitoring, April 2018

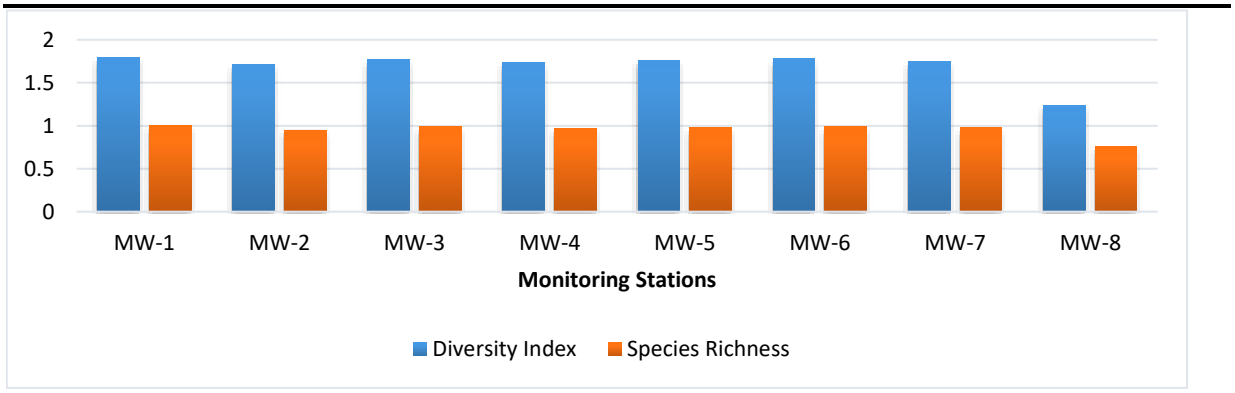
Figure 3.46 Distribution of Zooplankton Biomass and Abundance



Source: Marine Environmental Monitoring, April 2018

Highest sampling diversity is recorded at MW-1 station comprising of 1.79 and lowest diversity is recorded at 1.23 at MW-8. The species richness ranged between 0.76-1.00. Zooplankton diversity index and species richness in presented in ***Figure 3.47.***

Figure 3.47 Zooplankton Diversity Index (H') and Richness



Source: Marine Environmental Monitoring, April 2018

Inference: Six (6) genera of zooplankton were identified in the study area, 2 Copepods, 2 Cladocerans, 1 Rotifer and one Protozoa across the sampling locations. Abundance of zooplankton varied from 6365 no/m^3 at MW-8 to 12545 no/m^3 at MW-1. Similar to that of

phytoplankton, diversity of zooplankton also did not show much variation among the sampling stations with diversity indices ranging between 1.23-1.79 indicating more or less uniform distribution of zooplankton in the study area.

Benthos

Benthos were composed of a wide variety of species with mainly polychaete foraminiferans, cnidarians, molluscs, crustaceans etc. living in burrows in the sediment or on the sediment surface. Changes in the benthic community are widely applied for the detection of impacts from contamination and eutrophication of waters. Benthic Communities were represented by meiobenthos and macrobenthos.

Meiobenthic community is represented by Copepods, Nematodes, Turbellarians, Nemertins, Foraminifera, Kinorynchs, Halacarids etc. The biomass of meiobenthos varied between 3171 individuals/m^2 at SD-4 to 6708 individuals/m^2 at SD-8. Among the meiobenthic communities, Halacrids was the most dominant group with an average composition of 49% of the total meiobenthic composition. The Halacrids were followed by Kinorynchs with average percentage composition of 16% and foraminiferans with average percentage of 10%. Higher abundance (>5000 individuals/m^2) was noticed at SD-3 and SD-8 stations.

Macrobenthic community is represented by Polychaetes, Molluscs, Cumceans, Amphipods, Isopods, Cnidarians, Oligochaetes and Tanaidacea etc. The biomass of macrobenthos varied between 4023 individuals/m^2 at SD-1 to 6698 individuals/m^2 at SD-6. Among the macrobenthic communities, no dominance amongst the communities were observed and average percentage composition of all the groups mentioned above varied between 12%-13%. Higher abundance (>5000 individuals/m^2) was noticed at SD-6, SD-7 and SD-8 stations.

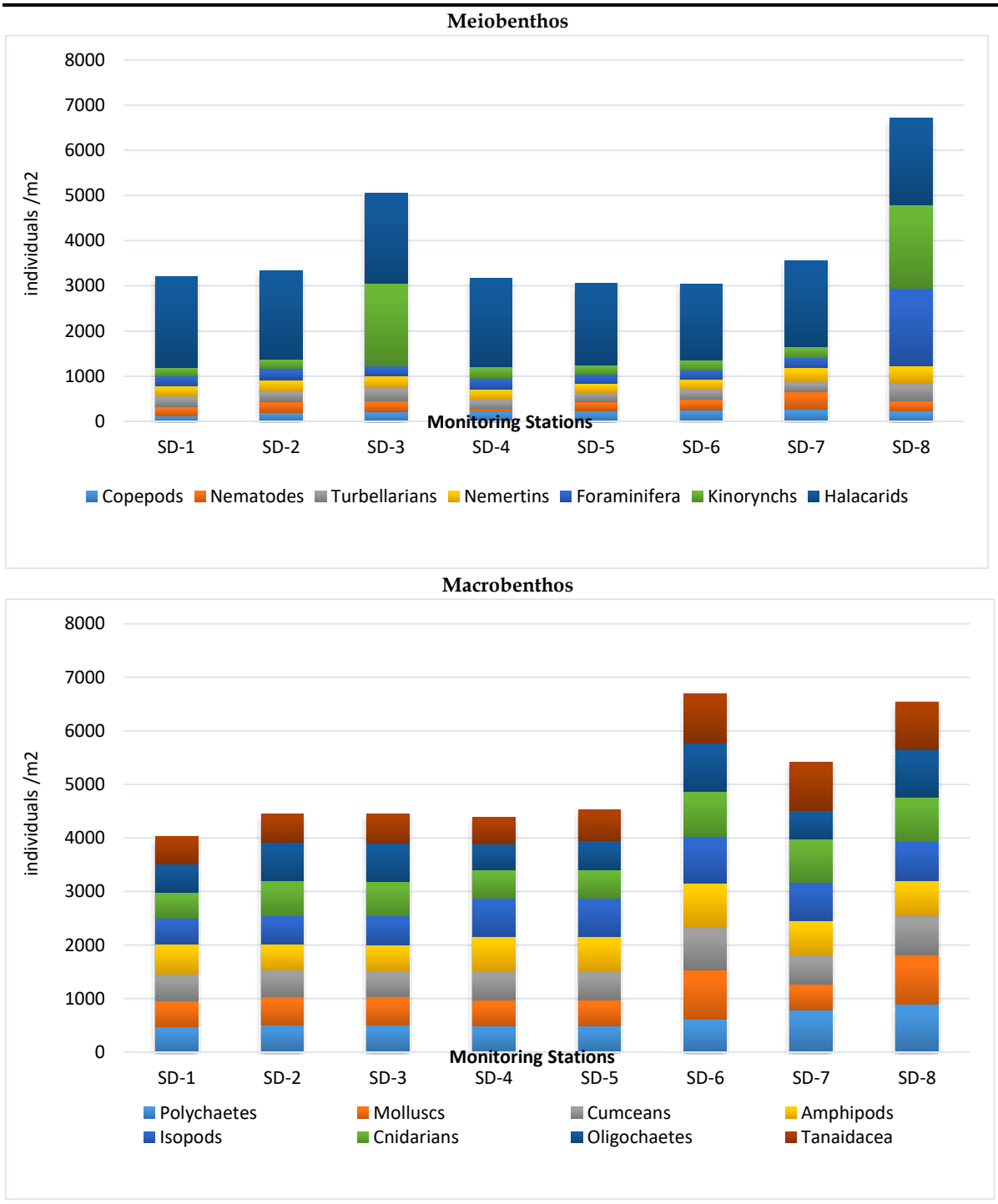
Distribution of meiobenthic and macrobenthic communities at the monitoring stations is presented in ***Figure 3.48***.

Table 3.29 Diversity of Benthic Communities in Sampling Stations

Benthic Community		**SD-1**	**SD-2**	**SD-3**	**SD-4**	**SD-5**	**SD-6**	**SD-7**	**SD-8**
Meiobenthos (individuals/m^2)									
1	Copepods	120	200	213	229	230	252	260	223
2	Nematodes	210	238	232	40	210	238	397	229
3	Turbellarians	225	236	310	211	199	220	213	397
4	Nemertins	238	242	248	230	197	218	321	380
5	Foraminifera	210	248	231	239	199	200	219	1720
6	Kinorynchs	197	218	1820	252	210	238	243	1839
7	Halacarids	2000	1960	1990	1970	1820	1680	1900	1920
Shannon Wiener Diversity Index		1.35	1.43	1.49	1.32	1.4	1.5	1.51	1.62
Macrobenthos (individuals/m^2)									
1	Polychaetes	475	510	512	490	490	615	790	891
2	Molluscs	480	529	519	488	488	920	488	925
3	Cumceans	510	490	490	533	533	810	533	736
4	Amphipods	550	488	488	650	650	818	650	657
5	Isopods	490	533	533	715	715	870	715	718
6	Cnidarians	485	650	650	531	531	830	810	838
7	Oligochaetes	523	715	715	475	540	910	524	889
8	Tanaidacea	510	531	537	501	580	925	910	890
Shannon Wiener Diversity Index		2.09	2.04	2.05	2.03	2.07	2.08	2.06	2.1

Source: Marine Environmental Monitoring, April 2018

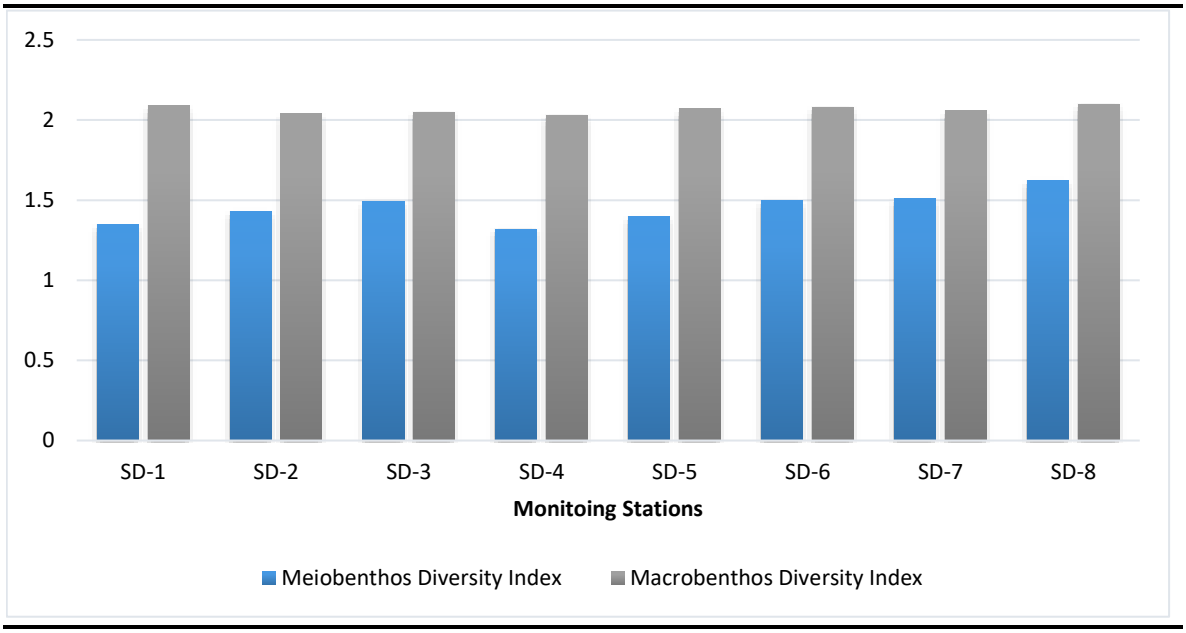
Figure 3.48 Distribution of Benthos Biomass and Abundance



Source: Marine Environmental Monitoring, April 2018

The diversity of meibenthos varied between 1.32-1.62 and the diversity index of macrobenthos varied between 2.06-2.01. Variation of diversity index of the monitoring stations is presented in ***Figure 3.49*** and station wise listing of benthic communities is presented in ***Table 3.29***.

Figure 3.49 Benthic Community Diversity Index (H')



Source: Marine Environmental Monitoring, April 2018

Inference: Meiobenthic community is represented by Copepods, Nematodes, Turbellarians, Nemertins, Foraminifera, Kinorynchs, Halacarids etc. Macrobenthic community is represented by Polychaetes, Molluscs, Cumceans, Amphipods, Isopods, Cnidarians, Oligochaetes and Tanaidacea etc. The biomass of meiobenthos varied between 3171 -6708 individuals/m^2 at whereas the biomass of macrobenthos varied between 4023 - 6698 individuals/m^2. Among the meiobenthic communities, Halacrids was the most dominant group followed by Kinorynchs and foraminiferans. Among the macrobenthic communities, no dominance amongst the communities were observed. The diversity index among the stations did not reveal any marked difference indicating that the meiobenthic and microbenthic communities are distributed more or less uniformly in the study area.

Study Conducted by Andhra University, 2017

As mentioned earlier, Andhra University conducted analyses of marine biological parameters at all 37 locations as mentioned in ***Table 3.9.*** A summary of the key findings are presented below:

Chlorophyll-a

Chlorophyll-a was measured at all 37 locations. Chlorophyll-a concentrations varied from 0.35 mg/m^3 to 6.11 mg/m^3 and the overall mean value was 1.27±0.95 mg/m^3. Total chlorophyll varied from 0.43 to 6.93 mg/m^3 and the overall mean was 1.66±1.15 mg/m^3.

Phytoplankton.

- Altogether 37 surface samples were examined from coastal waters near Ravva by Anna University;
- The phytoplankton in the coastal waters off Ravva region was reported to be quite diverse and is dominated by bacillariophyceans;
- During the study, mean phytoplankton numerical abundance ranged between 141 nos.ml^{-1} - 3415 nos.ml^{-1}; the overall mean being 492 nos.ml^{-1};

- 144 species of phytoplankton represented by 9 groups composed of 91 species of Bacillariophyceans (centrales 62, pennales, 29); 25 species of Dinophyceans; 12 species of Cyanophyceans; 6 species of Euglenophyceans; 4 species of Chlorophyceans; 2 species of Prymneciophyceans; 2 species of Prasiniphyceans and 1 species each of Chrysophycean and Kinetoplastid were reported;

Overall, pinnate diatoms formed the bulk (59.4%) of the population followed by Centric diatoms (28.6%), Cyanophyceans (6.5%), Dinophyceans (1.7%), Chlorophyceans (1.6%), Euglenophyceans (1.0%), Prymneciophyceans (0.7%) and prasinophyceans (0.5%).

Coscinodiscus jonesianus, Lauderia annulata, Chaetoceros diversus, Odontella mobiliensis and Hemiaulus sinensis were the most dominant species.

Mesozooplankton

- Altogether 37 surface samples were examined from coastal waters near Ravva by Anna University;
- Total mesozooplankton abundance varied between 160 and 5230 ind.m-3 (ca. 974 ind.m-3; CV: 1.08);
- Among holoplankton, copepods represented by 37 species constituted the most diverse and numerically abundant taxa. Their contribution to total mesozooplankton abundance varied between 32.6% and 95.1% with a mean of 68.4% (CV: 25.3%);
- In terms of species richness, copepods constituted 64% of total mesozooplankton taxa recorded. Small sized copepods (≤1mm size), *Corycaeus sp., Bestiolina similis* and *Paracalanus indicus* were the most dominant copepods.
- Meroplankton, constituted by bivalve veligers, followed in the order of their abundance by gastropod veligers, decapods larvae, and fish eggs and larvae were the most important taxa.

Macrobenthos

- Altogether 37 samples were examined from coastal waters near Ravva by Anna University;
- Overall 87 species of macrobenthic (epi) fauna (dredge samples) was recorded from the study area;
- The mean abundance of epi-fauna was 12 nos, per dredge haul^{-1}.
- Gastropods (47.36%), bivalves (26.52%), followed by crustaceans (9.07%), echinoderms (12.17%) and other groups (Cnidarians polychaeta and Lingula) (4.88%) constituted the epi-faunal macrobenthos population.
- Out of 87 taxa, the most abundant species of epi-fauna was the olivid gastropod, *Oliva vidua* that contributed up to 19.22% of the total population. This is followed by bivalves *Anadara inaequivalvis* (7.71%), the mitrid gastropod *Mitra luctuosa* (6.22%), gastropod *Ptychobela nodulosa* (3.93%), bivalves *Macoma* sp. (3.79%) and *Mactrinula plicataria* (3.65%).
- 74 grab samples were collected (2 each at 37 locations) for analyses of the infaunal taxa (living buried in the sediment).
- 55 taxa of infauna represented by 16 families including polychaetes, cnidarians, crustaceans (brachyurans, amphipods, alphaeid shrimps, copepods, stomato pods), priapulids, Echinoidds, ophiuroids and holothuroids were reported.
- Infaunal numbers varied from a minimum of <15 individuals per 0.1m^2 to a maximum of 177 individuals per 0.1m^2

3.14 BIOLOGICAL ENVIRONMENT

An ecological survey was undertaken in the study area of PKGM-1 Block and 10 km surrounding the block in East Godavari District of Andhra Pradesh, to understand and establish the prevailing ecological baseline as input to impact assessment of the proposed project on biological environment - species and habitats in surrounding areas.
The ecological surveys were conducted with following scope:

Flora

- Identification of floral species from sample sites in terrestrial and freshwater ecosystems;
- Identification of habitats sensitive to the kind of development planned;
- Presence of rare, endangered, endemic and threatened species of plants within the study area and ascertaining their conservation status based on review of literature published;
- Detailing of Forests types (reserved, protected) from sample locations in the study site Plant Species richness and diversity of selected sample site on land and freshwater ecosystems;
- Identification of forest vegetation representative of the region and current status of natural habitats or species, which are unique or of special conservation and scientific interest based on available data (primary and secondary);
- Collection of secondary information on flora and forests in the study area from offices of Divisional Forest and Botanical Surveys of India etc., for ascertaining the check list of species surveyed/reported from the study area, type of flora, bio-diversity aspects and conservational status BSI Red List, IUCN Ver. 3, 2017 and other national and international conventions;
- Statistical analysis of the observed floral species in sampled area to work out their frequency, density, abundance IVI and Species Richness and Diversity indices;
- Identification of areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value.

Fauna

- Identification of faunal species from representative areas in the terrestrial, freshwater, mangrove, backwater, littoral and marine ecosystems during the survey.
- Identification of sensitive habitats, rare, endangered and threatened species within the study area (including project block) based on available data (primary and secondary).
- Classification of fauna for any endangered or protected species or endemic species prevailing in the study area (including project block) based on field survey and review of literature;
- Collection of secondary information on faunal diversity for the study area from offices of Divisional Forest, Zoological Surveys of India etc.; etc. for ascertaining the check list of species, bio-diversity aspects and conservational status based on Wild Life Protection Act, 1972, IUCN Ver. 3, 2017 and other international conventions;
- Identification of areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value;
- Identification and mapping of areas which are important or sensitive for ecological reasons including their breeding, nesting, foraging, resting, over wintering areas including wildlife migratory corridors /avian migratory routes; based on long-term secondary data.

Data on the marine flora (mainly sea grasses) and marine animals (fishes, reptiles and mammals) are presented based on secondary information collected during visits to forest department and literature surveys.

3.14.1 Approach and Methodology of the Ecological Assessment

Approach

A team (1) of plant ecologist and wildlife biologist visited the region, focusing on vegetation (woody as well as non- woody vegetation), wildlife presence especially mammals, avifauna and herpetofauna.

Two surveys were undertaken to understand the ecological settings of the Study Area

Reconnaissance Survey: A two-member team visited the site from 19th to 22nd February, 2018 to meet with site officials and undertook the reconnaissance ecological survey of the PKGM-1 Block onshore areas, onshore well pad locations and 10 km radius surrounding area to identify and understand the existing ecological attributes and different habitats available.

Ecological Baseline Survey: Detail baseline survey were conducted by two member team from 11th to 17th April 2018 for the primary baseline data generation. The survey was conducted targeting the habitats around the terminals, approach roads, other facilities and proposed well pads of Vedanta Ltd (Cairn Oil & Gas).

The climatic conditions during both the survey duration were sunny.

The diversity of the vegetation, fauna and their distribution has been worked out after field survey and sampling. Lists of flora and fauna and their abundances have been compiled. Ecological sensitivity of the region has been assessed based on primary and secondary information available.

Extensive literature survey was conducted by reviewing previously published studies on vegetation, ecology and biodiversity of the study area and surrounding region. The offices of the Range Forest Officer (Wildlife), Kakinada Range was made to understand the ecological attributes of the study area. Consultations were also held with NGOs working in the region such as EGREE (East Godavari River Estuarine Ecosystem) Foundation who undertakes *In Situ* and *Ex Situ* conservation to Olive Ridley Turtle Nests along the beach areas and sand spits of Godavari delta.

Published literatures of Botanical Survey of India (BSI) and Zoological Survey of India (ZSI), were reviewed. RED data book (BSI publication), IUCN threatened species list and Management Plan for Coringa Wildlife Sanctuary and available references about endemic and endangered plant species of the region were referred. Schedules of the Wildlife (Protection) Act, 1972 for wild animal species have been referred.

(1) The ecological team included Dr Rahul Srivastava, Dr Abhishek Roy Goswami and Saumabha Bhattacharya.

Methodology -Floral Assessment

Quantitative data was collected using standard quadrate methods of sample plot size 10 m x 10 m for trees, 5 m x 5 m for shrubs and 1 m x 1 m for herbs and grasses. Density of herbs and grasses were taken as 5mX 5m to obtain a better sample size. Frequency, Density, Abundance and Importance Value Index (IVI) were calculated. Random stratified sampling was carried out in the zones to compare diversity of flora and fauna. In each zone, quadrats were laid to enumerate vegetation details and to bring out the various aspects of plant diversity. At the sampling points, bird data (species and number of individuals) were collected. Broadly, the following points were considered while conducting the field survey:

- Study the land use of the project area;
- Identification of the vegetation types was based on the composition and the dominant species found in them;
- Different habitat types were sampled for assessing their ecological status;
- Species diversity was studied quantitatively to bring out biodiversity aspects;
- Species diversity for flora and fauna, including avifauna was observed; and
- Presence and distribution of endemic and threatened biodiversity was noted.

Quantification of Vegetation

Frequency refers to the degree of dispersion of individual species in an area and usually expressed in terms of percentage occurrence. It was studied by sampling the project influence area at several places at random and recorded the name of the species that occurred in each sampling units. It is calculated by the equation:

$$\text{Frequency (\%)} = \frac{\text{Number of quadrates in which sample occoured x 100}}{\text{Total number of quadrates studied}}$$

Relative Frequency is the degree of dispersion of individual species in an area in relation to the number of all the species occurred. It is calculated by the equation;

$$\text{Relative Frequency} = \frac{\text{Number of ocurrance of the species x 100}}{\text{Number of occurances of all the species}}$$

Density indicates numerical strength of plants in a community and implies number of plants in a unit area. The total number of individuals encountered in the zone studied is converted into individuals per hectare (10000 sq.) for trees and per one square meter for shrubs, climbers and herb species.

$$\text{Density} = \frac{\text{Total number of individuals ofa species in all quadrats}}{\text{Total Number of Quadrates studied}}$$

Relative density is the study of numerical strength of a species in relation to the total number of individuals of all the species and can be calculated as:

$$\text{Relative Density} = \frac{\text{Number of individuals of the species x 100}}{\text{Number of individuals of all the species}}$$

Abundance is the study of the number of individuals of different species in the community per unit area. By quadrats method, samplings are made at random at several places and the number of individuals of each species was summed up for all the quadrats divided by the total number of quadrats in which the species occurred. It is represented by the equation:

$$\text{Abundance} = \frac{\text{Total number of a species in all quadrates}}{\text{Total number of quadrates in which species occurred}}$$

The formulae used for calculation of the three parameters are based upon Misra(1).

Species richness (N) is the primary measure of biodiversity. It is simply the number of species observed in the area.

Shannon Diversity Index (H')(2) has been used for estimating the diversity between the four sampled zones in order to highlight the most diverse zone. Diversity index is a ratio between number of species and number of individuals present in a sample. Shannon index (H') is expressed by the formula:

$$H' = -\sum_{n=1} \left((\frac{ni}{N}) (\text{Log}(\frac{ni}{N}) \right)$$

Where, H' = Shannon index, n^i= number of individuals of each species
N = total individuals of each species, (Log to the base 2 is used)

Importance Value Index (IVI): gives an overall estimate of the influence of importance of a plant species in the community. It is the sum of relative density, relative frequency and relative coverage or relative basal area of tree species.

Description of Quadrates

The distribution of quadrates are given as per details given in ***Table 3.30.***

Table 3.30 Distribution of Quadrates Habitats wise

Habitats	Quadrates Code	Coordinates	Area Covered
Mangroves	MG1	16°26'57.59"N 82° 2'9.96"E	100 m²
	MG2	16°27'2.02"N 82° 2'35.41"E	100 m²
	MG3	16°29'9.69"N 82° 5'5.26"E	100 m²
	MG4	16°33'26.13"N 82°12'27.73"E	100 m²
	MG5	16°35'35.23"N 82°15'47.52"E	100 m²
	MG6	16°35'15.45"N 82°16'29.80"E	100 m²
	MG7	16°35'52.83"N 82°16'41.66"E	100 m²
	MG8	16°36'3.23"N 82°17'24.34"E	100 m²
Beach Area	BH1	16°35'34.51"N 82°19'1.56"E	100 m²
	BH2	16°35'20.16"N 82°18'52.52"E	100 m²
	BH3	16°31'51.32"N 82°12'50.52"E	100 m²
	BH4	16°30'0.81"N 82° 8'56.41"E	100 m²
	BH5	16°29'7.53"N 82° 7'5.07"E	100 m²
	BH6	16°28'33.63"N 82° 5'56.29"E	100 m²
	BH7	16°26'58.96"N 82° 3'1.49"E	100 m²
Shelter Belt	SB1	16°32'0.21"N 82°12'49.13"E	100 m²
	SB2	16°30'12.75"N 82° 9'19.65"E	100 m²
	SB3	16°28'57.30"N 82° 6'42.66"E	100 m²
	SB4	16°28'43.01"N 82° 6'13.00"E	100 m²
	SB5	16°27'1.08"N 82° 2'59.78"E	100 m²

(1) Misra, R. 1974. Manual of Plant Ecology, Oxford and IBH Publishing Company, New Delhi
(2) Shannon CE & W Weaver 1949, the Mathematical Theory of Communication, University of Illionis Press, Urbana, IL, USA.

Habitats	Quadrates Code	Coordinates	Area Covered
Aquaculture Ponds	AC1	16°27'55.41"N 82° 1'37.19"E	100 m²
	AC2	16°27'42.17"N 82° 3'14.54"E	100 m²
	AC3	16°29'49.00"N 82° 5'17.79"E	100 m²
	AC4	16°30'30.00"N 82° 6'49.09"E	100 m²
	AC5	16°31'48.26"N 82° 8'31.37"E	100 m²
	AC6	16°36'19.83"N 82°15'11.40"E	100 m²
Agriculture Farms	AF1	16°30'34.85"N 82° 3'2.02"E	100 m²
	AF2	16°30'32.04"N 82° 4'3.12"E	100 m²
	AF3	16°29'14.60"N 82° 4'21.88"E	100 m²
	AF4	16°34'23.71"N 82° 8'45.68"E	100 m²
	AF5	16°36'0.87"N 82°13'15.20"E	100 m²

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Methodology-Faunal Assessment

Faunal groups within the PKGM-1 Block onshore areas and surrounding 10 km radius areas were enumerated based on primary survey along the studied quadrates and complemented by the secondary literature of the area. The methodologies adopted for various faunal groups are presented as following:

Herpetofauna

- Opportunistic sampling involved searching micro habitats for amphibians and reptiles as and when encountered during the survey within the block area.
- Amphibians and reptiles were assessed through intensive search in quadrat and patches (Allison and Englund 2005)(1) in different sites and along the hedges of all the aquatic habitats. Further status of amphibians and reptiles were also assessed using time constrained search (Welsh, 1987)(2) that involved intensive search of micro habitats.

Avifauna

- Avifaunal status was assessed both in terrestrial and aquatic habitats
- Total or flock / block count methods (Sridharan 1989(3), Bhupathy 1991(4), Thompson 2002)(5) were adopted to assess the status of aquatic birds in dam /water bodies and point count method in the riparian forest along stream / river side (Gregory *et al.* 2002(6)) of the project area. Birds in the riparian habitats were recorded and enumerated within 50 m radius as part of point count.
- Point Count (Hutto *et al.* 1986(7), Bibby *et al.* 1992(8), Rosentod *et al.* 2002(9), Salim and Rahul 2002(10)) and area search (Dieni and Jones 2002(11)) techniques were applied to assess the status of terrestrial birds. Point counts in the forest and allied habitats were made within

(1) Allison, A., and Englund, R. 2005, Terrestrial animals and aquatic vertebrates, Biodiversity Assessment of Tropical Island Ecosystems. 49-70 p.

(2) Welsh, H.H., jr. 1987. Monitoring herpetofauna in woodlands of north western California and south west Oregon: a comparative strategy. Pp. 203-213. In. Multiple – Use Management of California's hardwood resources. T.R. Plumb, N.H. Pillsbury (eds. Gen. Tech. Regional Environmental Planning. PSW – 100) US Department of Agriculture, Forest Service.

(3) Sridharan, U. 1989. Comparative ecology of resident ducks in Keoladeo National Park, Bharatpur. Ph.D. Dissertation, University of Bombay, Bombay.

(4) Bhupathy, S. 1991a. Population and Resource Utilisattion of Waterfowl in Keoladeo National Park, Bharatpur. Ph.D. Thesis, Rajasthan University, Jaipur.

(5) Thompson, W.L. 2002.Towards reliable bird surveys: accounting for individuals present but not detected. The Auk. 119:18-25.

(6) Gregory, R. D., Gibbons, D. W. and Donald, P. F. 2002. Bird census and survey techniques. Pp:17-56. In: Bird Ecology and Conservation : A Handbook of Techniques. (Eds.) W. J. Sutherland, I. Newton and R. E. Green. Oxford University Press, Oxford. 386 p.

(7) Hutto, R.L., S.M. Pletsechel and P. Hendrick. 1986. A fixed radius point count method for non breeding season use. The Auk. 103: 593-602.

(8) Bibby, C.J., N.D., Burgerss and D.A. Hill. 1992. Bird Census techniques, Academic Press, London.

(9) Rosentod, S.S., Anderson, B.R., Giesenk. N, Leukerig, T., and Carter, M.F. 2002. Land bird counting techniques: Current practises and an alternative. The Auk 119(1):46-53

(10) Salim, J. and Rahul, K. 2002. Field methods for bird surveys. Bombay Natural History Society; Department of Wildlife Sciences, Aligarh Muslim University, Aligarh, and world Pheasant association, South Asia Regional Office (SARO), New Delhi, India. 61 p.

(11) Dieni, J.S. and Jones, S.L. 2002. A field test of the area search method for measuring breeding birds population. J. Field Ornithology, 73: 253-257.

50 m radius, while in agriculture that include fallow lands, and scrub / grassland / barren area habitats, birds were recorded within 100 m radius.

- Additional effort was made to locate/identify the presence of any breeding/nesting sites / roosting sites of avifauna.
- All this information thus collected was used to provide the species richness, diversity, abundance status, migratory and foraging guild status of birds recorded within the block area.

Mammals

Mammalian fauna was assessed at each sampling locations in different habitats through recording both direct and indirect evidences.

Status and distribution of different mammalian fauna is presented using direct count covering all the terrestrial habitats of the block area adopting road count (Burnham *et al.* 1980(1), Sale and Berkmuller 1988(2), Rodgers 1991(3)). These survey routes were the area between two sample points and the roads that traverse across different habitats and land uses.

In addition indirect evidences (pellets, dungs, droppings, scats and other tracks and signs), were searched within circular (25m radius) plots at each sampling location, which provide relative abundance of presence of mammalian fauna (Thompson *et al.* 1989 (4) , Rodgers 1991, Henke and Knowlton 1995(5) , Allen *et al.* 1996(6)).

- Further presence of different faunal species was also ascertained and substantiated by interviewing the local people with the pictures of the mammals that could probably occur in the area and discussion with local experts.
- Secondary information collected from the state forest department and other secondary sources for the block area was incorporated into the field data to derive a near complete list of all the major faunal groups. Photos showing the survey efforts and community consultations are shown in ***Figure 3.50.***

Figure 3.50 Ecological Survey in the PKGM-1 Block

(1) Burnham, K.P., D.R. Andreson., and J.L. Laake. 1980. Estimation of density from line transect sampling of biological population. Wildl. Mongr. No. 72. The Wildlife Society, Washington D.C. 202p.

(2) Sale, J.B. and K. Berkmuller, 1988. Manual of Wildlife Techniques for India. FAO, United Nation's India Establishment of Wildlife Institute of India Dehra Dun.

(3) Rodgers, W.A. 1991. Technique for Wildlife Census in India, A field Manual. Technical Manual. TM2. Wildlife Institute of India, Dehra Dun. India.81pp.

(4) Thommpson, I.D., Davidson, I.J., O' Donnell, S. and Brazeau, F. 1989. Use of track transect to measure the relative occurrence of some arboreal mammals in uncut forest and regeneration stands. Canadian Journal of Zoology. 67: 1816-1823.

(5) Henke, S.E. and knowlton, F.F. 1995. Techniques for estimating Coyote abundance. Pp; 71-78. In: Proceedings of the symposium: Coyotes in the southwest. Parks and wildlife Department: Austin, Texas.

(6) Allen, L., Engeman, R. and Krupa, H. 1996 Evaluation of three relative abundance indices for assessing dingo population. Wildlife Research. 23 197-206.

Community consultation for presence of floral and faunal species

Consultation with Fisherman (near shore and deep sea) regarding presence of Cetaceans

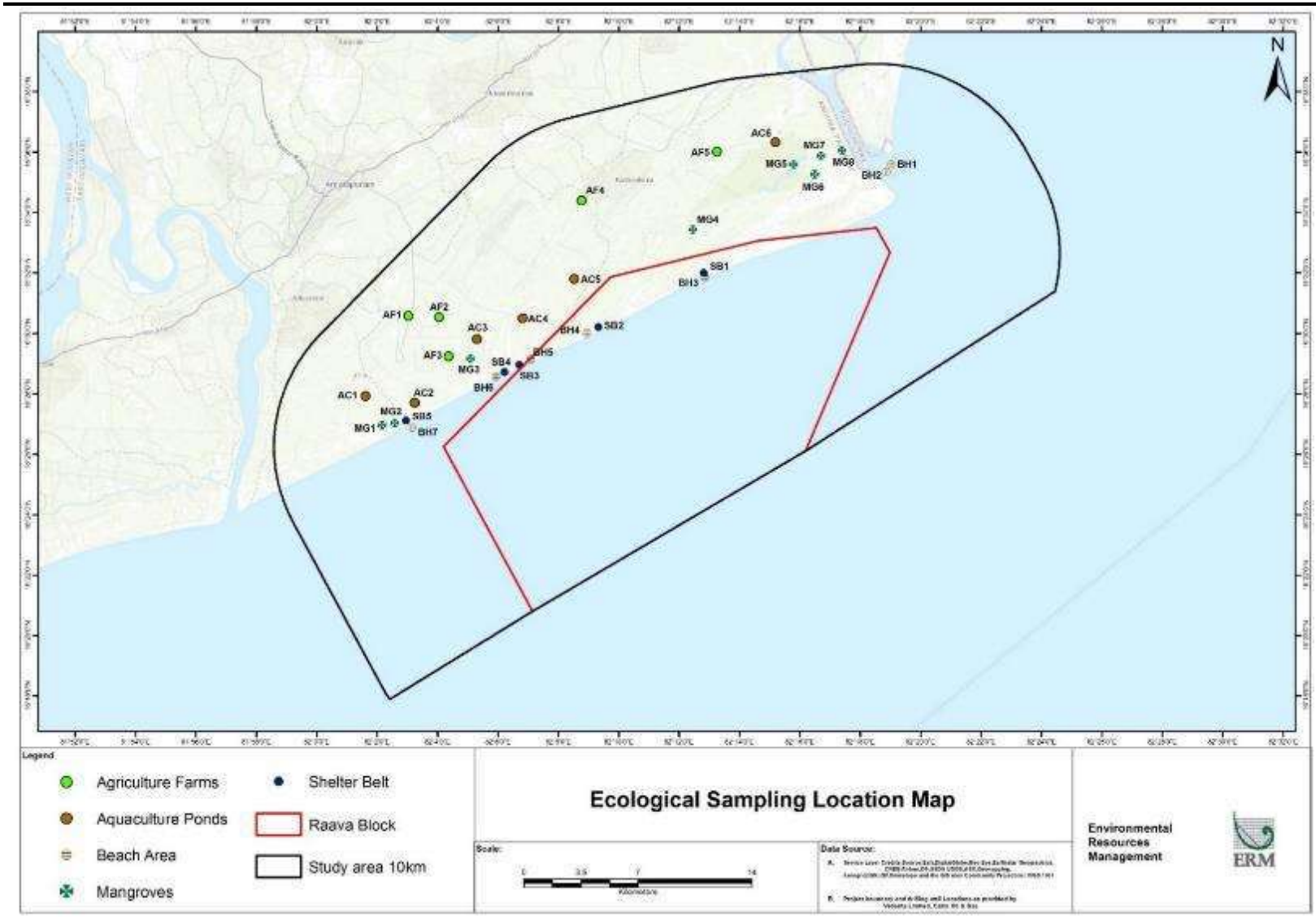
Discussion with Guards at In Situ and Ex Situ ORT nest conservation sites at Sacramento Shoals

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

3.14.2 Study Area

The ecological survey was conducted in the study area taken as an area of 10 km from the sea coast towards the land side all along the PKGM-1 block between Vainateyam Godavari River and Guatami Godavari River. The study covers terrestrial and backwater zone, which is likely to be affected by the proposed development. The map of the study area with ecological monitoring locations is provided in ***Figure 3.51.***

Figure 3.51 Map of the Study Area with Ecological Sampling Locations



3.14.3 *Terrestrial Floral species*

The available habitats in the Study area are discussed hereunder

Beach Vegetation

The beach habitat is represented by species of *Ipomoea biloba* and *Spinifex littoreus* which are dominant and widespread along the beach habitat of Study area. *Caesalpinia bonduc*, *Derris trifoliata*, *Crotalaria retusa*, *Thespesia populneoides* can be commonly seen here. *Tephrosia purpurea*, *Solanum xanthocarpum* are commonly seen near the coast. *Cassytha filiformis* is a common climber on trees. Vegetation in the beach habitat are represented in ***Figure 3.52.***

Figure 3.52 Beach Vegetation

Ipomoea biloba

Solanum xanthocarpum

Spinifex littoreus

Crotalaria retusa

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

The beach habitat is represented by 2 shrub species, 3 climber species and 2 herb species. The highest density calculated for shrubs is for *Thespesia populneoides* (4.71 individuals/sq.m.), while for herbs is for *Tephrosia purpurea* (15.29 individuals/sqm). Highest density for climbers is calculated for *Ipomoea biloba* (5.14 individuals/sq.m) as the species grows well in the shade of the adjoining shelter belt while *Spinifex littoreus* is limited to the dry areas. The details on phytosociology of beach habitats are provided in ***Annex 19 of EIA Volume 2.***

Casuarina Plantation/Shelter Belt

Shelter belt plantation is seen all along the coast with varied density. The *Casurina equistifolia* is prominent tree species planted along the coast in the Study area. Where habitation is close to coast species of *Cocos nucifera* and *Borassus flabellifer* the palm species are also seen planted as a second line in the shelter belt areas of *Casurina* plantation. The ground herbaceous layer comprise of *Calatropis procera* and creeper species from the coastal vegetation. Isolated

patches of *Pandanus tectorius* are also seen in villages of Nakka Rameshwaram, Chirriyanam which are close to the beach area. Vegetation in the Shelter belt habitat are represented in ***Figure 3.53.*** Phytosociology of shelter belts in the study area are presented in **Annex 19*of EIA Volume 2***.

Figure 3.53 Shelter Belt Vegetation

Shelter belt plantation of *Casurina equistifolia*

Land side view of Shelter belt with second line of *Cocos nucifera* & *Borassus flabellifer* plantation

Shelter belt at Rameshwaram (land side View)

Shelter belt plantation with associated shrubs (*Calatropis procera*) and other herbaceous layer

Pandanus tectorius growth in Rameshwaram Village

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Back Waters/Lagoons

Back waters from the sea ingression/creeks covers area next to shelter belt habitats. It is also the area where most of the onshore development of the projects will take place. Onshore well pad locations such as 1,2,3,4,5 and 6 are coming on the backwater regions adjacent to the Shelter belt areas. The major vegetation in these areas are mangrove species *Avacinia officianalis* and mangrove associate species such as *Sueda maritima, Salicornia brachiata* and *Sesuvium portulacastrum.* Vegetation in the Backwater habitat are represented in ***Figure 3.54.***

Figure 3.54 Back water Vegetation

Back waters south of Ravva Terminal with *Avacinia officianalis* near 16° 28' 27"N, 82° 5' 32"E.

Backwaters near 16° 28' 36"N, 82° 5' 39"E

Salicornia brachiata near 16° 28' 27"N, 82° 5' 32"E

Vegetation near 16° 29' 14" N, 82° 07' 02" E

Sesuvium portulacastrum near 16°29'04"N 82°06'42"E

Creek near Ramershwaram Village

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Phytosociology was not conducted for the habitat. The vegetation is very sparse and is detailed in the section above.

Mangrove Vegetation/Reserve Forest Areas

The study area has a large reserve forest patches, mainly in the mangrove habitat. They are divided according in forest blocks, as per villages. Till 1990, they were heavily exploited by the forest department itself for sale of fuel wood, (1) but later with better scientific understanding of the habitat values they were protected by the forest department. However, till then much damage had been done to the mangroves in the study area and most were reduced to scrub mangroves. Later plantation activity was taken up on a large scale in all reserve forest areas, leading to slow improvement in mangrove cover. However, local population are still dependent on it for fuel wood and timber and hence recovery is slow and mature forests are degrading. Plantation of mangrove species, mainly *Avicennia* spp. has been

(1) Rao R. S.; S. Sudhakar and P. Venkanna (1999) Flora of East Godavari district. INTACH, A.P.State Chapter. Hyderabad.

done in most blocks of mangrove habitats. Plantation of *Casuarina* and Cashew has been done on the coastal sandy area as wind breakers.

Forest height of mature vegetation is up to 8-10m in well protected areas. However in most areas, there is low secondary growth of *Avicennia* spp. with *Aegiceras corniculata* and *Ceriops decandra*. Other species such as *Rhizophora* spp. *Bruguiera* spp. are interspersed in the vegetation. Details of the forest areas within the study area are given in ***Table 3.31***.

Table 3.31 Reserve Forest in Study area

RF	Area	Description
Balusutippa RF	475.91Ha	Balusutippa R.F. is named after the village Balusutippa. Soil of this R.F. is clayey. The extent of mangroves under this R.F. is about 475 ha. of which 427 ha. Is under mangrove vegetation. Large trees of *Avicennia officinalis*, *A. marina*, *Rhizophora apiculata*, *R. mucronata*, *Bruguiera gymnorrhiza*, *Xylocarpus moluccensis* and *Ceriops decandra* are recorded in this R.F. Large areas of mangroves are seen outside this RF. along the Goutami Godavari River.
Kandikuppa RF	3302.23Ha	This RF bears healthy mangroves. Large areas of *Casuarina* plantations along the shore, is also a part of this R.F. Vegetation in this R. F. is relatively healthy and also rich in diversity. Species namely *Rhizophora apiculata, Bruguiera gymnorrhiza, Ceriops decandra* and *Xylocarpus molluccensis* are found in the RF. *Excoecaria agallocha, Avicennia marina, A. officinalis* and *Lumnitzera racemosa* are also recorded in this R.F. The vegetation in this RF. is disturbed due to the human pressure from the nearby villages namely Molletimogga, Kothapalem, Pandi and Pora. The soil is clayey in the landward side and it is sandy clay near the seaward side. The species composition is also high. *Excoecaria agallocha* and *Avicennia marina* contribute to about 90% of area of mangroves of the Godavari estuarine complex.
Kothapalem I	80.3 Ha	This is also named after the village Kothapalem. The soil is clayey. The species diversity is rich and the vegetation is fairly dense. A rare species viz. *Scyphiphora hydrophyllacea* Gaertn. f. (Rubiaceae) is recorded near the Sacramento lighthouse. They are about 2 m. in height. Along the entire East coast of Andhra Pradesh, this species occurs only in this R.F. Other plants namely *Excoecaria agallocha, Lumnitzera racemosa, Rhizophora apiculata, R. mucronata, Xylocarpus moluccensis, Bruguiera gymnorrhiza, Avicennia marina* and *A. officinalis* are recorded. Trees of these species are about 4-5 m. in height. Climbers namely, *Derris trifohata* and *Sarcolobus carinatus* are recorded. Shrubs like *Dalbergia spinosa*, *Clerodendrum inerme* and the halophytic herbs such as *Suaeda* and *Salicornia* are also recorded. The nearby aquaculture ponds and habitation are constant sources of threat to the mangrove ecosystem in this area.
Kothapalem II	61.1 Ha	

Source: Mangroves of Andhra Pradesh: Identification and Conservation Manual (1)

Other Vegetation Types of Mangroves Habitats

Mangroves form the most dominant habitat in the study area. Although in most areas dense growth of mangroves can be seen, it is mostly secondary vegetation, regrown after protection or planted by the forest department. Primary mangrove forest is only left in some patches, mainly away from the villages and in less accessible areas between the channels and coast. Mangroves can be further divided into following communities:

- ***Aegiceras- Ceriops*** dominated dense shrubby community is seen almost throughout, even in *Avicennia* forest undergrowth and disturbed areas. *Lumnitzera* is a common shrub among these, near the landward side.
- ***Rhizophora- Brugiera*** generally occurs along the edges of channels, in or near open water and mudflats.

(1)Mangroves of Andhra Pradesh Identification and Conservation Manual Pubs: M.S. Swaminathan Research Foundation, 2003 .67 p.

- Avicennia spp. is dominant throughout, but mostly forms dense tall forest near the landward side. Sonneratia, Xylocarpus are interspersed. Exoecaria agallocha is very common in this community and occurs mostly in degraded areas.
- ***Acanthus illicifolius*** occurs on mudflats and water edges in thick impenetrable community.
- ***Sueda- Salicornia*** form the dominant herbaceous community of halophytes associated with the mangroves. *Aelurops* is a common grass occurring on sandy areas.
- ***Prosopis juliflora***, which was previously introduced as sand binder and fuelwood species, has become invasive even in parts of the mangrove areas, especially those disturbed by lopping, cutting, and land reclamation activities.

Champion and Seth(1) have described these as Mangrove forests (Swamp forest-mangrove scrub, 4B/TS1). Vedanta Ltd (Cairn Oil & Gas) has already developed a 55 acre mangrove plantation adjacent to the terminal in S Yanam village. The mangrove plantation provide excellent roosting site to many avifaunal species and refuge to the smooth coated otter. Pictorial representation of mangrove habitats are presented in ***Figure 3.55*** and listed in ***Table 3.32.***

Figure 3.55 Mangrove Habitats

Mangroves near Kothapalem Village

Mangroves adjacent to Rameshwaram

Mangroves view from the Sacramento Lighthouse towards confluence of Gautami Godavari

Mangroves at Ravva Plantation area

(1) Champion, H.G. and S.K. Seth (1968). A revised survey of the forest types of India. Manager of publications, Delhi, 6, pp.xxv+404, pl. 103, map 7.

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

There are 17 species of mangroves recorded from the East Godavari region belonging to 9 families.

Table 3.32 Major Mangrove species in the Godavari Region

SN	Species Name	Vernacular Name
Family: AVICENNIACEAE		
1.	*Avicennia marina* (Forsk.) Vierh.	Nalla mada
2.	*A. officinalis* Linn.	Tella mada
3.	*A. alba* Blume.	Vilava mada
Family: ACANTHACEAE		
4.	*Acanthus ilicifolius* Linn.	Alchi
Family: COMBRETACEAE		
5.	*Lumnitzera racemosa* Willd.	Thanduga
Family: EUPHORBIACEAE		
6.	*Excoecaria agallocha* Linn.	Tilla
Family: MELIACEAE		
7.	*Xylocarpus moluccensis* M. Roem.	Senuga
8.	*Xylocarpus granatum* Koen	Senuga
Family: MYRSINACEAE		
9.	*Aegiceras corniculatum* (Linn.) Blanco.	Guggilam
Family: RHIZOPHORACEAE		
10.	*Rhizophora apiculata* Bl.	Ponna
11.	*R. mucronata* Lamk.	Ponna
12.	*Bruguiera gymnorrhiza* (Linn.) Lamk.	Kandriga
13.	*B. cylindrica* (Linn.) Bl.	Urudu
14.	*Ceriops decandra* (Griff.) Ding Hou.	Togara
Family: SONNERATIACEAE		
15.	*Sonneratia apetala* Buch.-Ham.	Kalinga
16.	*S. caseolaris* (Linn.) Engler. Pedda	Kalinga
Family: RUBIACEAE		
17.	*Scyphiphora hydrophyllacea* Gaertn. f.	-

A total of 16 species of trees and 1 climber, 1 Shrub and 4 herbaceous mangrove associates were enumerated from the mangrove habitats. The highest IVI calculated for trees is *Avicennia officianalis* (11.77) while the lowest IVI calculated for tree is *Scyphiphora hydrophyllacea* (1.63). The details on phyto sociology of mangrove habitats are provided in ***Annex 19 of EIA Volume 2.***

Aquaculture Ponds

Aquaculture ponds are located after the back waters/lagoon areas where bunding has been made to undertake prawn/crab culture in brackish water followed by fresh water fish culture. No plantation is generally undertaken in bracking water culture, however, dense plantation of coconut (*Cocos nucifera*) is maintained at the fresh water fish culture. Apart from coconut plantations, other preferred species are *Albizia saman, Azadirachta indica, Mangifera indica, Millettia pinnata.* Some area above inundation level *Prosopis juliflora* has been established. Vegetation in the Aquaculture habitat are represented in ***Figure 3.56.***

Figure 3.56 Vegetation at Aqua culture ponds

Prawn & crab culture ponds at S.Yanam South of S.Yanam Light House

Cab culture ponds North of Chirrayanam village

Vegetation at Fish Culture pond at Challapalle

Vegetation at Fish culture pond at N. Kothapalle

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

A total of 6 tree species were enumerated in aquaculture pond habitats. The highest IVI calculated was of *Cocos nucifera* (75.63) which predominate the entire habitat. The lowest IVI calculated for *Mangifera indica, Millettia pinnata, Prosopis juliflora* is 4.63. The details on phytosociology of aquaculture pond habitats in the study area are presented in ***Annex 19 of EIA Volume 2.***

Agriculture Land

The agricultural lands predominantly rice fields are located after the aquaculture pond areas (land side) where fresh water are supplied from Dowleswaram Barrage through a network of canal system. Most of the study area has dense cultivation of paddy together with groves of coconut palms. *Borassus flabellifer* are also seen. The entire plain areas are modified by human activities and no original forests or its remnants can be seen. A few tolerant wild species (*Sarcolobus*, *Ficus hispida*, *Urena lobata*, *Sida* spp., *Chloris* sp.) grow along canals and bunds. Herbs and shrubs are also seen near village dumps. In the cultivated areas, they are often cleaned as weeds, and therefore the coconut-paddy farms are very low in species richness. Shrub flora is dominated by *Lantana camara*, *Eupatorium odoratum, Calotropis* etc. Species of *Erythrina variegata*-Indian Coral Tree is also seen close to Gatchakayalapora village and *Tamarindus indicus* close to Gopavaram and Challapalle village

Figure 3.57 Vegetation at Agriculture Fields

Single species of Erythrina variegata-Indian Coral Tree

Agricultural Land at Challapalle village

Agricultural land in Gopavaram

Agricultural Land at T. Challapalle village

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

The agriculture land scape is represented by 18 tree species, 1 climber species, 5 shrubs species and 18 herbs species. Highest density of trees is calculated for *Cocos nucifera* (7 individuals/ 100sq.m). This species is widely planted at the boundary of each agricultural field. Highest density for Shrubs is calculated for *Kirganelia reticulata* and *Lantana camara* (2 individuals/sq m) whereas highest density for herbs is calculated for *Paspalidium geminatum* (5.80 individuals/sq.m). The details on phytosociology of agricultural lands in the study area are presented in ***Annex 19 of EIA Volume 2.***

Species Richness and Species Diversity

Species richness of the study area is represented by number of species in the habitat and species diversity is represented by Shannon Weiner Species diversity index detailed in the methodology sections. The details of species richness and species diversity is presented in ***Table 3.33.***

Table 3.33 Species Richness and Diversity in Various Habitats

Habitats	Species Richness	Number of species in each Group	Species Diversity Index H' value
Shelterbelt	5	Trees-5; Climber-0; Shrubs-0; Herbs-0	1.31
Beach Areas	10	Trees-0; Climber-5; Shrubs-2; Herbs-3	3.13
Aquaculture	6	Trees-6; Climber-0; Shrubs-0; Herbs-0	1.43
Agriculture	42	Trees-18; Climber-1; Shrubs-5; Herbs-18	4.78
Mangroves	22	Trees-18; Climber-0; Shrubs-0; Herbs-4	4.15

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

3.14.4 Terrestrial Faunal Species

Given the presence of diverse and dynamic types of habitat present within the study area, wide diversity of fauna were reported from the study area. Faunal species from the study area were enumerated as various faunal groups such as Butterflies, Herpetofauna (amphibian and reptiles), avifauna and mammals. These are described in the following sections:

Butterflies

A total of 26 species of 17 genera belonging to 4 families of butterflies were observed from the study area. None of these species bear any conservational status from IUCN or WPA. List of the species is provided in ***Annex 20 of EIA Volume 2.***

Ichthyofauna

As the study area being located in Godavari delta, diverse variety of fish can be found here ranging from fresh water species, estuarine species (brackish water) as well as strictly marine species. A total of 312 species of fish species are reported in study(1) undertaken by Zoological Survey of India. A list of species are given in ***Annex 20 of EIA Volume 2*** based on the study undertaken by ZSI. Fish fauna from the study area is provided in ***Figure 3.58.***

Figure 3.58 Ichthyofauna species in the Study Area

Mudskipper (*Boleophthalmus boddarti*)

Blue panchax or whitespot (*Aplocheilus panchax*)

Ribbon fish (*Trichiurus lepturus*)

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Amphibians

A total of three (03) species of amphibians pertaining to freshwater habitats such as village ponds and fresh water canals were observed. None of the species are listed in IUCN Red List

(1) Editor-Director, 2001. Fauna of Godavari Estuary, Estuarine Ecosystem Series 4 : i-iv, 1-166 (ZSI, Calcutta)

v2017.3 and WPA, 1972 schedules for their conservation status. List of species recorded are given in ***Annex 20 of EIA Volume 2.*** Species observed at site are depicted in ***Figure 3.59.***

Reptiles

A total of 14 species of 11 genera belonging to 7 families of reptiles were enumerated from the study area. These belong to variety of habitats from fresh water to marine, terrestrial and human habitation. Most have been assessed as "Least Concern". Olive Ridley turtle is vulnerable as per IUCN redlist category. Three species Olive Ridley Turtles (*Lepidochelys olivacea*), Indian flapshell turtle (*Lissemys punctata*) and Monitor lizard (*Varanus benghalensis*) are listed as Schedule-I species and two species Rat snake (*Ptyas mucosus*) and Checkered keelback (*Xenochrophis piscator*) are listed as Schedule–II species of Wildlife Protection Act, 1972 . The species with conservation status are given in ***Annex 20 of EIA Volume 2***.

Herpetofauna species (Amphibians and Reptiles) observed in the study area are depicted in ***Figure 3.59***.

Figure 3.59 Herpetofauna species recorded in the study area

Common Asian Toad *(Duttaphrynus melanostictus)* at Vedanta Ltd (Cairn Oil & Gas) Living Quaters

Common skink *(Eutropis carinata)* at Living Quaters

Garden Lizard (*Calotis versicolor*) at Kothapalem Village

Indian Flapshell Turtle (*Lissemys punctata*) at a pond in Samanthakuru Village

Olive Ridley Turtle (*Lepitochelys olivacea*) (In Situ protected nest) at Sacramento Shoals

Olive Ridley Turtle washed up dead at S.Yanam beach.

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Avifauna

A total of 96 species of 70 genera belonging to 40 families of avifauna were observed in the study area. These avifaunal species were observed from variety of habitats such as forests land, open scrub, agriculture fields, wetlands, coastal areas, mangroves, garden areas etc.

Out of the total 96 avifauna species observed 68 were resident bird species, 26 were winter visitor species and one vagrant species. Two species Western black tailed godwit (*Limosa limosa*) and Black headed Ibis (*Threskiornis melanocephalus*) were listed as Near Threatened as per IUCN red list category and four species Osprey (*Pandion haliaetus*), Brahminy Kite (*Haliastur indus*), Shikra (*Accipiter badius dussumieri*) and Pariah Kite (*Milvus migrans*) listed under Schedule-I of Wildlife Protection Act, 1972. Indian Pond Heron (*Ardeola grayii*) and Little Egret (*Egretta garzetta*) were the most abundant bird species.

The avifaunal species from the study area are depicted in ***Figure 3.60*** and listed with their conservation status as per IUCN red list v.2017.3 and Wildlife Protection Act, 1972 along with their migratory status in ***Annex 20 of EIA Volume 2.***

Figure 3.60 Avifaunal Species in the Study Area

Black Kite (*Milvus migrans*)

Black Winged Stilt (*Himantopus himantopus*)

Blue-tailed Bee eater *(Merops philippinus*)

White-throated Kingfisher *Halcyon smyrnensis*)

Little Tern (*Sternula albifrons*)

Black-headed Ibis (*Threskiornis melanocephalus)*

Bar-tailed Godwit (*Limosa lapponica*)

Pacific Golden Plover (*Pluvialis fulva*)

Lesser Whistling Duck (*Dendrocygna javanica*)

Grey Heron
(*Ardea cinerea*)

Purple Heron
(*Ardea purpurea*)

Common Red Shank
(*Tringa totanus*)

Night Heron
(*Nycticorax nycticorax*)

Black Ibis (*Pseudibis papillosa*)

Brown Headed Gull
(*Larus brunnicephalus*)

Black Headed Gull
(*Larus ridibundus*)

Asian Openbill
(*Anastomus oscitans*)

Great Egret
(*Casmerodius albus)*

Western Reef Heron
(*Egretta gularis*)

Oriental Skylark
(*Alauda gulgula*)

Lesser Sand Plover
(*Charadrius mongolus)*

Source: Coastal Site and Surrounding Areas Survey by ERM during 12-19 Dec 2017 and 11-17 April 2018

Mammals

A total of 25 species of 24 genera belonging to 13 families of mammals were observed/ reported (1) from the Coringa WLS and adjacent areas including our study area. These mammalian fauna are reported to present in variety of habitats such as agricultural field, aquaculture ponds, forest areas, Human habitation etc.

(1) Nagulu V. et al. (2002) Study of the status, distribution, habits and habitat preferences and strategies for conservation of otters in Coringa Wildlife Sanctuary. Wildlife Biology Section, Department of Zoology, Osmania University Hyderabad= 500 007.

Out of the 25 species observed/reported from the study area two (02) species Fishing cat (*Prionailurus viverrinus*) and Smooth coated Otter (*Lutragale perspicillata*) are listed as vulnerable category and one (01) species as Near Threatened as per IUCN red list. Three (03) species Fishing cat (*Prionailurus viverrinus*), Smooth coated otter (*Lutragale perspicillata*) and Indian Pangolin (*Manis crassicaudata*) are listed as Sch.-I as per Wildlife Protection Act, 1972. Six (06) species Jackal (*Canis aureus*), Indian Fox (*Vulpes bengalensis*), Jungle Cat (*Felis chaus*), Small Indian Civet (*Viverricula indica*), Common Palm Civet (*Paradoxurus hermaphrodites*) and Grey Mongoose (*Herpestes edwardsii*) are listed as Sch.-II species as Wildlife Protection Act, 1972. List of species reported from the study area are presented in ***Annex 20 of EIA Volume 2.***

Species of conservational significance are detailed further hereunder.

Fishing Cat (Prionailurus viverrinus)

Reports (1) of occurrence of Fishing Cat (IUCN-Endangered, WPA-Sch-I) are available from the mangroves of Coringa Wildlife Sanctuary. Forest department also confirms the presence of Fishing Cat in the Coringa WLS. The current Management Plan of Coringa WLS suggests population estimates of 30 no. based on May 2012 census.

As the mangrove forests within the study area, particularly in the north, are continuous vegetation patches with Coringa Wildlife Sanctuary. According to management plan of Coringa WLS, fishing cats are found in these mangrove forests. Fishing cats are more commonly found in around Mulletumoga, Kothapalem and Neelarevu region. But decline in number in noticed in Balusutippa and Masasanitippa area. Fishing cats are capable of living in modified aquatic habitats like areas under aquaculture, but according to forest department, fishing cats straying into aqua firms, are killed by villagers if caught.

Smooth Coated Otters (Lutrogale perspicillata)

Smooth Coated Otters (*Lutrogale perspicillata*) (IUCN-Vulnerable, WPA-Sch-II) are reported from Coringa WLS. Based on the latest available census of May 2012 there are 57 individuals in Coringa WLS. Current census is on-going. These Otters were not observed during the primary survey; however local fishermen have reported their presence as rare in the mangrove vegetation. Recent ecological survey(2) conducted in study area has recorded otter activity close to the Vedanta Ltd (Cairn Oil & Gas) onshore terminal. Probably security provide by Vedanta Ltd (Cairn Oil & Gas) to the plant adjacent mangrove, provide safe refuge to otter family.

3.14.5 Secondary Information on Marine Flora

Marine environment is presented based on secondary information for the published sources and community consultations.

(1) Mukherjee, S., T. Adhya, P. Thatte & U. Ramakrishnan (2012). Survey of the Fishing Cat *Prionailurus viverrinus* Bennett, 1833 (Carnivora: Felidae) and some aspects impacting its conservation in India. Journal of Threatened Taxa 4(14): 3355–3361.
(2) 2018 Biodiversity Management Plan for Ravva Block, for Vedanta Ltd. Cairn Oil and Gas, prepared by Terracon Ecotech Pvt. Ltd.

As per recent report[1], two sea grasses *Halophila beccarii* and *Halodule pinifolia* are common along east coast of India. In the study area, mangrove associated grasses have been reported.[2]

- *Myriostachya wightiana* – common along the creeks (not observed during the ecological survey)
- *Aeluropus lagopoides*- common along the coastal area and in open sandy areas near mangroves. (Dominant species as seen during the survey)
- *Porteresia coarctata*- Frequent in the coastal rice fields and abandoned fisheries areas (very common along the southern part of the study area near the coast)

Heavy tidal action, deep sea water currents, soil erosion and siltation, pollution due to industrialization, setting of major harbours along the east coast and over fishing were identified as main factors responsible for the absence of major sea grass bed in this region.

3.14.6 Secondary Informattion on Marine Fauna

Marine Fishes

Data [3] on marine fishes from fish landing centres and commercial trawling off Kakinada was maintained by Central Marine Fisheries Research Institute at Kakinada and compiled as Marine Fish Calendar. The details have been provided in ***Annex 20 of EIA Volume 2***and latest Annual Fish Production data from District Statistical Hand Book-2015 East Godavari District in ***Table 3.34.***

Table 3.34 Marine Fish Production Reported for the East Godavari District

Name of the Species	Year 2013-14	Year 2014-15
A) Marine Fishes		
Elasmobranch		
a. Sharks	674.00	642.00
b. Skates	237.00	282.00
c. Rays	423.00	374.00
Eels	623.00	579.00
Catfish	3171.00	2808.00
Clupeods		
a. Wolf Herrings	0.0	0.0
b. Sardines	2333.00	1673.00
c. Hilsa Shades	291.00	1857
d. Anchovies	1583.00	1488.00
e. Other Clupeoids	190.00	0.00
Bombay Duck	210.00	172.00
Half Beaks and Full Beaks	0.0	0.0
Flying Fish	0.0	0.0
Perches	1284.00	2062.00
Goat Fishes	0.0	0.0
Threadfins	0.0	0.0
Ribbon Fish	8388.00	9758.00
Carangids	0.0	0.0

(1) Swain, P.K., Rama Rao, N. & Sanjay Mohan (2008) New Mangroove Habitats and addition to the flora of Srikakulam District, Andhra Pradesh, India Indian Journal of Forestry Vol. 31(3):431-434.

(2) Ramasubramanian, R., T.Ravishankar and D.Sridhar, 2003. Mangroves of Andhra Pradesh: Identification and Conservation Manual. M.S.Swaminathan Research Foundation, Chennai. 67 pp.

(3) Murty, V Sriramachandra and Bandyopadhyay, M K and Ramalingam, P (1988) Marine fish calendar. V. Kakinada. Marine Fisheries Information Service, Technical and Extension Series , 83 . pp. 1-17.

Name of the Species	Year 2013-14	Year 2014-15
Silver Bellies	0.0	225.00
Big Jawed Jumpets	0.0	0.0
Promferts	15884.00	0.00
Mackerel		
a. Kanagartha	2925.00	0.0
b. Other Mackeries	472.00	0.0
Seer Fish	155.00	686.00
Tunnies	0.0	0.0
Baracudas	0.0	0.0
Mullets	530.00	946.00
FlatFish	0.0	0.0
Miscellaneous	79794.00	47305.00
Total Marine Fishes	***119167.00***	***82896.00***
B) Marine Shrimps		
a. Panaeid Shrimp	10125.00	10389.00
b. Non Panaeid Shrimp	5664.00	5914.00
Total Marine Shrimp	**15789.00**	**16303.00**
Total (A+B)	**119167.00**	**82896.00**

Source: Depurty Director of Fisheries, East Godavari District, Kakinada

Whale Shark (*Rhincodon typus*) listed as Endangered as per IUCN Red List of Threatened Species v.3, 2017 and Sch.-I of Wildlife Protection Act,1972. Fishery experts, researchers and local fishermen opined that until late 2007, the whale shark was a rare visitor to the EGREE region, but the number of sharks has increased in recent years. According to fishermen, whale sharks are seen at a depth of 20–40 m and sometimes come close to shore where they become entangled in shore seine nets. The fishermen revealed that whale sharks are seen mostly solitary or in small groups of 3 to 5 individuals, but sometimes over 200–300 individuals will aggregate in the open sea near the East Godavari River Estuarine Ecosystem (EGREE) region, of Andhra Pradesh, east-coast of India. As per the available literature, the total number of whale sharks killed as bycatch was 20 along the Andhra Pradesh coast between 1889 and 1998 (110 years).

But surveys by the EGREE Foundation that between June 2013 and January 2016, 79 individual whale sharks were killed. The whale shark landings happened in all months except during the fishing ban from 16th April to 15th June. In September of 2014, 22 whale sharks were brought to the landing centers. Of these 22 sharks, four were alive after being caught in a shore-seine fishing net.

A study(1) describes that Whale sharks, *Rhincodon typus*, are known to aggregate to feed in a small number of locations in tropical and subtropical waters. Study details the Whale shark aggregation near an Oil Rig Platform near Doha because of marine fish spawning events and increased planktonic density as the platforms act as fish aggregating devices (FADs). The tendency for tropical tuna to aggregate under floating structures is well-known, with half of the world's tuna catch now obtained around FADs(2)(3).

(1) Robinson DP, Jaidah MY, Jabado RW, Lee-Brooks K, Nour El-Din NM, Malki AAA, et al. (2013) Whale Sharks, Rhincodon typus, Aggregate around Offshore Platforms in Qatari Waters of the Arabian Gulf to Feed on Fish Spawn. PLoS ONE 8(3): e58255. https://doi.org

(2) Girard C (2004) FAD: Fish Aggregating Device or Fish Attracting Device? A new analysis of yellowfin tuna movements around floating objects. Animal Behaviour 67: 319–326. :http://linkinghub.elsevier.com/retrieve/pii/S000334720300438X

(3) Fonteneau A, Pallares P, Pianet R (2000) A worldwide review of purse seine fisheries on FADs. Pêche thonière et dispositifs http://archimer.ifremer.fr/doc/00042/15278/

Marine Reptiles

Along the eastern coast, only one species of marine turtle i.e. Olive Ridley Turtle (*Lepidochelys olivacea*) nesting sites have been reported (1). Based on the discussion with Forest Range Officer, Wildlife Division Kakinada, Wildlife Division has developed in-situ and ex-situ conservation sites for Olive Ridley Turtles nests in Kandikuppa (Sacramento Shoal), Hope Island (Coringa Wildlife Sanctuary) and Yellayyapeta in East Godavari District. Site visits to Sacramento Shoal area confirmed presence of nests of Olive Ridley Turtles.

Marine Mammals

Four (04) species Short-beaked Common Dolphin (*Delphinus delphis*), Bottlenose Dolphin (*Tursiops truncates*), Minke Whale (*Balaenoptera acutorostrata*) and Unidentified Baleen whales have been found to be reported (2) from off Kakinada region of the East Godavari District. These are presented as ***Table 3.35.***

Table 3.35 Marine Mammals Reported from the Region

Date of Record	Scientific Name	Details	Reference
Short-beaked Common Dolphin (IUCN-Least Concern), WPA-Not Listed			
Not Available	*Delphinus delphis*	Two female Common Dolphins measuring 2.16 and 2.09 m entangled in gillnet and landed at Dummulapeta, East Godavari district, AP	Anonymous (1998) on landing of dolphins at Dummulapeta, East Godavari district, AP. Marine Fisheries Information Service Technical & Extension Series 152,17-18.
05-Feb-89		Eight of this species sighted at 16°4'N, 81°31'E, north of Kakinada	Jayaprakash, A.A.,Nammalwar, P., Krishna Pillai, S. & Elayath, M.N.K. (1995) Incidental by-catch of dolphins at Fisheries Harbour, Cochin, with a note on their conservation and manage-ment in India. Journal of the Marine Biological Association of India, 37, 126-133.
Common Bottlenose Dolphin(IUCN-Least Concern), WPA-Not Listed			
28-Apr-93	*Tursiops truncatus*	Female caught in a bottom-set gillnet about 30 km northeast of Kakinada	Nageswara Rao, T. & Venkata Raman, P. (1994) On the landing of Bottlenose Dolphin Tursiops truncates at Kakinada.Marine Fisheries. Information Service Technical & Extension Series, 127, 16.
07-Jul-97		One female Bottlenose of length 2.45 m caught off Kakinada	Venkataramana, P. & Achayya, P. (1998) On the capture of a bottlenose dolphin off Kakinada. Marine Fisheries Information Service Technical & Extension Series, 155, 20.
Minke Whale (IUCN-Least Concern), WPA-Not Listed			
04-Aug-85	*Balaenoptera acutorostrata*	A 6.31 male whale with a prominent white band over the flippers caught alive off Kakinada, believed to be of this species	Seshagiri Rao, C.V. (1991) On a Minke Whale *Balaenoptera acutorostrata* caught off Kakinada coast.Marine Fisheries Information Service Technical & Extension Series, 109, 15-16.
Baleen Whales (IUCN-Least Concern) WPA-Not Listed			
19-Jul-59	Unidentified Baleen whales	7.8 m (26 feet) long *Balaenoptera sp.* whale driven ashore near Etumoga village, Kakinada	Lakshmana Rao, C. (1961) On the capture of a baleen whale at Kakinada on the east coast of India.Journal of the Marine Biological Association of India, 3, 273.

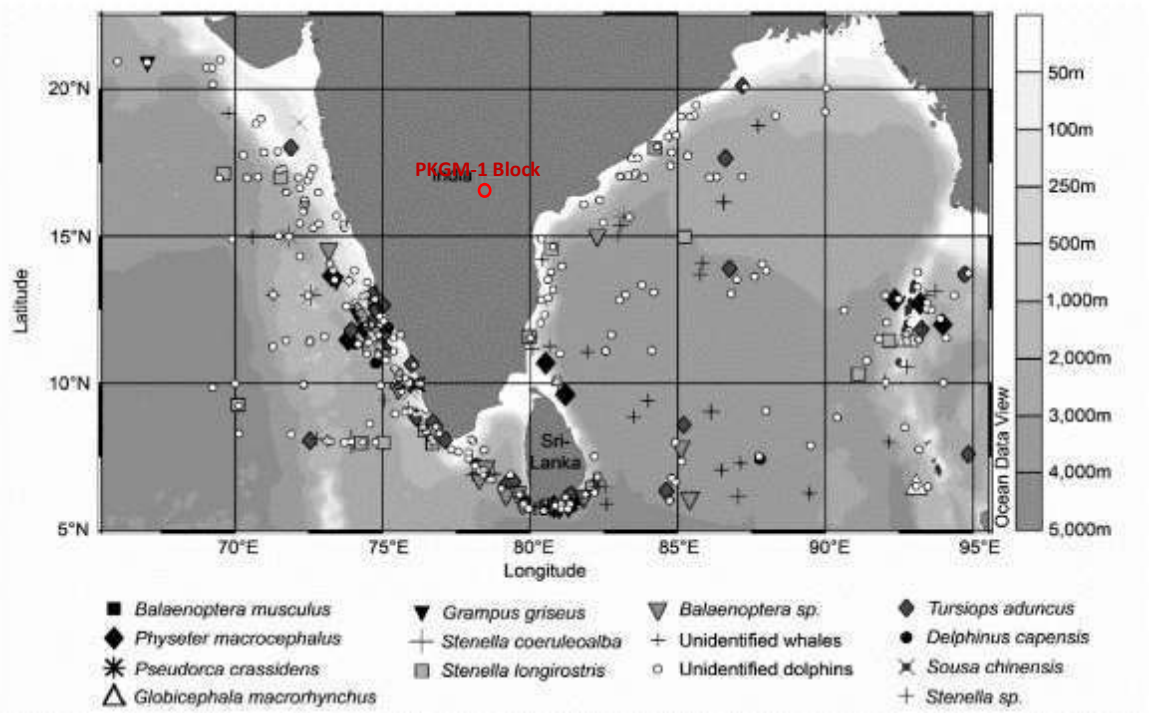
Note: IUCN: International Union for Conservation of Nature Red Data List of threatened species. Wildlife Protection Act, 1972

(1)As per document sea turtles of India, 2011 -a comprehensive field guide to research, monitoring and conservation (Compiler: S. Shenoy, T. Berlie and K. Shanker), Dakshin Foundation, Bangalore and Madras Crocodile Bank Trust, Mamallapuram, India. 148 pages

(2) http://www.marineconnection.org/docs/Indian_Marine_Mammals.pdf

A recent study [1] on distribution of Cetacean species in Indian Exclusive Economic Zone (EEZ) indicates the presence of unidentified dolphins in 50 m water depth. Distribution map of Cetaceans in Indian EEZ is given in ***Figure 3.61.***

Figure 3.61 Distribution Map of Cetaceans in Indian EEZ



Source: Afsal et. al. (2008)

The Dolphin and Whale species are under conservation by Convention on Conservation of Migratory Species of Wild Animals (CMS) to which India is a party. The main threats reported in the area are direct exploitation and capture, by-catch in fisheries, habitat loss and degradation, contaminants and disturbance from increased vessel traffic.

Overall, the Cetaceans generally occurs in water depth of 50 m or more. Water depth in PKGM-1 Block gradually increases to 10 m up to ~10 km from shore followed by further increase beyond southern boundary of the block. As the block has shallow water depth, Cetacean species have not been reported in the study area. However, sporadic with rare sighting of dolphin species - short-beaked Common Dolphin (Delphinus delphis) and Bottlenose Dolphin (Tursiops truncates) are sometimes reported in lower water depths. Cetaceans have been reported away from existing facilities in PKGM-1 Block. Minke Whale (Balaenoptera acutorostrata) and Unidentified Baleen whales have been reported off Kakinada region of the East Godavari District.

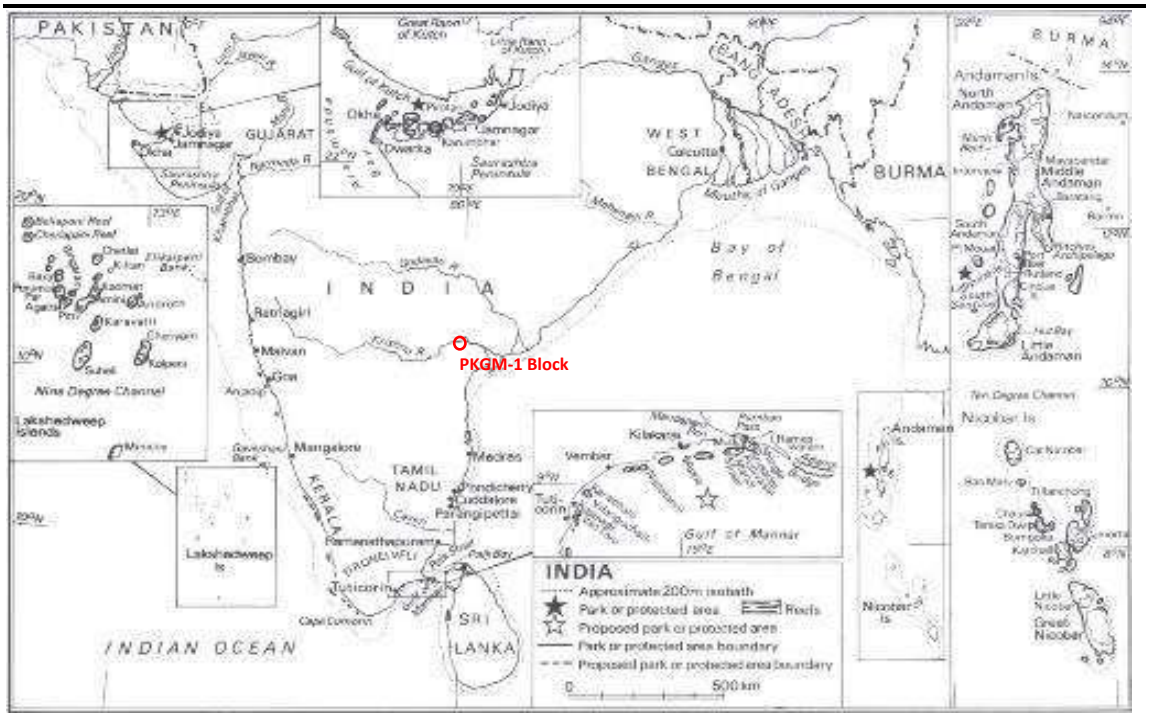
Coral Reef

The offshore Ravva Field and surrounding region is devoid of any "Fringing Reef", "Barrier Reef" and "Atoll" coral reefs. The major reef formations in Bay of Bengal, India are restricted to the Gulf of Mannar, Palk Bay and Andaman and Nicobar Islands as shown in ***Figure 3.62.***

(1) Afsal, V.V.;Yousuf, K.S.S.M.; Anoop, A.K.; Kannan,P; Rajagopalan,M and Vivekanandan, E. 2008 A note on cetacean distribution in the Indian EEZ and contiguous seas during 2003-07 J. CETACEAN RES. MANAGE. 10(3):209–215,

The nearest coral reefs are situated in Gulf of Mannar (Arial distance 843 km) and A&N Islands (aerial distance 1,180 km) from PKGM-1 Block.

Figure 3.62 Coral Reefs along Bay of Bengal



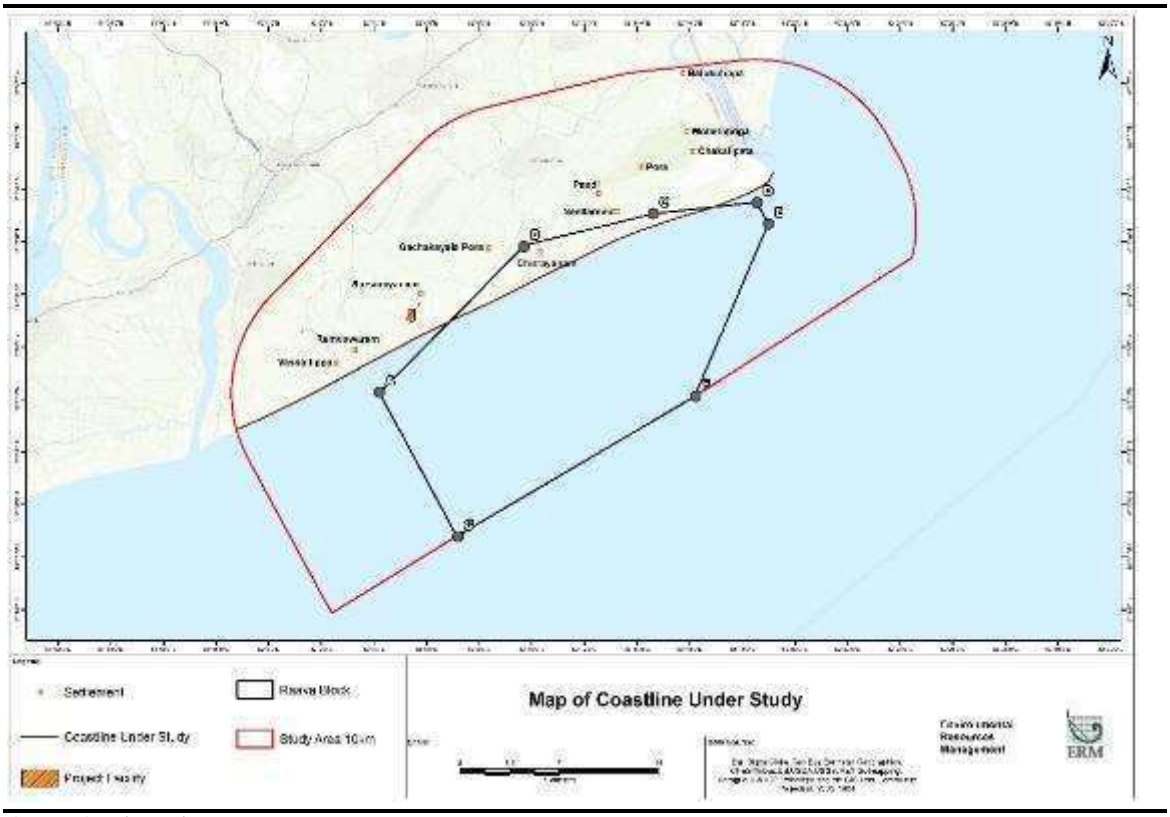
Source: http://niobioinformatics.in/corals/corals_locality_page.php

3.14.7 Coastal Survey

Coastline survey was undertaken by ERM team on 11th to 17th April 2018, along different stretches of coastline within the study area, in order to enumerate habitation, habitats, sensitive receptors such as mangrove forests, breeding and spawning areas and other ecologically sensitive areas. Broadly, the sandy coastline falls between the confluence of Vainateya Godavari River and Gautami Godavari River with sea. Coastline is intersected at three locations, at Rameswaram village, Chirrayanam Village and before Sacramento shoals. During the survey, the sensitivities/activities along the 41 km coastline falling between Village Odalaravu, Allavaram Mandal, East Godavari District and Sacramento Shoals area near Kandikuppa, Katrinikona Mandal East Godavari District were enlisted and presented below.

In order to establish the effect of project related activities on the sanctuary, secondary data was collected from the Kakinada Range of Wildlife Management Division, tasked with management of Coringa Wildlife Sanctuary and Olive Ridley turtle conservation. Consultation was carried out at East Godavari Estuarine Ecosystem (EGREE) office at Kakinada to gather secondary information, particularly on Olive Ridley Turtle nesting, within the study area. Map of the coastline understudy is given in ***Figure 3.63***

Figure 3.63 Coastline Map in Study Area



Source: Google Earth

3.14.8 Habitats

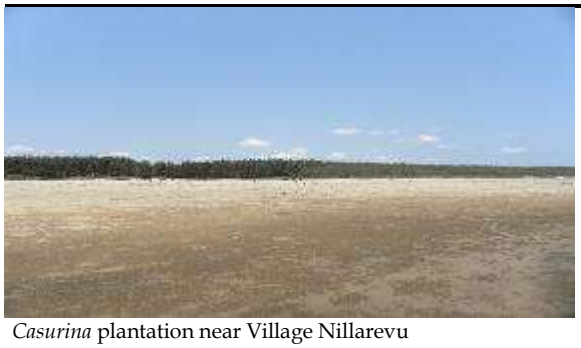
The habitats available were mainly plantation, forest area (including mangroves), water logged area, sea coast, estuary, and habitation. All these habitats forms a part of East Godavari River Estuarine ecosystem(EGREE). Plantation and Forest area in the region is discussed below:

Plantation

Casuarina equisetifolia plantation has been raised as a shelter belts all along the coastline to act as wind brakes during cyclonic activity. These *Casurina* plantation are developed at revenue as well as on forest land. The plantation were raised in 800 ha. area by forest department in the entire coastline. In addition to plantation in Kandikuppa, Masanitippa and Hope Island, *Casuarina* was also planted in the new accretions of Vodalarevu through various Field Labour Cooperative Societies. These lands have since been notified as Protected Forests. *Casurina* plantation is being shown in ***Figure 3.64.***

Casurina plantation along the sea side of the Sacramento Shoal and Kandikuppa area has been raised extensively in phases. Within the lighthouse area of Kandikuppa *Casurina* is grown along with the *Anacardium occidentale* (Cashew) trees in patches. These cashew trees have survived the harsh conditions and have grown well.

Figure 3.64 Plantation along the Coastline



Casurina plantation near Village Nillarevu

Casurina Plantation along coastline at Village Naka Rameswaram

Natural growth of *Pandanus* near Village Naka Rameswaram

Mixed growth of *Borassus, Phoenix and Prosopis* near Chirrayanam

Coastline Survey, by ERM during 12-19 Dec 2017, 11-17 April 2018

Natural Vegetation (Non forest)

Natural growth of *Phoenix sylvestris* (Indian date), *Borassus flabellifer* (Indian Palm) and *Pandanus tectorius* can be seen growing along the coastline. *Pandanus tectorius* is more abundantly found along the mangrove margin, edge of *Casuarina plantation* and beach. These *Pandanus* species provides habitat for mammals like Golden Jackal and wild boar in the study area. Throughout the study area at different places *Prosopis juliflora* was found to grow along with native species. It was never systematically planted in this region, but established itself as an invasive species and even recorded along the margin of mangrove as well as *Casurina* plantation.

Forest Areas

One protected forest was identified along the sea side along with four reserve forests (mainly mangroves) on the land side of the coastline under study. The details of forest areas along the coast from Vainateya Godavari River to Kakinada Bay area are given in ***Table 3.36***.These forest areas fall under the jurisdictions of Kakinada Forest Division and range.

Table 3.36 Forest Areas on the Coastline

Division	Range	Forest Block	Area in Ha.	Legal Status
Kakinada	Kakinada	Vodalarevu PF	217	PF
Mangrove Forest Non Sanctuary Area				
Kakinada	Kakinada	Balusutippa RF	475.91	RF
Kakinada	Kakinada	Kandikuppa RF	3302.23	RF
Kakinada	Kakinada	Kothapalem I RF	80.3	RF
Kakinada	Kakinada	Kothapalem II RF	61.51	RF
Kakinada	Kakinada	Masanithippa RF	1089.91	RF
Kakinada	Kakinada	Matlatippa RF	445.16	RF

Division	Range	Forest Block	Area in Ha.	Legal Status
Kakinada	Kakinada	Rathikalava RF	2049.32	RF
Mangrove Forest Sanctuary Area				
WLM, Rajahmundry	Coringa Wildlife Sanctuary	Bhyravapalem RF	972.05	RF
WLM, Rajahmundry	Coringa Wildlife Sanctuary	Coringa Extn RF	19467.2	RF
WLM, Rajahmundry	Coringa Wildlife Sanctuary	Coringa RF	4242.38	RF

Source: Forest Working Plan Kakinada Forest Division 2000-01 to 2010-11

Odalrevu PF was mainly monoculture *Casuarina equisetifolia* and mainly serves as wind break for cyclonic activity. Isolated trees of *Phoenix sylvestris* (Indian date) were also observed.

Reserve forest areas at Kandikuppa, Kothapalem I & II and Balustippa are mainly mangroves dominated by species of *Avecennia officinalis*, *Avicennia marina*, *Excoecaria agallocha, Rhizophora apiculata R. mucronata, Xylocarpus moluccensis, Cenops decandra* and *Bruguiera gymnorrhiza* have also been recorded. *Scyphiphora hydrophyllacea* a rare and endemic species is been recorded in these reserve forest. Most of the mangrove dominated reserve forest area located in the northern part of the study area. Southern part of the Kandikuppa RF falls within the northern boundary of the Ravva block. These mangrove forest areas are under threat of frequent destruction for firewood, house construction and fishing poles. Mangrove forest in the study area is detailed in the ***Figure 3.65.***

Figure 3.65 Mangrove Vegetation in Study Area

Mangrove vegetation at north of Sacramento Light House showing Kandikuppa and Kothapalem RF

Mangrove vegetation near Pallam Island Village (Kandikuppa RF)

Mangrove near Ravva Terminal

Mangrove near Ravva Terminal

Mangrove near Naka Ramesaram Village

Mangrove vegetation in front of new Sacromento Light House (Kothapalem RF)

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Mangrove area within the study area provide excellent habitat for mudskippers (*Boleophthalmus boddarti*), fiddler crab (*Uca sp*) and wide variety of estuarine fishes. Apart from estuarine fishes mangroves act as natural nursery for different types of marine as well as freshwater fishes, which spend the early stage of lifecycle in estuarine mangroves.

Smooth coated otters are also reported from the mangroves in the study area, particularly from the mangroves developed by Vedanta Ltd (Cairn Oil & Gas), adjacent to the Ravva Terminal. Probably protection provided by Vedanta Ltd (Cairn Oil & Gas)to these mangroves, aided in establishment of Otter colony. Mangroves of Coringa Wildlife sanctuary is a very good habitat for fishing cat. As the mangrove forests within the study area, particularly in the north, are continuous with Coringa Wildlife Sanctuary, there is a high probability of fishing cat distribution in the mangrove forests. However consultation with local people have failed to establish presence of fishing cat in the study area. Presence of elusive cat like fishing cat, can easily go unnoticed.

Figure 3.66 Fauna Recorded in the Mangrove of Study Area

Mudskipper (*Boleophthalmus boddarti*) recorded near Sacramento Light House

Fiddler Crab like *Uca dussumieri,* red in colour and *Uca lacteal,* white in colour, recorded near Kothapalem

Jellyfish recorded near Surasaniyanam

Fiddler Crab (*Uca Triangularis*) Recorded near Pallam

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Protected Area

Coringa wildlife sanctuary, a part of Godavari mangroves is located in East Godavari River Estuarine Ecosystem (EGREE) area of Coastal region of the Bay of Bengal in the East Godavari District of Andhra Pradesh. This area was declared as a wildlife sanctuary under sec. 18 of the Wildlife Protection Act 1972 (Central Act No. L III of 1972) in 1978 through G.O. Ms. No. 484 Forests and Rural Development (For. III) Department dated 5-7-1978 and was notified in the East Godavari District Gazette No. 8 Dated 22-8-1978 and under section 26-A of wildlife protection Act, 1972 (Central Act No. 53 of 1972) in 1998 through G.O.Ms.No.45, Environment, Forests, Science and Technology Department (For. III) dated 21-4-1998 and was notified in the East Godavari District Gazette vide Ref.No.C5/May/126/97 dated 16-5-1998 to conserve the mangrove vegetation of the estuary, extending in area of about 235.70 sq.km.

Notification of Forest areas under Sanctuary

The entire sanctuary is covered by Coringa Reserve Forests, Coringa Extension Reserve Forests and Bhyravapalem Reserve Forests. All the areas included in the sanctuary are reserved forests which belong to the Government and are notified under section 16 of Madras Forest Act or under 15 A.P. Forest Act as detailed below:

- **Coringa Reserve Forest:** Notified as Reserve Forest in G.O.Ms. No. 302 dated 27-4-1888 to take effect from 15-6-1888. **Coringa Extension Reserve Forest:** Notified as Reserve Forest vide Reserve Forest. Fort Saint George Gazette No.36, Dated 5-2-1921. Coringa wildlife sanctuary is located beyond 18 km north of the block (Apex Point D) and ~25 km from nearest proposed well (E-11).
- **Bhyravapalem Reserve Forest:** Notified as Reserve Forest in Forest G.O. Ms. No. 103 – Forest and Rural Development (For.III), Dated 24-4-1974. The location details of the Coringa Wildlife Sanctuary are given in ***Table 3.37.***

Table 3.37 Location details of Coringa Wildlife Sanctuary

Protected Area	**Coringa Wildlife Sanctuary (CWS)**
Latitude	16^0 – 43″ to 16^0 - 58″North
Longitude	82^0 – 14″ to 82^0 – 23″ East
District	East Godavari
Mandal	Tallarevu & Polavaram Mandals
Forest Division	Wildlife Management Divin, Rajahmundry
Range	Kakinada
State	Andhra Pradesh (India)

Note: Coringa WS is located ~25 km from nearest proposed well (E-11) & beyond 18 km north of apex point D of PKGM-1 Block.

3.14.9 Olive Ridley Turtle Breeding , Nesting & Spawning Sites

Olive Ridley's Turtles (Lepidochelys olivacea)

In Andhra Pradesh, Olive Ridley Turtle are known for nesting along the Godavari delta particularly Kakinada beach, Sacramento and Hope Island. Olive Ridley's Turtles (*Lepidochelys olivacea*) are listed as Vulnerable by IUCN, India's "Wildlife Protection Act 1972" identifies it as Schedule I, providing highest degree of protection. Moreover Olive Ridley Turtle is listed in "Appendix I" of Convention of International Trade in Endangered Species of Wild Fauna & Flora (CITES).

Based on data collected from Kakinada Range of Wildlife Management Division, and other published research papers, four turtle nesting grounds were identified within the study area. From north to south these nesting sites are Sacramento or Kandikoppa, Gachykola Pora (GK Pora), Surasaniyanam (S Yanam) and Vasalathippa. Forest department maintains camps in all these locations during the nesting season till the eggs hatch, for in-situ as well as ex-situ conservation and protection of nests and hatchlings from predation. Sacramento Shoal is located ~ 12 km from the nearest proposed well E-11) and beyond 4.5 km from PKGM-1 Block boundary (Apex Point D).

<u>Conservation Technique</u>

- In-situ conservation is generally carried out by guarding individual nest from all side by net supported by firm stick on four corners.
- In case of nests that are more isolated or are at risk of beach erosion Ex-situ conservation is practiced. In this case eggs are carefully collected and places under sand at suitable depth at designated fenced ex-situ conservation areas, located close to monitoring camp.
- Both in case of in-situ and ex-situ conservation nests are marked by the date and time of egg laying, providing an estimated time of hatching.

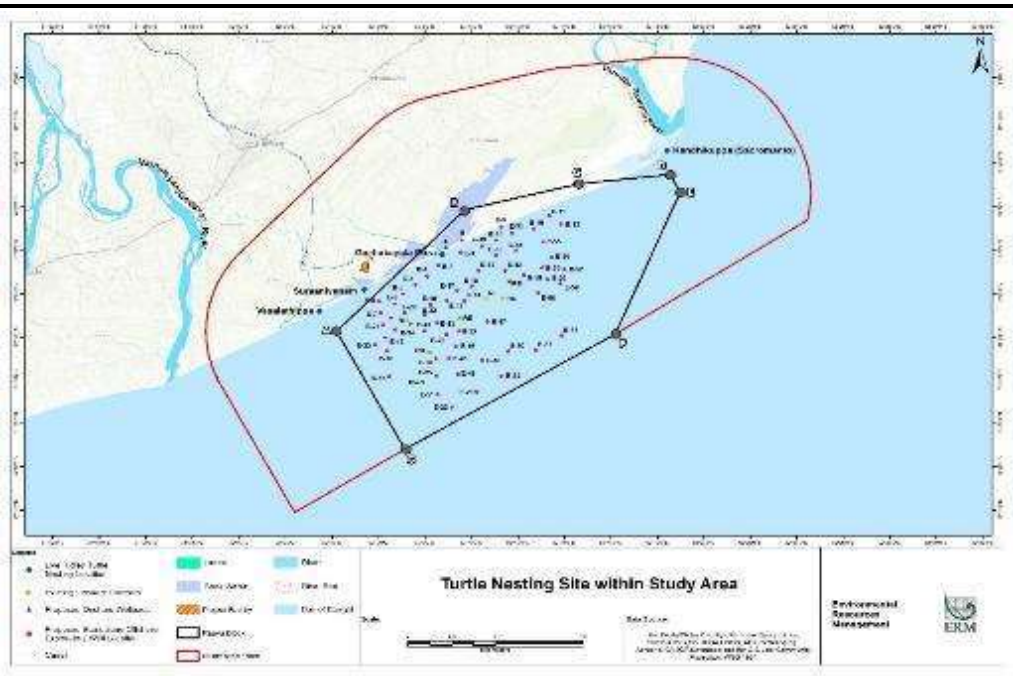
This programme is being closely monitored by the UNDP-GEF_GOI_GOAP project on "Mainstreaming Coastal and Marine Biodiversity Conservation into the Production Sector" with the funding from the Global Environmental Facility (GEF). Data on nesting for the duration of January 2018- 9th April 2018 was collected from forest department Kakinada. Details of these four nesting grounds are provided in the ***Table 3.38.***

Table 3.38 Details of Turtle Nesting Ground in Study Area

SN	Nesting Ground	In-Situ Nest	ExSitu Nest	Total Nest	Sensitivity associated with Nesting Ground
1	Sacramento or Kandikoppa	406	14	420	It is the northern most nesting ground within the study area, and in terms of number of nesting most important nesting ground within the area of interest. This Nesting ground is a sandspit located at the mouth of Goutami Godavari river channel, located about 3km north of the Ravva Block. Nearest well pad # WP-8 (i.e. WP-B / RX-9) is located ~18 km Southwest of the nesting ground.
2	Gachykola Pora (GK Pora)	95	57	152	This nesting ground is located at the mouth of a water inlet channel leading to a large back water or lagoon near Gachykola Pora village. This nesting site is located along the north-western boundary of the Ravva Block. Distance from Wellpad WP-7 (i.e. WP-A/RX-8) 600m NE
3	Surasani-yanam (S Yanam)	213	55	268	This nesting site is located close to the S Yanam beach, about 900m north-west of Ravva block. Distance from Ravva Onshore Terminal is 1.2 km North.
4	Vasalathippa	158	55	213	This nesting site is located about 2km NW of Ravva Block.

Source: Coringa Wildlife Management Plan, Kakinada Range office, Wildlife Management Division

Figure 3.67 Turtle Nesting Site within Study Area



Source: Source: Kakinada Range of Wildlife Management Division

Figure 3.68 Olive Ridley Turtle Egg Conservation Sites

Ex situ Egg Nest at Sacramento Shoals

In situ Nests marked at Sacramento Shoals

Consultation with Guards at Sacramento Forest Camp

Signs of Egg Predation at Sacramento orKandikoppa

In-Situ Nest conservation at S Yanam Beach

To protect from predation nests are covered and marked in In Situ conservation at S Yanam

Guards deputed by EGREE for In Situ and Ex Situ conservation of Olive Ridley Nest at S.Yanam beach.

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

During the current coastline study, 1km of beach near well location 4 was exclusively surveyed for Olive Ridley Turtle carcass. Within this 1 km stretch of beach about 10 Olive Ridley Turtle carcass was recorded in different of decomposition. The main cause attributed to these mortality due to collision with trawlers in the area, which have washed ashore.

Figure 3.69 Recorded Olive Ridley Carcass

Carcass - C1: near 16°28'42.97"N, 82° 6'17.02"E

Carcass – C2 near 16°28'46.35"N, 82° 6'23.57"E

Carcass – C3 near 16°28'46.42"N, 82° 6'24.93"E

Carcass – C4 near 16°28'50.43"N, 82° 6'31.83"E

Carcass – C5 near 16°28'50.90"N, 82° 6'32.65"E

Carcass – C6 near 16°28'51.19"N, 82° 6'33.17"E

Carcass – C7 near 16°28'52.32"N, 82° 6'36.75"E

Carcass – C8 near 16°28'53.04"N, 82° 6'37.68"E

Carcass – C9 near 16°28'55.89"N, 82° 6'43.34"E

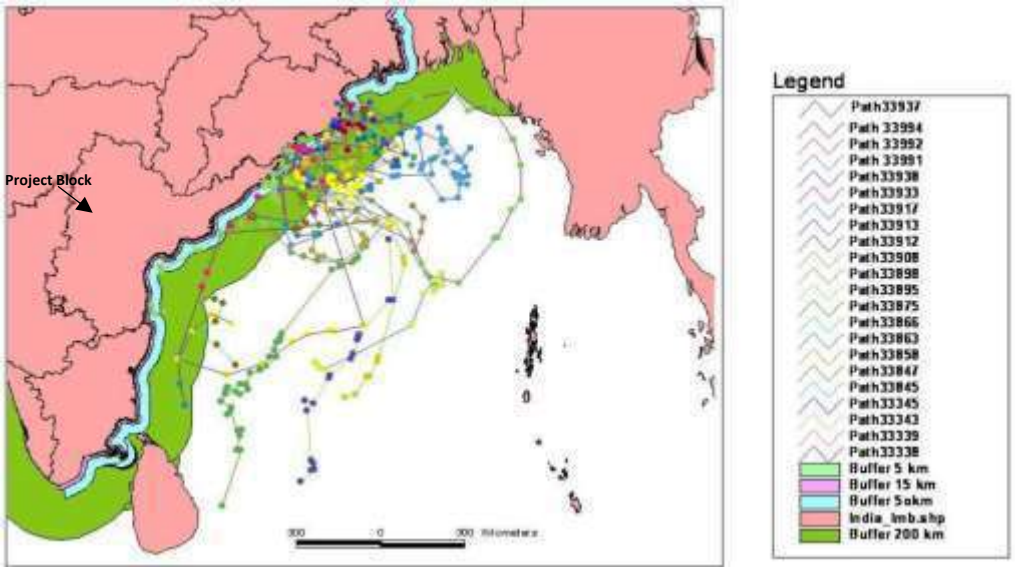
Carcass – C10 near 16°28'56.01"N, 82° 6'43.58"E

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

These evidences confirm the movement of turtles along the coastline under study. Consultation with forest department as well as EGREE revealed that, major threat to adult turtle movement in this area is mechanised trawlers used for fishing, operating mostly out of Kakinada.

Olive Ridley turtle movement(1) has been tracked by Satellite tracking study of migratory path of Olive Ridley Sea Turtles in the east coast of India funded by Directorate of General Hydrocarbon and Ministry of Petroleum and Natural Gas in association with Wildlife Institute of India, Dehradun as provided in ***Figure 3.70***.

Figure 3.70 Olive Ridley Turtle Movement Map based on Satellite tracking study



Source: Movement Patterns of Olive Ridley Sea Turtle May, 2011. Wildlife Institute of India

(1) Unpublished Report of WII

Fishing Cat (Prionailurus viverrinus)

Reports [1] of occurrence of Fishing Cat (IUCN-Endangered, WPA-Sch-I) are available from the mangroves of Coringa Wildlife Sanctuary but no such reports are available for the area of interest. Local fisherman was also consulted by showing photographs to which their response was negative.

Forest department also confirms the presence of Fishing Cat in the Coringa WLS. The current Management Plan of Coringa WLS suggests population estimates of 112 no. based on 2002-03 census. The current census data collection is on-going.

As the mangrove forests within the study area, particularly in the north, are continuous with Coringa Wildlife Sanctuary, there is a high probability of fishing cat distribution in the mangrove forests. However consultation with local people have failed to establish presence of fishing cat in the study area. Presence of elusive cat like fishing cat, can easily go unnoticed.

Smooth Coated Otters (Lutrogale perspicillata)

Smooth Coated Otters (*Lutrogale perspicillata*) (IUCN-Vulnerable, WPA-Sch-II) are reported from Coringa WLS. Based on the latest available census of 2002-03 there are 324 individuals in Coringa WLS. Current census is on-going. These Otters were not observed during the primary survey; however local fishermen have reported their presence as rare in the mangrove vegetation. Recent ecological survey [2] conducted in study area has recorded otter activity close to the Ravva onshore terminal. Probably security provided by Vedanta Ltd (Cairn Oil & Gas) to the plant adjacent mangrove, provide safe refuge to otter family.

3.14.10 Old Structures

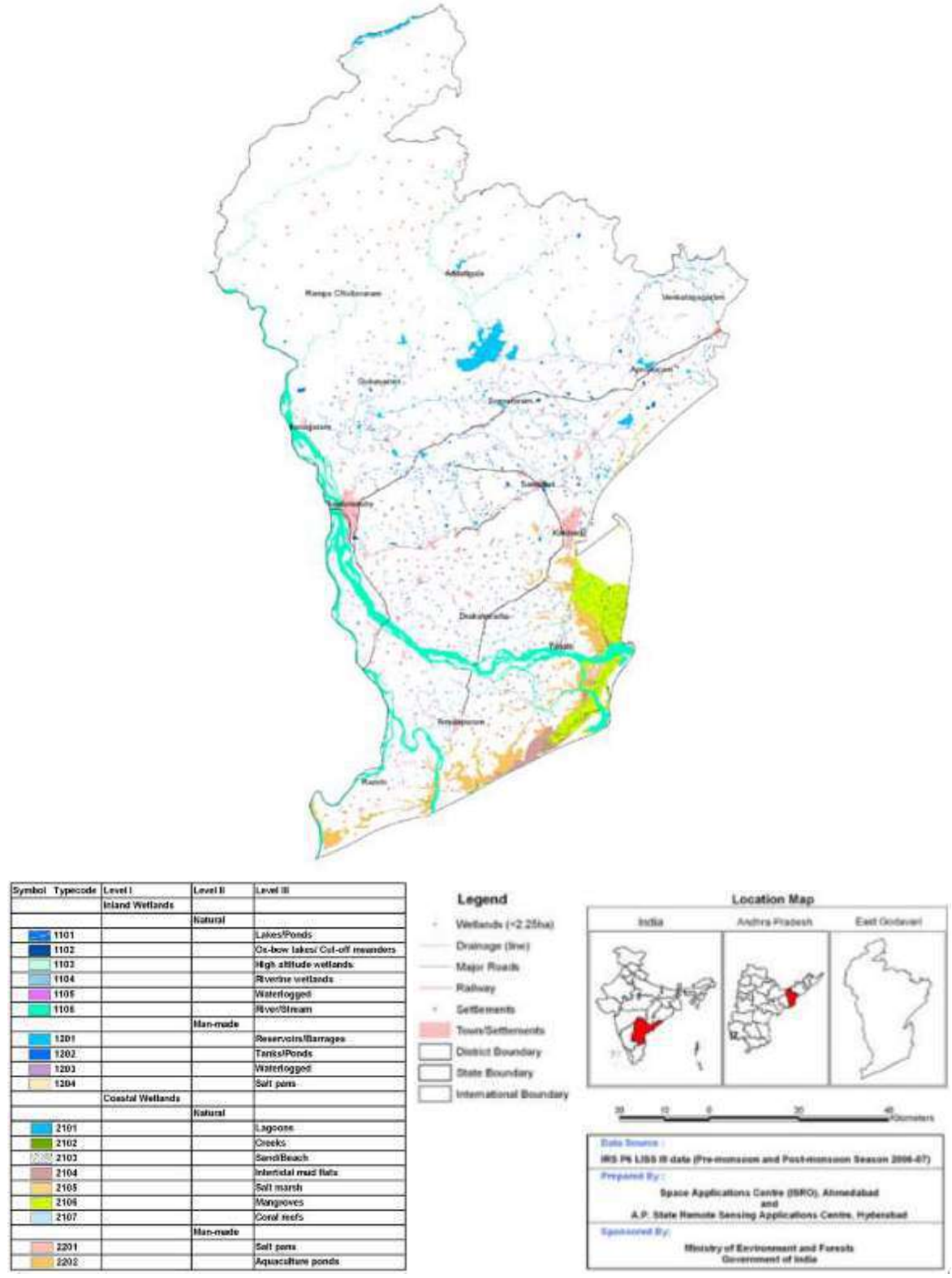
No notified archaeological monuments are available along the coast line, however, two (02) no. of Light house are available along the coast line. One present in Corangi reserve forest is not in used and had turned into ruins, another one situated in Sacramento and is still in use. The nearest Adurru Budhist archaeological site is located ~35 km from Ravva Terminal.

3.14.11 Wetlands

The wetland atlas for East Godavari district is enclosed as ***Figure 3.71***

(1) Mukherjee, S., T. Adhya, P. Thatte & U. Ramakrishnan (2012). Survey of the Fishing Cat Prionailurus viverrinus Bennett, 1833 (Carnivora: Felidae) and some aspects impacting its conservation in India. Journal of Threatened Taxa 4(14): 3355–3361.
(2) 2018 Biodiversity Management Plan for Ravva Block, for Vedanta Ltd. Cairn Oil and Gas, prepared by Terracon Ecotech Pvt. Ltd.

Figure 3.71 Wetland Map of East Godavari District



Symbol	Typecode	Level I	Level II	Level III
		Inland Wetlands		
			Natural	
	1101			Lakes/Ponds
	1102			Ox-bow lakes/ Cut-off meanders
	1103			High altitude wetlands
	1104			Riverine wetlands
	1105			Waterlogged
	1106			River/Stream
			Man-made	
	1201			Reservoirs/Barrages
	1202			Tanks/Ponds
	1203			Waterlogged
	1204			Salt pans
		Coastal Wetlands		
			Natural	
	2101			Lagoons
	2102			Creeks
	2103			Sand/Beach
	2104			Intertidal mud flats
	2105			Salt marsh
	2106			Mangroves
	2107			Coral reefs
			Man-made	
	2201			Salt pans
	2202			Aquaculture ponds

Source: National Wetland Atlas: Andhra Pradesh, SAC/EPSA/AFEG/NWIA/ATLAS/33/2010, Space Applications Centre (ISRO), Ahmedabad, India, 172p.

The important wetlands identified along the coast line are Vrudha Gautami Godavari and Vainateya Godavari River mouths are mangroves, intertidal mudflats, water logged areas and aquaculture ponds.

3.15 SOCIOECONOMIC ENVIRONMENT

This section provides the socio-economic baseline for the project area identified for the project

3.15.1 Approach and Methodology

The socio-economic baseline for this project has been developed on the basis of a combination of secondary literature review, as well as the inferences drawn from stakeholder consultations undertaken for the EIA.

Review of Secondary Information

A review and assessment of the available secondary data and information for the study area was undertaken in order to substantiate and corroborate the understanding gained through stakeholder consultations, under the performance of the area on socio-economic parameters and allow for a comparative assessment of the study area vis-à-vis the tehsil and district level socio-economic baseline information. For the purpose of the desk based assessment, the following documents and literature were reviewed

- Census of India Data 2011, including Primary Census Abstract and Village and Urban Directory
- Project description and study area related reports to understand social sensitivities; if any; in the study area; and
- Published research papers, articles and other information available in public domain on aspects such as development of the district, aquaculture, physical and social infrastructure, local governance, civil society and NGOs in the area, regional development plans at the state and district level
    - Handbook of Statistics for East Godavari District, 2015
    - Fisheries Department website
    - Note on inland activities of the fisheries department
    - Schemes for fisherwomen
    - Government of Andhra Pradesh, Department of Fisheries, Status report of Fisheries Activities
    - Annual Report (2010-2011) of the National Fisheries Development Board
    - Socio-economic and Health Profile of the East Godavari District

Stakeholder Mapping and Consultation

The stakeholders for this project differ in terms of the degree of impact, interest, and influence over the project. The stakeholder mapping and its analysis was conducted with the objective of identifying each stakeholder group; studying their profile, characteristics and the nature of their stakes; gauging their influence on the project; and understanding the specific issues, concerns as well as expectations of each group from the project.

Figure 3.72 Consultation with the Community in Project study area

Source: Site Visit by ERM Team

Key groups of stakeholders who were consulted during the study process were as follows

Table 3.39 Stakeholder Consultations Undertaken for the EIA

S. N	Date	Stakeholder Group
1.	12-04-2018	Fishermen at Cherriyanam
2.	12-04-2018	Local community at Neelrewo
3.	12-04-2018	Aquaculturist at Wasalteppa
4.	12-04-2018	Local community at Rameswaram
5.	13-04-2018	Fisheries Department
6.	13-04-2018	Local Fishermen community at Balsalatippa
7.	13-04-2018	Mandal Revenue Office
8.	14-04-2018	Local community at Surasaniyanam
9.	14-04-2018	Local Women's group at Gachakayala Pora

Consultations and discussions were conducted so as to gain a better understanding of the developmental and historical context of the area, as well as the development needs of the area in general and of the specific stakeholder groups in particular. The consultation process was also undertaken with the aim of informing the stakeholders about the project, its proposed activities, while assessing the awareness levels about the project in the community and simultaneously identifying some of the key issues, concerns and expectations of the community.

3.15.2 Project Area for Socio-Economic Baseline

Administratively, the East Godavari District is divided into 5 revenue divisions and 60 Mandals/Tehsils. The five revenue divisions are Kakinada, Rajahmundry, Peddapuram, Rampachodavaram and Amalapuram. The Project falls in Upplaguptam Mandal under Amalapuram Division of the District. The study area for the socioeconomic impact assessment for this project has been identified and presented in ***Figure 3.1***.

The study area is classified into following two areas:

- Villages falling within the Project area and upto 2 km radius of the project footprint; and
- Villages falling between 2 to 10 km radius from project footprint.

The villages falling within the study area are listed in ***Table 3.40***

Table 3.40 Villages within Study Area

Study Area Category	Village Names
Project Area and up to 2 km from Project Footprint	Chirrayanam Surasaniyanam
2-10 km from Project Footprint	Kothapalle, Geddanapalle, Rajupalem; Vetlapalem, Vaddiparru, Kesanakurru, Ainapuram, Rameswaram, Tadikona, Devaguptam, Rellugadda, Komaragiripatnam, Samanthakuru, Sannavalli, Chinagedavalli, Pedagadavilli, Munipalle, Gollavilli, Uppalaguptam, Kunavaram, Gopavaram, T. Challapalle, Lakshmiwada, Penuwalla, Bantumilli, Uppudi, Katrenikona, Kundaleswaram, Nadavapalle, Dontikurru, Pallamkurru, Kandikuppa, Gundepudi, Samanthakur, Turpulank, Challapalli, Raghavulu Peta, Perayi Cheruvu, Ammanna Agrahaaram, Koppigunta, Pora, Kothapalem, Maasaani Tippa

Note: During the survey of the study area, it has been observed that revenue villages having population more than 5,000 are divided into two Gram Panchayats for effective implementation of Panchayati Raj System.

The immediate vicinity of the project footprint area is scarcely populated and has only two village namely Surasaniyanam and Chirrayanam. In keeping with this, the socio-economic baseline presented in the following sub- sections provides a brief profile of the district, tehsil and the tehsil in the 10 km radius and a detailed analysis of the profile of the settlements within the tehsil.

3.15.3 Demographic Profile of Study Area

Demographic Profile

The study area is comprised of six mandals, i.e. Uppalaguptam, Allavaram, Katrenikona, Mummidivaram, I.Polavaram and Amalapuram. Major part of the study area is covered within Uppalaguptam Mandal. The following table provides a brief understanding of the demographic profile of the State, District and Mandals

Table 3.41 Demographic Profile of State, District and Mandals

Name	No. of House holds	Total Population	Population Density	Avg. House hold Size	Sex Ratio	SC%	ST%	Literacy %	Female Literacy %
Andhra Pradesh	21022588	84580777	528	4.02	993	16.41	7.00	59.77	52.93
East Godavari District	1428528	5154296	409	3.61	1006	18.34	4.14	63.80	60.81
Uppalaguptam	16778	59931	510	3.57	979	39.28	0.67	66.79	62.17
Katrenikona	20235	74819	541	3.70	981	32.72	0.59	60.27	54.94
Allavaram	17853	68242	650	3.82	1005	32.57	0.71	70.11	65.71
Amalapuram	39239	141693	1758	3.61	993	23.02	1.06	76.60	73.06
Mummidivaram	19459	68586	688.34	3.52	994	28.17	0.84	70.77	66.37
I. Polavaram	19253	67434	336.19	3.5	985	26.81	0.43	62.12	58.95

Source: Census of India, 2011

The East Godavari District is characterised by a total population of 51,54,296 individuals, of which 1.16% is from the Uppalaguptam Mandal. Amongst the four Mandals, the Amalapuram Mandal has the highest population (1,41,693 individuals) and population density (1757.98 individuals per sq. km). This has primarily been attributed to the fact that of the six Mandals, only Amalapuram has reported an urban population (46% of total population), the rest of the five Mandals are understood to be completely rural[1].

Table 3.42 Demographic Profile of Villages in Study Area

Name	No. of House holds	Total Population	Population Density	Average House hold Size	Sex Ratio	SC%	ST%	Literacy Rate %	Female Literacy %
Project Footprint Area and Village in 2 km Radius									
Chirrayanam	477	1736	138.00	3.64	1052	0.00	0.00	49.48	41.35
Surasaniyanam	958	3878	273.10	4.05	955	34.17	0.70	63.33	57.92
Villages in 2-10 km Radius									
Kothapalle	4378	14926	473.84	3.41	1040	12.41	3.17	52.25	49.06
Geddanapalle	1402	4711	1301.38	3.36	1024	8.30	0.15	51.90	49.45
Rajupalem	602	2155	730.51	3.58	1041	29.61	0.09	57.96	56.51
Vetlapalem	4769	15757	801.07	3.30	1050	20.60	0.51	58.58	56.87
Vaddiparru	909	3176	564.12	3.49	996	40.77	0.16	65.02	62.90
Kesanakurru	3131	11570	548.86	3.70	973	29.97	0.29	65.62	62.47
Ainapuram	1772	6249	610.85	3.53	960	43.56	0.83	67.77	62.30
Rameswaram	1322	5218	675.91	3.95	1015	28.23	0.73	73.15	68.07
Tadikona	484	1662	474.86	3.43	998	58.12	0.66	68.71	64.82
Devaguptam	2264	8298	647.78	3.67	960	42.76	0.25	69.20	64.91
Rellugadda	274	985	266.94	3.59	939	53.50	0.00	75.84	72.75
Komaragiripatnam	3351	13197	350.33	3.94	988	30.30	0.53	71.83	66.57
Samanthakuru	888	3386	625.88	3.81	1017	14.35	0.12	58.74	54.36
Sannavalli	555	1878	733.59	3.38	981	29.34	0.85	72.42	68.17
Chinagedavalli	545	1708	759.11	3.13	934	33.96	0.00	68.91	64.85
Pedagadavilli	462	1511	662.72	3.27	988	35.21	1.06	73.86	68.31
Munipalle	459	1453	615.68	3.17	948	32.21	0.00	74.60	71.85
Gollavilli	1151	4164	1196.55	3.62	988	31.82	0.41	69.72	65.64
Uppalaguptam	2623	9397	490.70	3.58	966	50.67	0.85	65.12	60.41
Kunavaram	778	2863	799.72	3.68	977	51.90	1.36	67.87	64.95
Gopavaram	1231	4280	741.77	3.48	969	58.50	0.96	65.07	60.87
T. Challapalle	2501	9291	426.78	3.71	1011	42.34	0.58	65.21	60.44
Lakshmiwada	356	1157	575.62	3.25	1009	47.45	0.00	68.19	64.72
Penuwalla	590	1919	896.73	3.25	993	43.67	0.83	71.39	66.00
Bantumilli	293	894	827.78	3.05	939	33.67	0.00	71.59	64.67
Uppudi	498	1843	616.39	3.70	908	47.42	1.52	68.42	65.68
Katrenikona	3680	13678	480.44	3.72	972	31.58	1.36	66.08	60.11
Kundaleswaram	544	1756	722.63	3.23	1021	39.18	0.68	71.01	65.95
Nadavapalle	1035	3756	875.52	3.63	1063	27.72	1.12	70.42	63.15
Dontikurru	1105	3918	666.33	3.55	1019	55.49	0.74	72.08	67.37
Pallamkurru	3230	12423	556.59	3.85	974	50.80	0.29	57.51	52.50
Kandikuppa	3297	12585	683.60	3.82	987	19.72	0.24	51.59	44.94

Source: Census of India, 2011

In comparison to the District and Mandals, the average population density in the villages in the study area is 542.37 individuals per sq. km. the highest population density is recorded in

[1] District Statistical Handbook, East Godavari 2015

villages Geddanapalle and Gollavilli. On the other hand, the village Surasaniyanam reported the highest average household size followed by Rameswaram.

During consultation with different stakeholders in study area, it has been observed that declining population in coastal area is owing to migration of fishing communities from their native places to other places in search of livelihood opportunities. Fishing communities located mostly along the coast have the opinion that over the period of last 15 years due to ongoing Oil & Gas activities in the Krishna Godavari region, posing restrictions in the surrounding areas, the fishing communities are being advised to travel more into the sea for fishing which requires highly mechanised boats involving higher cost. It was also observed that good number of families from fishing communities used to migrate to other places temporarily during fishing holiday period in search of alternate livelihood and come back to their native place once the fishing holiday period is over.

Sex Ratio

The average sex ratio in the study area is 994, with the villages Nadavapalle, Chirrayanam, Kothapalle, Rameswaram, Samanthakuru, T. Challapalle, Lakshmiwada, Geddanapalle, Rajupalem, Vetlapalem, Kundaleswaram, Nadavapalle, Dontikurru reporting a positive sex ratio (more than 1000 women per 1000 men).

Social Groups

Hinduism is the major religion followed by a very small population belonging to Christianity and Islam religions. During consultation process, it was reported that conversion to Christianity is quite common in study area. Conversion is relatively more apparent in SC community. People getting converted into Christianity from SC community are considered BC (Backward community) by the government.

The study area has a negligible presence of Scheduled Tribe population (0.78% of total population) and 32.9% of Scheduled Caste population. The analysis of the different types of caste present in study area indicates that the OC (other caste) category primarily includes people from Kapu, Raju, Kamma, Chaudhary, Reddy and people from Brahmin category. The SC group in study area are mainly from Mala and Madiga community. Mala community members are traditionally involved in agricultural labour activities and Madiga community are traditional involved in selling buffalo meat. The proportion of Madiga community is however reported to be quite less.

Backward caste reported in the study area includes as following:

- *Agnikula Kshatriya:* this is a fishing community and they are traditionally involved into sea fishing activities;
- *Setti Baliji:* this community are traditionally skilled into coconut dropping and this is their primary livelihood activity;
- *Rajakumu:* people from this community are primarily washer man;
- *Nai Brahmin:* people from this community traditionally serves as barber in society; and
- *Gouda:* this community is also involved into coconut dropping business.

Apart from above, there is one more community in study area i.e. Eruka community. This is ST community and traditionally involved in piggery.

Literacy Profile

The East Godavari District is characterised by a literacy rate of 63.8% and a female literacy rate of 60.81%. Of the six Mandals, the Amalapuram has the highest total literacy and female literacy rate at 76.6% and 73.6% respectively. In comparison to this, the study area villages have an average literacy rate of 63.42% and a female literacy rate of 58.98%. Of the villages in the study area Rellugadda and Munipalle have the highest total literacy rate and female literacy rates.

3.15.4 Land Use Profile

a) Landuse as per Census Data

As can be seen from the following table, the land use in the project study area is characterised by a dominance (64%) of net sown area (agricultural land and aquaculture land) this is followed by the area under non-agricultural uses, which includes the residential areas. From the consultations with local community members it is understood that the net sown area along the coast is primarily used for aquaculture, while the land as you move away from the shore is primarily used for agriculture under multi-cropping systems. There is no forest cover in the study area.

Table 3.43 Key Land Use Categories in Study Area

Name	Total Area	Area under Non-Agricultural Uses	Barren & Un-cultivable Land Area	Permanent Pastures and Other Grazing Land Area	Culturable Waste Land Area	Net Area Sown
Project Footprint Area and Village in 2 km Radius						
Chirrayanam	1258	94	536	0	549	79
Surasaniyanam	1420	398.38	0	0	218.62	291.09
Village in 2-10 km Radius						
Kothapalle	3150	382	0	0	114	2654
Geddanapalle	362	73.7	0	0	0	278
Rajupalem	295	58.3	0	0	0.4	236.3
Vetlapalem	1967	596	0	0	0	1371
Vaddiparru	563	163	0	0	0	400
Kesanakurru	2108	435.44	0	0	0	1633.71
Ainapuram	1023	150.95	0	0	0	870.03
Rameswaram	772	167.4	0	0	37.6	567
Tadikona	350	31.16	0	0	0	311.2
Devaguptam	1281	178.87	0	0	0	1102.13
Rellugadda	369	56.66	0	0	0	281.66
Komaragiripatnam	3767	488.15	0	0	504.58	1221.3
Samanthakuru	541	148.12	0	0	33.93	352.07
Sannavalli	256	35.63	0	0	0	220.37
Chinagedavalli	225	26.32	0	0	0	198.68
Pedagadavilli	228	18.22	0	0	0	209.78
Munipalle	236	38.87	0	0	0	194.74
Gollavilli	348	73.68	0	0	0	270.99
Uppalaguptam	1915	155.4	0	0	0	1759.6
Kunavaram	358	63	0	0	0	295
Gopavaram	577	62	0	0	26	489
T. Challapalle	2177	571.26	0	0	194.33	1138.87
Lakshmiwada	201	22	0	0	0	179
Penuwalla	214	0	26	0	22	166

Name	Total Area	Area under Non-Agricultural Uses	Barren & Un-cultivable Land Area	Permanent Pastures and Other Grazing Land Area	Culturable Waste Land Area	Net Area Sown
Bantumilli	108	13	0	0	0	95
Uppudi	299	4	0	0	0	295
Katrenikona	2847	756	819	0	61	1211
Kundaleswaram	243	19	24	0	4	196
Nadavapalle	429	88	26	0	0	291
Dontikurru	588	62	0	0	33	489
Pallamkurru	2232	325	160	0	27	1535
Kandikuppa	1841	175	300	0	583	719

Source: Census of India, 2011. Forest land is not reported in the Census Survey

Furthermore, as can be seen from the following figure, most of the net sown area (67%) is irrigated, primarily through a network of canals. There are primarily two canal systems within every village along the coast. While one of the canals carries water from the Godavari River for irrigation purposes and for fish culture, the second canal carries seawater for the use in aquaculture for prawns. A Barriage across river Godavari at Dowleswaram near Rajahmundry is the biggest irrigation Project in East Godavari. Of the villages in the study area, only Chirriyanam has no irrigated land. On the other hand, the highest proportion of irrigated land is in the village Vetlapalem and Rajupalem

b) Land use as per Satellite Imagery

The land use pattern with the study area shows sea area of 60.24% followed by agriculture land area of 12.73%, aquaculture land area of 13.14% and reserve forestland of 4.68% (3.96% under mangrove vegetation and 0.72% under Casuarina Plantation). The other major landuse types observed in the study include backwater (2.83%), Casuarina Plantation (1.42%), Settlements (0.99%) and sand dunes (0.86%). Landuse map as per satellite imagery is included in ***Figure 3.73.***

Table 3.44 Land Use in Study Area (as per Satellite Imagery)

S.N.	Landuse Type	Area, Sq. Km.	Area %
1	Agriculture	130.59	12.73
2	Aquaculture	134.86	13.14
3	Back Water	29.04	2.83
4	Canal	1.32	0.13
5	Casuarina Plantation	14.60	1.42
6	Mangrove	11.57	1.13
7	Mudflat	5.56	0.54
8	Reserve Forest – R.F. (Casuarina)	7.39	0.72
9	Reserve Forest – R.F. (Mangrove)	40.68	3.96
10	River	12.77	1.24
	Road Network	0.65	0.06
	Sand Dunes	8.78	0.86
	Sea	618.24	60.24
	Settlements	10.18	0.99
	Total	**1026.22**	**100.00**

3.15.5 Occupation and Livelihoods

Agriculture and fishing is the mainstay of the economy of the study area. The farm sector employs approximately 74% of the main workers (more than 180 days of engagement in a year) whereas the non-farm sector employs about 25% of the main workforce in study area. The overall work participation rate (WPR [(1)]) is around 45.42%. The WPR was found to be higher among males (60.97%) as compared to the females (29.79%). The key economic activities of the Project study area are built around:

- Agriculture -mostly paddy cultivation;
- Fishing activities culture and capture fishing; and
- Non-farm activities. including the following:
  - Working as agriculture labour;
  - Non-farm livelihood options like labour in oil & gas operations or other small scale business units in the area; and
  - Local trading, etc.

(1) WPR depicts the engagement of main and marginal workers in different occupations at household, commercial or agriculture level. WPR is calculated as ratio of working population (both main and marginal workers) to the total population (both working and non-working population) of the town/village.

Figure 3.73 Landuse and Land cover Map

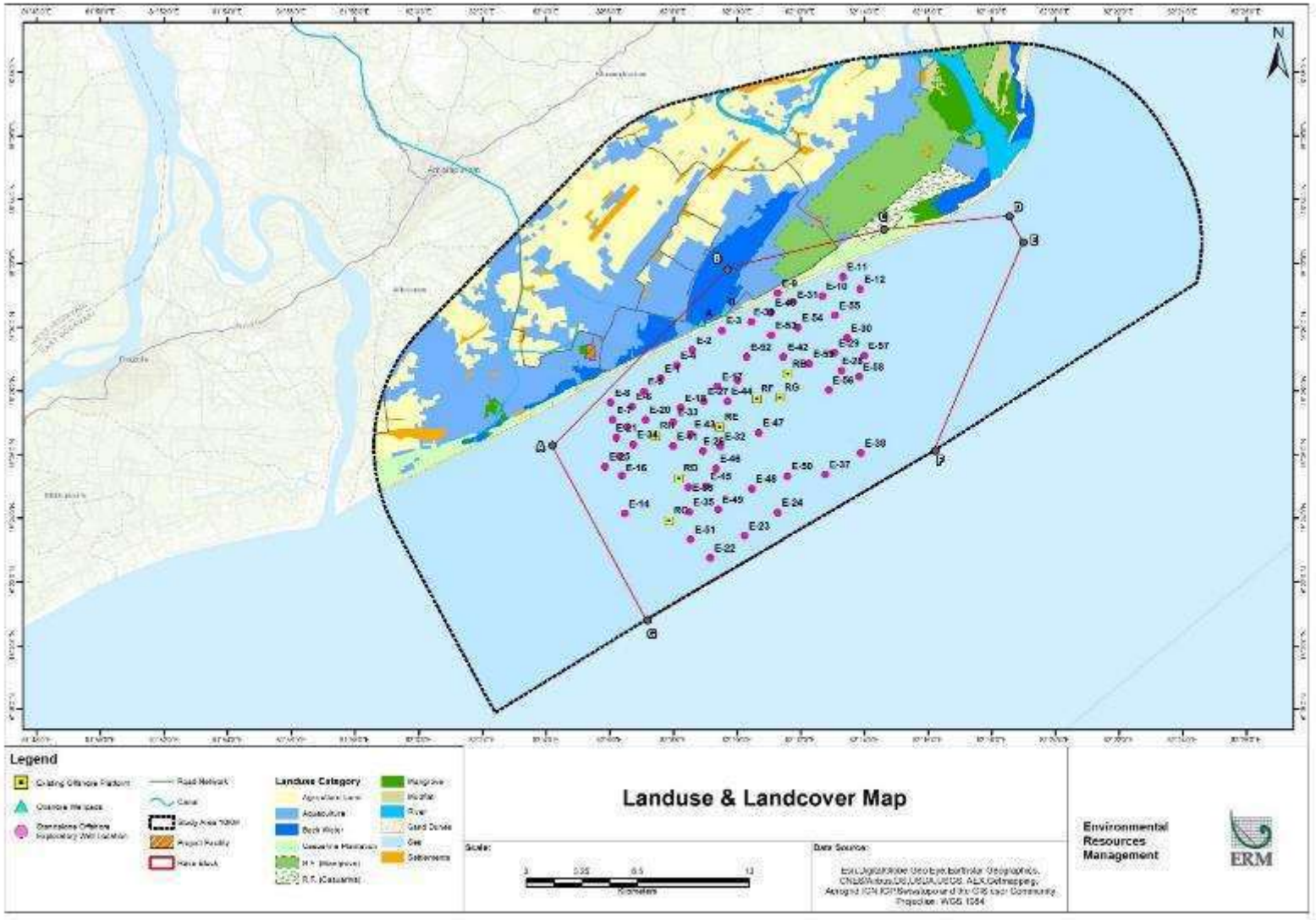


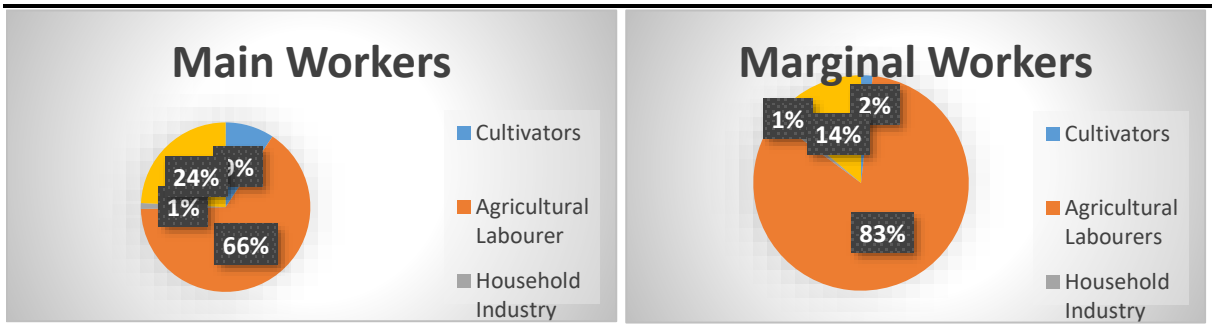
Table 3.45 Worker Participation Ratio in Study Area

Name	WPR	MaleWPR	Female WPR	Main Workers	Marginal Workers	Non Workers
Chirrayanam	53.92	57.45	50.56	504	432	800
Surasaniyanam	44.74	61.29	27.40	1581	154	2143
Kothapalle	43.19	61.16	25.91	5375	1071	8480
Geddanapalle	32.26	57.54	7.59	1365	155	3191
Rajupalem	38.70	58.52	19.65	536	298	1321
Vetlapalem	42.76	63.93	22.60	6109	629	9019
Vaddiparru	46.69	63.10	30.22	1432	51	1693
Kesanakurru	43.78	61.08	26.00	3417	1648	6505
Ainapuram	43.91	57.87	29.37	1823	921	3505
Rameswaram	42.24	63.20	21.58	1802	402	3014
Tadikona	48.68	62.38	34.94	792	17	853
Devaguptam	49.37	63.11	35.06	3366	731	4201
Rellugadda	45.89	60.63	30.19	432	20	533
Komaragiripatnam	44.73	61.11	28.14	4840	1063	7294
Samanthakuru	49.44	63.79	35.33	1653	21	1712
Sannavalli	45.26	62.76	27.42	802	48	1028
Chinagedavalli	46.31	61.27	30.30	666	125	917
Pedagadavilli	44.74	63.42	25.83	632	44	835
Munipalle	47.35	66.49	27.16	594	94	765
Gollavilli	45.15	62.00	28.08	1742	138	2284
Uppalaguptam	49.81	64.69	34.42	4219	462	4716
Kunavaram	51.31	64.71	37.60	1314	155	1394
Gopavaram	50.28	62.65	37.51	1563	589	2128
T. Challapalle	48.22	62.06	34.53	3024	1456	4811
Lakshmiwada	42.44	58.33	26.68	379	112	666
Penuwalla	46.80	62.51	30.96	709	189	1021
Bantumilli	46.98	60.30	32.79	200	220	474
Uppudi	36.03	55.49	14.60	340	324	1179
Katrenikona	48.54	58.05	38.75	4163	2476	7039
Kundaleswaram	47.55	62.60	32.81	828	7	921
Nadavapalle	46.14	63.54	29.77	1545	188	2023
Dontikurru	50.23	61.62	39.05	1040	928	1950
Pallamkurru	49.87	59.10	40.38	3270	2925	6228
Kandikuppa	39.41	54.82	23.80	3187	1773	7625

Source: Census of India, 2011 WPR = workers' participation ratio (in %)

Figure 3.74 depicts split of main and marginal workers according to work stream.

Figure 3.74 Division of Work Force in Study Area



Source: Census of India, 2011

The occupational profile distribution of the population in study area as presented in above figure clearly indicates that proportion of agriculture labour (including aquaculture labour) is largest source of livelihood in the study area. This is followed by the proportion of 'other' workers which possibly includes people engaged in the service and industrial sector. The proportion of household industries workers is lowest in entire study area indicating less presence of small scale industries in the study area. Brief understanding of the key sources of livelihood in the area is described as following:

Agriculture and Farm Based Livelihoods

Agriculture is the prime economic activity of the study area. Rice, coconut and Banana are most produced crops in study area. The following table provides an understanding of area cultivated in Hectares, production in tonnes and yield of kgs per hectare for the key crops grown in the study area.

Table 3.46 Area, Production and Yield per Hectare of Key Crops

Crops	Total Area (Ha)	Production (tonnes)	Yield (kg/hectare)
Rice	394117	1563229	3966
Maize	12911	100757	7804
Green gram	16687	6238	374
Blackgram	21105	10311	489
Redgram	2220	1854	835
Coconut	46865	780162	16647

Source: District Statistical Handbook 2015, East Godavari

The date presented above highlights significance of certain crops sown in study area in terms of the geographical coverage throughout the year. While rice, blackgram, is grown in both Kharif and Rabi seasons, crops such as Maize, Greengram, Coconut is the next important crops of the study area; it is also an important cash crop for the locals here. Other crops grown in study area includes gram, fresh & dry fruits, vegetables etc.

The agriculture sector in study area seems to be doing well for the livelihood of the people and one of the notable factors for this was observed to be good coverage of irrigation facilities provided by the Government. It was observed that most of the agricultural field have access to the canals developed by government which serves as major source for irrigating the agricultural field.

Table 3.47 Net Area Irrigated in the year 2014-2015

Mandal	Net area irrigated under (In Ha)							Area irrigated more than once (In Ha)	Gross area irrigated (In Ha)
	Canals	Tanks	Tube Wells	Dug Wells	Lift Irrigation	Other Sources	Total		
Allavaram	3308	0	144	0	0	0	3452	3497	6949
Amalapuram	2985	0	1102	0	0	0	4087	4221	8308
Uppalaguptam	5584	0	0	0	0	0	5584	5435	11019
Katrinekona	4816	0	0	0	0	0	4543	4542	9085

Source: District Statistical Handbook 2015, East Godavari

The above mentioned table illustrates that canal has been only source of irrigation in Uppalaguptam and Katrinekona Mandal. Apart from canal water, tube wells have also been used to some extent for irrigation in Amalapuram and Allavaram mandals.

The main aquaculture produce is in terms of shrimps, black tiger prawns, crabs and fishes in the East Godavari district. However, according to discussions during site visit, the aquaculture in the study area is primarily pertaining to shrimps and fishes.

Fishing Community present along the coastline was enlisted. These are basically communities whose livelihood is dependent on fishing and associated aquaculture industries. There fishing ground are mainly mangrove vegetation and open sea. A map of the habitation dependent on the fishing is given in ***Figure 3.75*** and their coordinates in ***Table 3.48.***

Table 3.48 Coordinates of Habitation along the coastline and Mangrove Vegetation

Name of the Village	Latitude	Longitude
Rameswaram	16°27'0.37"N	82° 2'47.53"E
Vassaltippa	16°27'21.27"N	82° 3'19.51"E
Chirrayanam	16°31'5.10"N	82°10'21.99"E
Pandi	16°33'16.59"N	82°12'38.74"E
Pora	16°34'21.72"N	82°14'12.55"E
Molletimoga	16°35'30.14"N	82°15'57.99"E
Kottapalem	16°35'37.31"N	82°15'58.99"E
Balusutippa	16°37'54.32"N	82°15'51.89"E
Neellarevu	16°32'40.16"N	82°13'17.06"E
Surasaniyanam	16°29'28.35"N	82° 5'51.22"E
Chakalipeta	16°34'59.27"N	82°16'13.65"E

Box 3.1 Fisheries in East Godavari District

East Godavari District has a coastal line of 144 Kms. with a natural Port at Kakinada. There are 8 reservoirs and 3380 tanks for fish production in the District with 66777 fishermen engaged in island fishing activity. There are nearly 551 fishermen Co-Operative Societies in the District. A fishing harbour was constructed in the year 1979 at Kakinada with an estimated cost of Rs. 1141.81 lakhs, which provides boating facility to 4,101 mechanized fish boats.

Fishing practice of the local people in study area can be broadly understood by classifying them into two categories; culture fishing and capture fishing. The following figure provides an understanding of the key villages/ settlements in terms of culture and capture fishing.

Culture Fishing

The coastal area up to 2 km area from the shore in study area was observed to have huge concentration of fish culture tanks. Different variety of fishes and prawns are being produced in these fishing tanks. Owners of these tanks have access to big land holding and usually belong to general category, whereas the labours working on these tanks are typically either from scheduled caste or from other backward caste of the society.

The local culturist, dry out the tanks in the months of December- January . the average gestation period for prawns is 110 days while that for fish (average weight of 1 kg) is 8 months. Most of the produce is exported through ports in Odisha, Petapuram, Bheemdol and Mandapeta. The produce is picked up by contractors and large sellers from the farms itself, in refrigerated trucks, with the farmers receiving pay within 10-15 days. The average cost of undertaking prawn 'seed' is INR 50,000/acre and INR 2,000/acre for fish culture. The average

cost for fish culture over 8 months is INR 3 lakh/acre. Average labour charge for workers engaged in fishing tanks ranges between INR 300-400/ day with men being paid higher than women. Typically male workers are engaged in main process of the culture fishing. Role of women workers are limited to clearing the ground by way of grass cutting, removing coconut leaf and cleaning. *Catla* and *Rohu* fish are found in aboundance. Other variety of fish found here includes Mrigala, Barbus, Cat Fishes, Murrel, Mullets, Hilsa etc. Prawns fetch a price of INR 300 per kg compared to INR 70 to 80 for fish.

The fish lings are usually purchased from the nurseries in West Godavari. People with smaller plots of land also maintain nursery tank. The fishes are kept for a year in nursery tanks up until they are the size of 250 gram, then they are transferred to large tanks, for a period of 7-8 months till they are approximately 1 kg and then it is taken out and sold in the market. The feed is mostly de-oiled bran rice and probiotics and minerals such as Magnesium Chloride and Calcium Chloride. The fishes can be preserved for 7-8 days without spoilage.

Figure 3.75 Maps Showcasing Villages Engaged in Captive and Culture Fishing

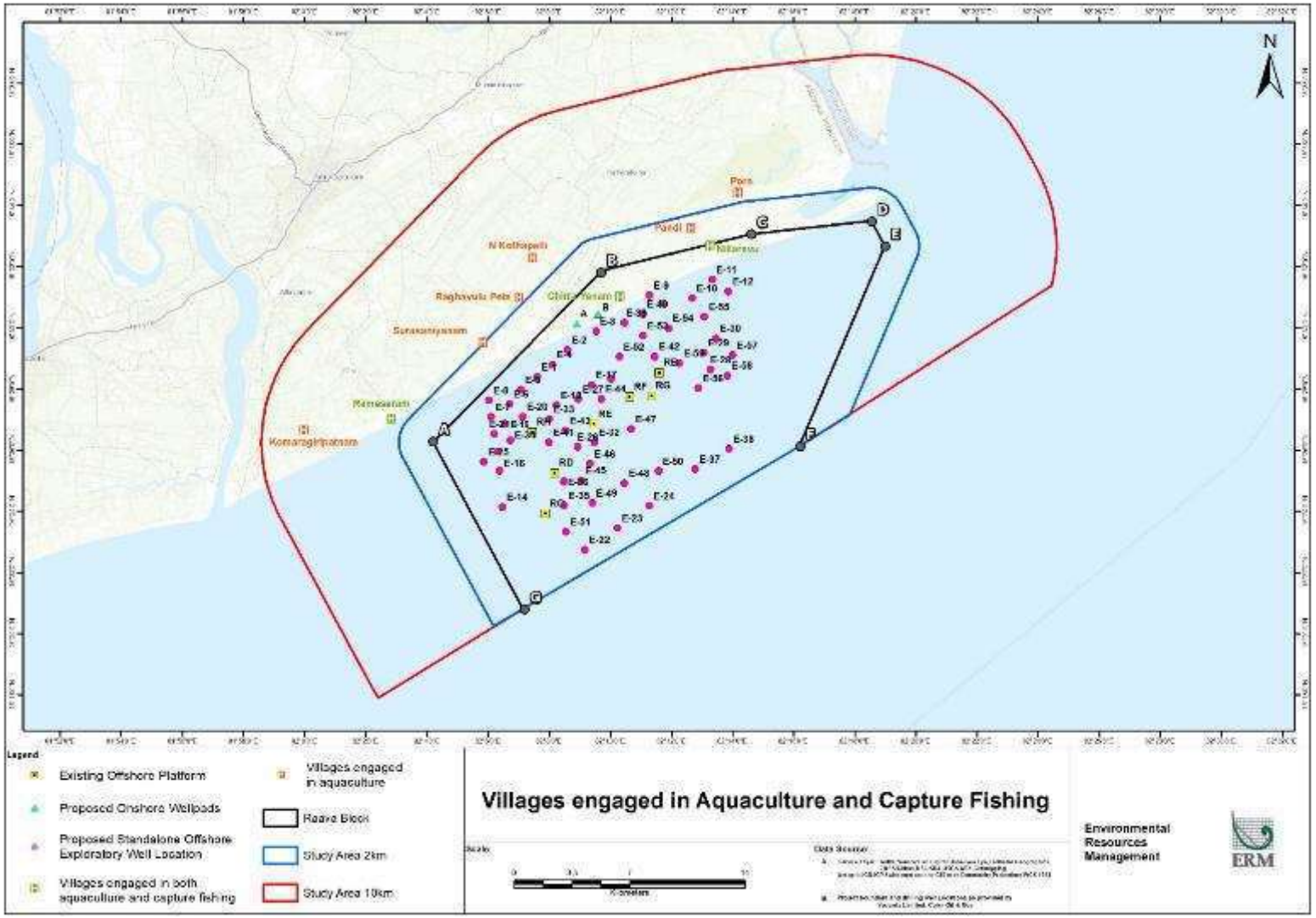


Figure 3.76 Fish & Prawn Culture and Agriculture Activities within nearby study area

Prawn culture is considered as a gamble by the locals. It can yield huge profit, almost 10 times of the total investment provided it is safely cultured. Prawns culture tanks require at least 10 aerators per acre. Aerators are used to provide sufficient oxygen to fish lings in tanks. Operating aerators continuously involves significant electricity cost as there is no electricity supply the locals depend upon diesel generators. Prawns are sensitive to the soil in the tank, the chlorine level etc. On daily basis water tests need to be undertaken and very close monitoring has to be done. Threads, wires are tied above the tanks to ensure no birds are able to land, to avoid diseases and infections. Similarly fencing is done to make sure no outside fauna is able to enter.

Another key concern of the local community pertaining to the rise in aquaculture in the area was the increase in contamination and diseases in fishes and prawns in the backwaters as well. According to the discussions with the local community, prawns and fish being produced through culture are prone to diseases and viruses. Once a disease is detected, the culturists have to change the entire water in the tank. This 'contaminated' water is then disposed off into the salt water canals running along the tanks, which is connected to the backwaters and Bay of Bengal. This in turn results in the spread of diseases and viruses in the prawns and fish found in the backwaters and immediate vicinity of the coast line. According to the respondents, this has resulted in an overall decline in the productivity of fish and prawn in these waters.

Capture Fishing

The fishing communities located along the shore are the ones engaged in capture fishing on the sea. This is their traditional as well as primary source of livelihood. Few fishing communities located along the Godavari River towards north-east side of the study area

normally engage in fishing in Godavari River. Types of sea fish captured by fisherman in study area includes Skates, Rays, Eels, Cat Fish, Sardines, Hilsa Shades, Anchovies, Other Clupeoids, Perches, Goat Fish, Thread Fins, Ribbon Fish, Carangids, Silver Bellies, Bother Mackerles,Seer Fish,Mullets,Flat Fish,Panaeid,Marine Shrimp and Marine Fish. The fishermen engaged in fishing in the sea are primarily from the Pali (Backward Class) Caste. The local community is primarily engaged in fishing in backwaters and within 2-5 km of the coastline. None of the local community members are reported to own trawlers or boats capable of deep sea fishing.

Figure 3.77 Capture Fishing in Study Area

Source: ERM Site visit, 2018

The following table provides an understanding of the fishing vessels and fishermen registered with the fisheries department.

Table 3.49 Number of Active Fishermen and Crafts in the Study Area

Village	No. of Active Fishermen	Fishing Craft			
		Mechnical Fishing Vessel	Motorized Craft	Country Craft	Total
Neelapalli	220	0	28	4	32
Neelarevu	50	0	0	0	0
Gatchakayalapora	160	0	0	0	0
Chirrayanam	320	0	0	0	0
N.Kothapalli	210	0	0	0	0
S.Yanam	190	0	0	0	0
Vasalthippa	520	0	4	0	4
N. Rameswaram	110	0	0	0	0
Komaragiripatnam	60	0	0	0	0
Odalarevu	380	1	39	0	40

According to the discussion with the local community, apart from the residents of the villages, there are groups of fishermen who migrate from cities such as Vishakhapatnam during peak fishing season into the area. These fishermen usually arrive in families, during the months September- February and reside in temporary settlements (as can be seen in figure above) along the coastline. These fishermen usually have larger boats which are capable of deep sea fishing. These fishermen pay rent to the host village and are dependent upon the host community for daily provisions, while providing the community employment opportunities as fishing labour on the boats. The catch from these vessels are sold to the merchants in these villages through an auction process on a daily basis. In addition to this, there are trawlers which operate in the area. However these are understood to be from Vishakhapatnam and do not land in the study area.

Other Non-Farm based Livelihoods

Other sources of livelihood in study area include direct or indirect employment opportunities in oil & gas operations in the study area and other small scale factories available there. Rice, Sugar, Fertilizers, Paper and Textiles are the large and medium scale industries in the district. There are small-scale industries like agro-based industries, chemical, ceramic, light engineering, Non-Ferrous metals, leather etc.

Table 3.50 Number of Registered Factories & Employment in Mandals in Study Area

Mandal	No of Factories	No of Male Employed	No of Female Employed
Factories under Factories Act			
Allavaram	19	90	8
Amalapuram	41	491	149
Uppalaguptam	20	94	23
Katrinekona	12	45	11
Mummidivaram	NA	NA	NA
I.Polavaram	NA	NA	NA
Small Scale Industries			
Allavaram	3	17	8
Amalapuram	2	14	6
Uppalaguptam	1	7	4
Katrinekona	0	0	0
Mummidivaram	NA	NA	NA
I.Polavaram	NA	NA	NA

Source: District Statistical Handbook 2015, East Godavari

Above mentioned table provides the existing number of factories and small scale industries and their corresponding employment opportunities related information in project region. The Vedanta Ltd (Cairn Oil & Gas) operation itself provides total of about 400 direct, indirect or contractual employment opportunities; however most of the employment benefit is restricted to the Surasaniyanam village only.

3.15.6 Physical and Social Infrastructure and Amenities

Education Infrastructure

All the villages in the study area have access to a government primary school Most of villages also have access to a private primary school and middle schools within their areas. However, only 19 villages of the 34 have access to a government secondary school and 5 villages (Kothapalle, Kesanakurru, Komaragiripatnam, Munipalle, Katrenikona) have access to a private secondary school. Only 3 villages, Kothapalle, Gollavilli and Uppalaguptam have a government and private senior secondary school in their area, while the villages Katrenikona and Kandikuppa have access to private senior secondary schools.

Table 3.51 Educational Facilities in Study Area

Name	Govt. Primary School	Private Primary School	Govt. Middle School	Private Middle School	Govt. Secondary School	Private Secondary School	Govt. Sr. Secondary School	Private Sr. Secondary School
Project Footprint Area and Village in 2 km Radius								
Chirrayanam	Yes	No	Yes	No	No	No	No	No
Surasaniyanam	Yes	Yes	Yes	No	Yes	No	No	No
Villages within 2-10 km Radius								
Kothapalle	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geddanapalle	Yes	Yes	Yes	Yes	Yes	No	No	No
Rajupalem	Yes	No	No	No	No	No	No	No
Vetlapalem	Yes	Yes	Yes	No	Yes	No	No	No
Vaddiparru	Yes	No	Yes	No	No	No	No	No
Kesanakurru	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Ainapuram	Yes	No	Yes	No	Yes	No	No	No
Rameswaram	Yes	Yes	Yes	No	Yes	No	No	No
Tadikona	Yes	No	Yes	No	No	No	No	No
Devaguptam	Yes	Yes	Yes	Yes	Yes	No	No	No
Rellugadda	Yes	No	No	No	No	No	No	No
Komaragiripatnam	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Samanthakuru	Yes	No	Yes	No	Yes	No	No	No
Sannavalli	Yes	No	No	No	No	No	No	No
Chinagedavalli	Yes	No	No	No	No	No	No	No
Pedagadavilli	Yes	No	No	No	No	No	No	No
Munipalle	Yes	No	Yes	Yes	Yes	Yes	No	No
Gollavilli	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Uppalaguptam	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Kunavaram	Yes	No	Yes	No	No	No	No	No
Gopavaram	Yes	Yes	Yes	No	Yes	No	No	No
T. Challapalle	Yes	Yes	Yes	No	Yes	No	No	No
Lakshmiwada	Yes	No	Yes	No	Yes	No	No	No
Penuwalla	Yes	No	No	No	No	No	No	No
Bantumilli	Yes	No	No	No	No	No	No	No
Uppudi	Yes	Yes	Yes	No	No	No	No	No
Katrenikona	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Kundaleswaram	Yes	No	No	No	No	No	No	No
Nadavapalle	Yes	No	Yes	No	No	No	No	No
Dontikurru	Yes	No	Yes	No	Yes	No	No	No
Pallamkurru	Yes	Yes	Yes	No	Yes	No	No	No
Kandikuppa	Yes	Yes	Yes	Yes	Yes	No	No	Yes

Source: Census of India, 2011

The local community in the study area primarily depend upon Amalapuram Town to access college level education.

Box 3.2 List of Colleges and Technical Institutions at Amalapuram

- Shri. Chaitanya Junior college
- Aditya Junior College
- Naraiyana Junior College
- Shanti Vocational College (Auto mobile, medical lab technician, multipurpose health workers)
- Saini vocational college
- Bharti Junior College
- Ravi teja Junior and vocational college
- Vigya Nidhi Junior College
- Bollubest Junior College
- SKBR College (Junior, graduate, post graduate)
- Government Women College (Intermediate)

Presently the colleges in East Godavari Districts are affiliated to Andhra University, Jawharlal Nehru Technological Deemed University in Kakinada and with the setting up of Adhikavi Nannayya University at Rajahmundry. The college are going to be affiliated to Adikavi Nannayya University.

Further it was observed during consultation with education department that high rate of drop outs among the children in fishing communities is commonly reported. Main reason behind this was cited to be their migration to other places, particularly during fishing off season (April-June) in search of alternate livelihood sources.

Health Infrastructure, Services and Amenities

The existing health care infrastructure in the region as per the information gleaned from District Census Handbook, 2010 illustrate that there is one government hospital in Amalapuram town. One PHC is there in each Mandal except for Uppalaguptam which has two operational PHCs. Government dispensary exists only in Allavaram Mandal. While District hospital is at Rajahmundry. Private Doctors are at Amalapuram Town.

Table 3.52 Rural Health Infrastructure in Study area

Health Facility	Name of Settlement
Community Health Centre	NA
Primary Health Centre	Vetlapalem, Uppalaguptam, Katrenikona
Maternity And Child Welfare Centre	NA
Family Welfare Centre	Devaguptam
Allopathic Hospital	NA

Source: Census of India 2011

Consultation with health officials in study area suggested that common form of ailment here are Viral, Diarrhoea, Conjunctivitis, Mums, Cold and cough, Dengue, Malaria, Jaundice and Water borne diseases. Ambulance facility (at telephone call no. 108) in case of medical emergency is also there. Each area hospital has an ambulance.

Water Supply and Sanitation

As can be seen from the below table, of the 34 villages, 30 are reported to have access to tap water, while information is not available for the remaining 4. Most villages have reported a mixed source of water, with wells (covered and uncovered), tank and canal being the most

common sources of drinking water supply. Some village do have hand pump and some village have to resort to river water as well for drinking purposes.

Table 3.53 Water Supply in Study Area

Name	Tap Water	Covered Well	Uncovered Well	Hand Pump	Tube Wells / Borehole	Spring	River / Canal	Tank / Pond / Lake	Others
Project Footprint Area and Village in 2 km Radius									
Chirrayanam	Yes	Yes	No	No	No	No	No	Yes	No
Surasaniyanam	Yes	No	No	Yes	No	No	Yes	Yes	No
Villages in 2-10 km Radius									
Kothapalle	Yes	Yes	No	Yes	No	No	No	Yes	No
Geddanapalle	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No
Rajupalem	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Vetlapalem	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No
Vaddiparru	Yes	No	Yes	Yes	Yes	No	Yes	No	No
Kesanakurru	Yes	Yes	No	Yes	No	No	Yes	Yes	No
Ainapuram	Yes	Yes	No	Yes	Yes	No	Yes	No	No
Rameswaram	Yes	No	Yes	No	No	No	No	No	No
Tadikona	Yes	No	No	No	No	No	No	No	No
Devaguptam	Yes	No	Yes	No	No	No	Yes	Yes	No
Rellugadda	Yes	No	Yes	No	No	No	No	No	No
Komaragiripatnam		No	Yes	Yes	No	No	No	No	No
Samanthakuru	Yes	No	Yes	No	No	No	Yes	Yes	No
Sannavalli	Yes	Yes	Yes	No	No	No	No	No	No
Chinagedavalli	Yes	Yes	No	No	No	No	No	No	No
Pedagadavilli	Yes	No	No	No	No	No	No	No	No
Munipalle	Yes	Yes	No	No	No	No	No	No	No
Gollavilli	Yes	No	Yes	Yes	No	No	No	No	No
Uppalaguptam	Yes	No	No	No	No	No	No	No	No
Kunavaram	Yes	No	Yes	No	No	No	Yes	Yes	No
Gopavaram	Yes	No	Yes	No	No	No	Yes	Yes	No
T. Challapalle	Yes	Yes	No	No	No	No	Yes	Yes	No
Lakshmiwada		No	Yes	Yes	No	No	No	No	No
Penuwalla		No	Yes	Yes	No	No	No	No	No
Bantumilli		No	Yes	Yes	No	No	No	No	No
Uppudi	Yes	No	No	No	No	No	No	No	No
Katrenikona	Yes	No	Yes	Yes	No	No	No	No	No
Kundaleswaram	Yes	No	Yes	Yes	No	No	Yes	No	No
Nadavapalle	Yes	No	Yes	Yes	No	No	Yes	Yes	No
Dontikurru	Yes	Yes	No	Yes	No	No	Yes	Yes	No
Pallamkurru	Yes	No	No	No	No	No	No	No	No
Kandikuppa	Yes	Yes	No	Yes	No	No	Yes	Yes	No

Source: Census of India, 2011

Access to toilet facility was common in the study area: however, open defection is practiced by good number of houses, particularly in backward communities like fishing communities and some of the SC communities. This situation is understood to have improved since the Swatch Bharat Abhiyan by the government. However, one of the biggest hurdles in total coverage of toilets is understood to be that the government subsidy of INR 18,000 is not enough for constructing a proper toilet, with most costing around INR 50,000 for construction. Village Surasaniyanam which is closest village from the Ravva Terminal Presently most houses of this village have access to their own toilet and household level water supply connection. Vedanta

Ltd (Cairn Oil & Gas) has taken up a number of CSR programs in this village. In terms of drainage facilities, as can be seen from the following table, of the 34 villages, 15 do not have access to a drainage facility. Furthermore, only 5 villages have access to a closed drainage system.

Table 3.54 Drainage Facilities in Study Area

Name	Closed Drainage	Open Drainage	No Drainage
Project Footprint Area and Village in 2 km Radius			
Chirrayanam	No	Yes	No
Surasaniyanam	No	No	Yes
Villages in 2-10 km Radius			
Kothapalle, Kesanakurru, Ainapuram, Tadikona, Rellugadda, Samanthakuru, Sannavalli, Chinagedavalli, Pedagadavilli, Munipalle, Gollavilli, Kunavaram, Gopavaram, T. Challapalle	No	No	Yes
Geddanapalle, Rajupalem, Vaddiparru, Rameswaram, Devaguptam, Uppalaguptam, Lakshmiwada, Penuwalla, Bantumilli, Uppudi, Kundaleswaram, Nadavapalle, Dontikurru	No	Yes	No
Katrenikona, Kandikuppa, Komaragiripatnam, Pallamkurru, Vetlapalem,	Yes	Yes	No

Source: Census of India, 2011

Electricity

Power supply for all purpose is available in each of the village under study area. However there is huge power cut in this area. During consultation with communities, it was reported that there is merely 10 hours average power supply in rural areas and 15 hours average power supply in urban areas.

Postal Services, Bank and Telecommunications

Every village in study area have access to postal service. Post offices are located in villages Kesanakurru, Rameswaram, Devaguptam, Komaragiripatnam, Uppalaguptam, T. Challapalle, Katrenikona, Pallamkurru and Kandikuppa. Banking facilities are there and number of banking units existing in study area was reported to be quite less. Presently Mobile phone is the major source of telecommunication in this area.

Archaeology and Heritage

There are lot of temples in study area; however no structure in the study area was reported to be recognised by ASI. There is one clock tower located eastern part of the area. One locally famous temple, *Hanuman temple* is located in Surasaniyanam village close to Terminal boundary. *Kundawaleshwaram temple* is also located in study area which is locally very popular. Besides these, small temples were observed in most of the villages in study area.

4 IMPACT ASSESSMENT AND MITIGATION MEASURES

4.1 INTRODUCTION

This section identifies and assesses the potential impacts in the environment that could be expected from the proposed oil and drilling activities of PKGM-1 Block, East Godavari District, Andhra Pradesh. The impacts due to the Project activities across different phases have been identified and assessed. The Project activities will impact the physical, social and ecological environment in two distinct phases:

a. Exploration Phase - Site preparation and drilling phase
b. Development and Production Phase

Impacts are identified and predicted based on the analysis of the information collected from the following:

- Project information (as outlined in Section 2);
- Baseline information (as outlined in Section 3).

The identification of likely impacts during exploration and operation phases has been carried out based on likely activities having their impact on environmental and socio-economic parameters. The impact assessment methodology; identification of potential impacts due to the proposed project related activities and their potential impacts have been worked out in the following sections.

4.2 IMPACT ASSESSMENT METHODOLOGY

Impact identification and assessment starts with scoping and continues throughout the remainder of the impact assessment process (IAP). The principal impact assessment (IA) steps are comprises of:

- **Impact identification**: based on the project activities and related aspects, potential impacts are identified. In this EIA, the impacts were identified based on interaction of proposed activities/aspects on various resources/receptors prevailing in physical, biological and socioeconomic environmental components;
- **Impact prediction**: to determine what could potentially happen to resources/receptors as a consequence of the Project and its associated activities;
- **Impact evaluation**: to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource/receptor;
- **Mitigation and enhancement**: to identify appropriate and justified measures to mitigate negative impacts and enhance positive impacts;
- **Residual impact evaluation**: to evaluate the significance of impacts assuming effective implementation of mitigation and enhancement measures.

Figure 4.1 Impact Assessment Process

4.2.1 *Prediction of Impacts*

Prediction of impacts is essentially an objective exercise to determine what could potentially happen to the environment as a consequence of the project and its associated activities. This is essentially a repeat of the process undertaken during scoping, whereby the potential interactions between the Project and the baseline environment are identified. From these potential interactions, the potential impacts to the various resources/receptors are identified, and are elaborated to the extent possible. The diverse range of potential impacts considered in the IA process typically results in a wide range of prediction methods being used including quantitative, semi-quantitative and qualitative techniques. The nature and types of impacts that has been addressed in this EIA is defined below.

Box 4.1 Nature & Types of Impacts Considered for Impact Assessment

Negative: when impact is considered to represent adverse change from the baseline or introduced a new undesirable factor;
Positive or beneficial: when impact is considered to represent improvement to baseline or introduced a new desirable factor;
Direct: impacts that result from a direct interaction between the project and a resource/ receptor;
Indirect: impacts that follow on from the direct interactions between the project and its environment as a result of subsequent interactions within the environment; and
Induced: impacts that result from other activities (which are not part of the project) that happen as a consequence of the project.

4.2.2 *Evaluation of Impacts*

Evaluation of significance of an impact is assessed by ascertaining (a) magnitude and (b) sensitivity/vulnerability/importance of resource/receptor likely to be impacted as defined in the following description:

Determining Magnitude of an Impact

Magnitude, i.e. severity of an impact or degree of change caused by a project activity is a function of interaction characteristics of Scale, Extent and Duration. The criteria that have been evolved for each of these key elements resulting in degree of change with corresponding

ranking/level of impacts (low, medium and high) on the environmental component are presented in ***Table 4.1.***

Table 4.1 Impact Prediction Criteria

Impact Elements	Criteria	Ranking
Scale: Degree of damage that may be caused to the environmental components concerned	▪ **Irreversible damage to natural environment** and/or likely difficult or may not to revert back to earlier stage with mitigation; ▪ **Major changes in comparison to baseline conditions** and / or likely to regularly or continually exceed the standard;	High
	▪ **Reversible damage to natural environment** but likely to easily revert back to earlier stage with mitigation; ▪ Perceptible change from baseline conditions but **well within acceptable norms**.	Medium
	▪ Effect is **within the normal range** of natural variation; ▪ **No perceptible or readily measurable change** from baseline conditions;	Low
Extent: Spatial or geographical extent of impact due to a project and related activities	▪ Project site and the entire study area i.e. beyond Project influence area (10.0 km from proposed well pad sites)	National
	▪ Project site and its surroundings (2.0 km from the well pad sites)	Regional
	▪ Project site and its immediate vicinity (0.5 km from proposed well pad sites)	Local
Duration: Temporal scale of the impact in terms of how long it is expected to last	▪ Spread beyond the lifecycle of the project	Long term
	▪ Spread across several phases of the project lifecycle	Medium term
	▪ Only during particular activities or phase of the project lifecycle	Short term

Magnitude essentially describes the intensity of the change that is predicted to occur in the resource/receptor as a result of the impact. The magnitude combines the impact characteristics of Extent, Duration and Scale and is a multiplicative factor of these three criteria set. Based on the above understanding magnitude of impact is assessed as per ***Table 4.2.***

Table 4.2 Assessing Magnitude of Impact

Scale	Extent	Duration	Magnitude
Low	Local	Short Term	**Negligible**
Low	Regional	Short Term	**Small**
Low	Local	Medium term	
Medium	Local	Short Term	
Low	National	Short Term	
Low	Local	Long term	
High	Local	Short Term	
Low	Regional	Medium term	
Medium	Regional	Short Term	
Medium	Local	Medium term	
Low	National	Medium term	**Medium**
Medium	National	Short Term	
Low	Regional	Long term	
High	Regional	Short Term	
Medium	Local	Long term	
High	Local	Medium term	
Medium	Regional	Medium term	
Low	National	Long term	
High	National	Short Term	
High	Local	Long term	

Scale	Extent	Duration	Magnitude
Medium	National	Medium term	**Large**
Medium	Regional	Long term	
High	Regional	Medium term	
Medium	National	Long term	
High	National	Medium term	
High	Regional	Long term	
High	National	Long term	

Determining Sensitivity/ Importance/ Vulnerability of Receptor

In addition to ascertaining magnitude of impact, the other principal step necessary to assign significance for an impact is to define the sensitivity/ vulnerability/ importance of the impacted resources/ receptor. There are a range of factors to be taken into account when defining the sensitivity/ vulnerability/ importance of the resource/ receptor, which may be physical, biological, cultural or human as per the following understanding:

- Where the resource is physical (for example, fresh water body) its quality, sensitivity to change and importance (on a local, regional, national importance) are considered;
- Where the resources/ receptor is biological or cultural (for example, sea turtle habitat and nesting site), its importance (for example local, regional or national importance) and its sensitivity to the specific type of impact are considered;
- Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered.

Definition as defined in has been adopted to determine sensitivity/ importance/ vulnerability of environmental resources or receptor.

Table 4.3 Sensitivity/Importance/ Vulnerability Criteria

Sensitivity	Contributing Criteria
High	▪ Existing physical environment quality is already under stress; ▪ Ecologically sensitive/ protected area, provides habitat for globally protected species; ▪ Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the project. ▪ Human receptors/ vulnerable community are located within the project footprint and directly affected by the project ▪ Resource exclusive for community use
Medium	▪ Existing physical environment quality shows some sign of stress; which is sensitive to change in quality or physical disturbance; ▪ Natural habitat provides habitat for wildlife, which are protected under National regulations; ▪ Some, but few areas of vulnerability; retaining an ability to at least in part adapt to change brought by the project. ▪ Human receptors/ vulnerable community are located adjacent the project site and likely to be affected by the project ▪ Alternative resource available with community
Low	▪ Existing physical environment quality is good; ▪ Modified habitat provides habitat for common species; ▪ Minimal vulnerability; consequently with a high ability to adapt to changes brought by the Project and opportunities associated with it. ▪ Human receptors are located away and are not likely to be affected due to the project related activities

Evaluating Significance of Impacts

Based on interaction of magnitude of impact and sensitivity/ vulnerability/ importance of resource/ receptor likely to be impacted, the significance of impact is assigned for each impact using the matrix shown in ***Figure 4.2***

Figure 4.2 Assessing Significance of Impact due to Proposed Project Related Activities

		Sensitivity /Vulnerability / Important Resource / Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

The context of various impact significance ratings is defined in **Box 4.2**.

Box 4.2 Context of Impact Significance

An impact of **negligible** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of **minor** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards.

An impact of **moderate** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of **major** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

4.2.3 Identification of Mitigation and Enhancement Measures

Once the significance of an impact is assessed, the next step is to evaluate what mitigation and enhancement measures are warranted. In this EIA, following Mitigation Hierarchy has been adopted:

- **Avoid or Reduce at Source**: avoiding or reducing at source through the design of the project;
- **Abate on Site**: add something to the design to abate the impact;
- **Abate at Receptor**: if an impact cannot be abated on-site then control measures can be implemented off-site;

- **Repair or Remedy**: some impacts involve unavoidable damage to a resource and these impacts can be addressed through repair, restoration or reinstatement measures;
- **Compensate in kind, compensate through other means**: where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate.

The priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

4.2.4 Residual Impact Evaluation

Once mitigation and enhancement measures are declared, the next step in impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation and enhancement measures.

Management & Monitoring

The final stage in the impact assessment process is to define the management and monitoring measures that are needed to identify whether:

a) impacts or their associated Project components remain in conformance with applicable standards; and
b) mitigation measures are effectively addressing impacts and compensatory measures and offsets are reducing effects to the extent predicted.

Environmental Management Plan summarises all actions (including mitigation/enhancement and compensatory measures) which the Project Proponent has committed to executing with respect to environmental/social/ health performance for the Project, is also included as part of the EIA report. The Plan also includes monitoring measures to assess performance of the actions.

4.3 IDENTIFICATION OF POTENTIAL IMPACTS

The potential impacts have been identified through a systematic process whereby the activities (both planned and unplanned) associated with the Project have been considered with respect to their potential to interact with environmental and social resources or receptors. In addition to the project components like onshore drilling activity, offshore drilling activity and onshore & offshore oil & gas pipelines (associated activities for this Project) has also been considered for the purpose of this current assessment.

An interaction matrix that also enables methodical identification of the potential interactions each Project activity may have on the range of resources/ receptors within the Area of Influence i.e. the study area for the Project is presented in ***Table 4.4.***

Table 4.4 Impact Identification Matrix for Proposed Oil & Gas Activities

Project Activity/ Hazards	Environmental Resources											Ecological Resource				Social-Economic Resources							
	Aesthetic & Visual Impact	*Land Use*	*Soil/ Sediment Quality*	*Air Quality*	*Ambient/Underwater Noise & Vibration*	*Topography & Drainage*	*Surface water resource*	*Surface water (inland & marine) quality*	*Ground water resource*	*Ground water quality*	*Traffic (road & river)*	*Terrestrial Flora & Fauna*	*Aquatic Flora (Inland & Marine)*	*Aquatic Fauna (Inland & Marine)*	*Migratory Route/ Corridor*	*Job & economic opportunity*	*Economy & Livelihoods*	*Social & Cultural Structures*	*Land Use (Economic Displacement)*	*Infrastructure & Services*	*Cultural Resources*	*Community Health & Safety*	*Occupational health & safety*
Onshore Oil & Gas Activities																							
Exploration - Onshore Well Pads and Site Approach Road related Construction																							
Land procurement		■															■		■				
Filling of land	■		■	■		■		■					■									■	■
Earth work for construction of waste pits, cellar pits	■	■						■			■		■									■	■
Transport of fill materials, construction materials, equipment & manpower				■	■						■	■										■	■
Storage and handling of construction material	■		■	■				■					■										
Storage & handling of fuel, lubricants, paints & other chemicals, etc.			■				■			■													■
Operation of heavy machineries & equipment			■	■	■			■						■									
Generation & disposal of construction waste	■		■							■													■
Sourcing of construction workers																■	■						
Operation of labour camp	■		■						■	■												■	
Drilling of Wells																							
Mobilization of drilling rig and physical presence of drilling facility	■																						
Operation of Drilling rig & associate machineries				■	■			■		■			■	■								■	■
Storage and disposal of drill cuttings & spent mud				■				■		■			■	■									■

Project Activity/ Hazards	Environmental Resources											Ecological Resource				Social-Economic Resources							
	Aesthetic & Visual Impact	*Land Use*	*Soil/ Sediment Quality*	*Air Quality*	*Ambient/Underwater Noise & Vibration*	*Topography & Drainage*	*Surface water resource*	*Surface water (inland & marine) quality*	*Ground water resource*	*Ground water quality*	*Traffic (road & river)*	*Terrestrial Flora & Fauna*	*Aquatic Flora (Inland & Marine)*	*Aquatic Fauna (Inland & Marine)*	*Migratory Route/ Corridor*	*Job & economic opportunity*	*Economy & Livelihoods*	*Social & Cultural Structures*	*Land Use (Economic Displacement)*	*Infrastructure & Services*	*Cultural Resources*	*Community Health & Safety*	*Occupational health & safety*
Storage, treatment and discharge of process waste water			■					■		■			■	■									
Storage and handling of oil, lubricant, chemical, etc.			■					■		■			■	■									■
Storage, handling and disposal of waste oil and other hazardous waste			■					■		■			■	■									
Operation DG sets				■	■																	■	■
Transport of chemical, oil & lubricant, equipment & manpower				■	■																	■	■
Storage and Disposal of MSW	■		■							■													
Sourcing of process water									■														
Sourcing of construction workers																■	■						
Flaring during testing				■																			
Demobilization of drilling rig																							
Dismantling of rig	■			■	■																		■
Transport of drilling rigs, machineries & equipment				■	■																	■	■
Laying on Onshore Pipeline and Testing																							
Laying of pipeline		■	■	■	■	■		■			■	■	■										
Disposal of Hydro-test water								■				■	■										
Offshore Oil & Gas Activity	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Offshore Drilling																							
Positioning of Jack up Rig			■					■					■	■									
Power Generation at the rig	■			■	■																		■

Project Activity/ Hazards	Environmental Resources											Ecological Resource				Social-Economic Resources							
	Aesthetic & Visual Impact	*Land Use*	*Soil/ Sediment Quality*	*Air Quality*	*Ambient/Underwater Noise & Vibration*	*Topography & Drainage*	*Surface water resource*	*Surface water (inland & marine) quality*	*Ground water resource*	*Ground water quality*	*Traffic (road & river)*	*Terrestrial Flora & Fauna*	*Aquatic Flora (Inland & Marine)*	*Aquatic Fauna (Inland & Marine)*	*Migratory Route/ Corridor*	*Job & economic opportunity*	*Economy & Livelihoods*	*Social & Cultural Structures*	*Land Use (Economic Displacement)*	*Infrastructure & Services*	*Cultural Resources*	*Community Health & Safety*	*Occupational health & safety*
Movement of support Vessels and Anchor Handling Support Vessels																							
Movement of crew personnel Helicopter																							
Fuel and drilling chemical transfer from supply vessels																							
Drilling of Wells – rotary movement of drill step and drill bit																							
Drill cutting discharges																							
Disposal of residual drilling mud																							
Cementing Discharges																							
Seawater lift and Cooling Water Discharges																							
Treated sewage and grey water Discharges																							
Waste generation																							
Well Testing - Test Flaring																							
Jack up rig demobilisation																							
Operational Phase																							
Oil and gas lifting from wells (onshore & offshore)																							
Transportation of well fluid to Terminal																							
Operation of Terminal																							
Decommissioning of Onshore and Offshore Facilities upon completion of Project Life																							
Flushing, purging and cleaning of pipelines, vessels and equipment – onshore and offshore																							

Project Activity/ Hazards	Environmental Resources											Ecological Resource				Social-Economic Resources							
	Aesthetic & Visual Impact	*Land Use*	*Soil/ Sediment Quality*	*Air Quality*	*Ambient/Underwater Noise & Vibration*	*Topography & Drainage*	*Surface water resource*	*Surface water (inland & marine) quality*	*Ground water resource*	*Ground water quality*	*Traffic (road & river)*	*Terrestrial Flora & Fauna*	*Aquatic Flora (Inland & Marine)*	*Aquatic Fauna (Inland & Marine)*	*Migratory Route/ Corridor*	*Job & economic opportunity*	*Economy & Livelihoods*	*Social & Cultural Structures*	*Land Use (Economic Displacement)*	*Infrastructure & Services*	*Cultural Resources*	*Community Health & Safety*	*Occupational health & safety*
Offshore and onshore well abandonment and Decommissioning																							
Dismantling and reinstatement of onshore well pad sites																							
Dismantling and reinstatement of onshore Ravva Terminal and Living Quarters																							
Solid and hazardous waste temporary storage and disposal																							

= Represents "no" interactions is reasonably expected

= Represents interactions reasonably possible but none of the outcome will lead to significant impact impacts

= Represents interactions reasonably possible with one of the outcomes may lead to potential significant impact

4.4 IMPACT ASSESSMENT OF ONSHORE DRILLING & ASSOCIATED ACTIVITIES

4.4.1 Impact on Landuse

Impact Sources

The land use impacts can result from:

- Land procurement on short term and long term leases for development of onshore well pads and pipeline corridor of ~8 km;
- Temporary disturbance to aquaculture activity during laying of onshore pipelines connecting well pads to Ravva Terminal; and
- Restriction of land use along the pipeline corridor.

Impact Assessment `

The land requirement for an onshore well pad is 3.83 ha (for general dimensions of 225 m x 170 m), which for two onshore well pads WP-7 (i.e. WP-A or RX-8) and WP-8 (i.e. WP-B or RX-9) will be ~8 ha[1]. These two onshore well pads were previously developed by Vedanta Ltd (Cairn Oil & Gas) in 2006-07 based on EC obtained in 2006 and are currentlty lying unused. The land for the two well pads will be taken from Andhra Pradesh Government on lease initially for three years. In case of commercially viable discovery of hydrocarbon resources, lease will be extended for a long-term period till decommissioning of the wells. With the setting up of well pads, the land use will be diverted from aquaculture or coastal area to industrial land.

The land requirement onshore pipelines corridor of ~8 km long (15 m wide) for laying of three subsurface pipelines will be ~12 ha on right of use (ROU) basis. The land use assessment along the proposed pipeline corridor reveals that 87.9% of the area is under coastal land (landward side along the beach and Casuarina plantation), 5% is under backwater and 7.1% is under aquaculture fields. With the laying of subsurface pipelines in the pipelines corridor, the existing land along the right of use for the pipelines corridor will be available with restricted land use. The onshore pipelines will be subsurface, and no structural development is envisaged which may lead to loss of value of land.

The overhead power transmission line (OHL) is proposed to run along the existing site approach road. The route for OHL has been considered to be away from residential areas and sensitive locations of coastal area.

The proposed land use change will not cause perceptible or readily measurable change in terms of existing land use of the study area; therefore, scale of impact is assessed to be ***low***. The impact will be limited to the local since the land belongs to people living in and around the previously developed two well pad sites, however the duration may change to long term in case of commercial viability of hydrocarbons reserves discovery. The well pads being proposed along coastal area, the resource sensitivity is considered as medium. The impact on land use is assessed to be ***Minor***.

[1] As discussed, ***Section 1.3*** the development of onshore well pads i.e. WP 1 to 5 as planned earlier to be located outside PKGM-1 Block (to tap hydrocarbon resources from within the Block) will not be developed under this Project. Also establishment of well pad 6 has been cancelled due to its location in backwater. All onshore wells planned i.e. 33 wells (22 exploratory + 11 production will be developed from two onshore well pads WP-7 and WP-8 located within PKGM-1 Block.

Mitigation Measures

The mitigation measures to minimize the above mentioned impact include:

- Land acquired for pipeline will be brought to its best achievable original state after completion of the pipeline laying activity, to merge it with surrounding land use.
- All wastes from area surrounding onshore well pad sites and pipeline corridor will be removed after completion of the drilling / pipeline laying activities.

Impact Significance

Impact	**Landuse impact due onshore well pads & pipeline**			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Minor**			

Residual Impact

Considering the implementation of above mentioned mitigations measures, the significance of residual impact on landuse is assessed as **Minor**.

4.4.2 Impact on Physiography & Drainage

Impact Sources

The potential impact on physiography and local drainage may arise due to:

- Development of two onshore well pads;
- Strengthening of approach roads to two onshore well pads;
- Laying of onshore pipelines corridor of 8 km long 15 m wide; crossing of drainage channels/ nalas (minor drainage streams), etc.

Embedded Controls

The Project embedded control measures are as follows:

- Storm water drainage structure will be provided to drain all the surface runoff into the backwater area.

Impact Assessment

The unplanned raising of two onshore well pads together with strengthening of approach roads, without provision of adequate cross drainage may disturb the drainage pattern of the area and potentially affect drainage in the coastal area. It can also potentially lead to instances of localised flooding / water logging.

The three subsurface pipelines in ~8 km long onshore pipelines corridor will be laid through a combination of HDD technique (at water crossings) and open trenching with limited excavations at some locations resulting in low and temporary impact on micro-drainage. In the beach area, the depth of subsurface pipeline will be maintained 1 m below surface level. Trenching, earthworks and stockpiling associated with pipeline and road works if not managed, can potentially disturb the micro-drainage of the area.

Physical presence of two onshore well pads with exploration and development activities would be for the entire life cycle of the Project (long term). The impact on topography and drainage is assessed to be Moderate.

Mitigation Measures

The proposed mitigation measures are as follows:

- Adequate drainage system for the two onshore well pads to be provided to maintain the micro-drainage of area;
- Strengthening of approach roads connecting the two onshore well pads will be designed with due consideration of micro drainage;
- Land after completion of the subsurfacece pipelines laying (in ~8km long onshore pipelines corridor) to be appropriately reclaimed and reinstated;
- Maintain the cross drainage structure along the pipelines route.

Impact Significance

Impact	**Physiography & drainage impact during construction of onshore project components**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor**			

Residual Impact

Considering the implementation of above mentioned mitigation measures, the significance of impact on topography and micro drainage during the construction phase is assessed as **Minor.**

4.4.3 Impact on Soil and Sediment Quality

Impact Sources

Development of two onshore well pads, strengthening of related approach road and laying of subsurface pipelines will result in soil and sediment quality impacts due to:

- Removal of top soil from the land along two onshore well pads and pipelines corridor;
- Compaction of soil;

- Disposal of construction waste/ municipal wastes in non-designated area;
- Spillage of chemical/oil on open soil;
- Surface runoff from material and waste storage areas and oil spillage area.

Drilling of wells

- Spillage of chemical, spent mud, hazardous waste, etc.;
- Surface runoff from waste storage area and spillage area.

Operation phase of wells

- Surface runoff from the well pads.

Decommissioning of well pads

- Disposal of decommissioning waste materials in open soil.

Embedded Controls

The Project has planned following embedded controls:

- Construction waste generated from two onshore well pad sites will be utilized for backfilling within the site itself;
- Food waste generated from the labour camp and well pads sites will be transferred to the Ravva Terminal and composted or sent to piggeries;
- Dedicated paved area will be identified for storae of drilling chemicals, fuel, lubricants and oils within the well pad sites;
- Paved storage areas will be provided for storage of oils, lubricants at the production facilities
- HDPE lined pits for temporary storage of drill cuttings, spent mud, and drilling wastewater.
- Testing of drill cutting prior to their disposal to determine if they are hazardous in nature and accordingly planning for their disposal.

Impact Assessment

The potential impact due to aforementioned activities has been discussed in following section.

Disturbance of the top soil: The two onshore well pads are located along coastal area. No disturbance of top soils is expected as two onshore well pad sites were developed earlier for onshore drilling of wells during 2006-07 based on EC obtained in 2006.

Handling of oil, chemical and waste: The drilling chemicals, cement for mud preparation, fuel and lubricants will be stored in dedicated paved storage sheds within well pad sites. The hazardous waste (spent oil & used oil), batteries, and municipal waste will be stored within designated storage areas of the well pad sites before final disposal. Thus, contamination of soil can happen only due to accidental spillage of fuel, lubricants and paints from storage areas and during the transfer of fuels and chemicals. Any contamination of soil with fuel, lubricants and paints may affect the soil microbes and bacterial growth and can affect soil quality.

Storage and disposal of drill cuttings and spent mud: Vedanta Ltd (Cairn Oil & Gas) is proposing use of water based mud (WBM) for the upper sections and use of synthetic base mud (SBM) for deeper and more difficult formations. It is estimated that nearly about 250m^3 drill cuttings and 200 m^3 spent drilling mud is likely to be generated from each well drilling. For onshore well pads, the project design takes into account construction of HDPE lined impervious pits for storage of drill cuttings, drilling mud and drilling fluid respectively. At

the end of drilling of a well almost the entire amount of the SBM will be collected for maximum reuse in next drillings, while spent WBM and SBM (after maximum reuse) will be disposed at CHWTSDF. Accidental spillage of drill cuttings and spent mud on nearby open soil may lead to change of soil characteristics due to chemical contamination.

Surface Runoff: Surface runoff during monsoon season from disturbed construction site, construction material and waste storage area and over any spillages have the potential to degrade soil quality due to deposition of foreign materials, hydrocarbon and other hazardous waste in the nearby land or backwater area.

Laying of Pipeline: The soil dug during trenching will be reused for covering after laying the pipelines. Care will be taken to restore the location of the concealed pipelines to its earlier state. The pipeline laying will be taken up one year after commercially viable discovery of hydrocarbons. The pipeline laying is expected to be completed within a short period of ~ 3 months.

Wastes: Any wastes if not managed well, it will cause nuisance and cause pollution of the soil and marine water.

Contamination of soil from wastes, contaminated surface runoffs from the well pad sites/production facilities may cause perceptible changes of the soil quality hence, the scale of impact is considered to be ***medium***. The above mentioned soil quality impacts will be localized within the project site or immediate vicinity hence the extent of impact would be ***local***. The duration of impact will spread across phases of the project life cycle hence duration is considered as ***medium*** term. Primary monitoring results of soil quality shows that there is no contamination of heavy metals in the nearby agricultural land, homestead plantation (***Refer Section 3.10***) hence the resource sensitivity is termed as **medium**. The impact on soil and sediment quality is assessed to be *moderate*.

Mitigation Measures

The mitigation measures to minimize the above-mentioned impacts are as follows:

- Fill material is to be sourced from approved quarries only;
- Project and related activities, to the extent possible will be restricted during monsoon season;
- For the onshore well pads, drainage system will be provided with sedimentation tank and oily-water separator to prevent contaminants, especially oil and grease, from being carried off by surface runoff;
- Construction waste generated from the onshore well pad sites will be utilized for backfilling within the site itself;
- All wastes will be disposed of as per inbuilt embedded controls. Food waste generated from the labour camp and construction sites will be transferred to the Ravva Terminal and composted in house or sent to piggeries;
- Dedicated paved area will be identified for storage of drilling chemicals, fuel, lubricants and oils within the well pad sites;
- Paved storage areas will be provided for storage of oils, lubricants at the production facilities
- HDPE lined pits will be provided for storage of drill cuttings, spent mud, drilling waste water, formation water, etc.
- Testing of drill cutting will be undertaken to determine if they are hazardous in nature and accordingly their disposal will be planned.
- Spills of contaminants on soil will be managed using spill kits;

- Best practices e.g. use of pumps and dispensing nozzle for transfer of fuel, use of drip trays, etc. will be adopted.

Impact Significance

Impact	**Soil & sediment impacts due onshore drilling & pipeline laying**			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Minor**			

Residual Impact

Considering the implementation of above mentioned mitigation measures, impact on soil quality is assessed to be ***Minor.***

4.4.4 *Impact on Air Quality*

Impact Sources

- Pre drilling Phase
  - Fugitive emission during development of two onshore well pads and subsurface pipelines laying;
  - Fugitive emission during transportation, storage, handling of construction material;
  - Vehicular emission during transportation of rig and associate machinery.
- Drilling Phase
  - Point source due to operation of diesel generators;
  - Point source due to due to temporary flaring of hydrocarbon during well testing in the case hydrocarbons presence is observed at the end of drilling;
  - Fugitive dust generation during loading of bulk solids (barite and bentonite).
- Decommissioning phase
  - Fugitive emission during decommissioning of rig and associated facilities;
  - Vehicular emission during transportation of de-mobilised rigs and machineries.
- Operation of Terminal
  - Operation of point and flare emission from well pads initially for two years (until commercially viable production is established) and Ravva Terminal as per already approved capacity to produce 50,000 BOPD crude oil and 2.32 MMSCMD of natural gas, which presently has declined to ~15,000 BOPD of crude oil and ~1.4 MMSCMD of natural gas. After the proposed Project, the production will remain within already approved capacity.

Embedded Controls

Project embedded control measures are as follows:

- Vehicle, equipment and machinery used for drilling would conform to applicable emission norms;
- Drilling chemicals and materials would be stored in covered areas on impervious surface to prevent fugitive emissions;
- DG set stacks would have adequate height, as per statutory requirements, to be able to adequately disperse exhaust gases; and
- For operation phase, elevated flare stack of 30 m height would be provided.

Impact Assessment

Increase in pollutant concentration in ambient air can cause health hazards to human and biological/ecological receptors. The potential impacts on air quality include the following:

Fugitive emissions: The dust generated would be primarily from the handling and transportation of fill material and re-entrainment of dust during movement of the vehicles on roads and earthwork at site and pipeline laying. Fugitive dust emissions are expected primarily from earthwork for development of two onshore well pads, handling and transportation of fill material and re-entrainment of dust during movement of the vehicles on village roads, handling of dry powdery ingredient of drilling mud during well drilling and excavation and soil handling during pipeline laying. The dust generated generally will settle down on the adjacent areas (expected to be within 500 m from the source) within a short period due to its larger particle size. Appropriate mitigation measures would be required to control fugitive dust emissions.

Emissions from Vehicles/Equipment: The pre-drilling, drilling, operation and decommissioning operations will involve movement of diesel operated vehicles and operation of machineries and equipment. Use of heavy vehicles will be particularly intense during site preparation and decommissioning phases. Gaseous pollutants such as NOx, SO_2, CO and hydrocarbons are likely to be emitted from operation of vehicles engaged as per description given in ***Section 4.4.6***.

Operation of Diesel Generators: The emission from diesel generators at onshore well pad sites [WP-7 (RX-8) & WP-8 (RX-9)] will be due to combustion of diesel. There will be two diesel generators each of 800 kW capacities (1 + 1 standby) attached to the drilling rig for power requirement of the rig during a duration of average 45 days for development well drilling and average 55 days for exploratory well drilling. Under no circumstances, even with mobilization and demobilization, timeline for drilling of a well is expected to exceed 90 days. Additionally, one 350 kVA DG set will be operational for supply of power for auxiliary operations.

Sour Gas: Crude produced from Ravva is sweet and light (API 35 degree) and gas produced is having CO_2 with ~2% of mole fraction but no H_2S is encountered. However, in the event of any H_2S encountered during drilling, adequate controls will be in place.

Temporary test flaring will be done only for Exploratory/Appraisal Well in the event of presence of hydrocarbons is observed at the end of drilling. The emission from the temporary test flaring will be due to estimated combustion of 0.105 MMSCMD of hydrocarbons, which will be only for a short period of 1 to 2 days per exploratory drilling of a well. During operation phase for initial period until onshore pipelines are laid, there will be elevated flaring to be done only in the event of emergency situation considered to be for 8 hours in a day. The

emission characteristics from the power generation due to diesel combustion and hydrocarbons flaring are summarised in ***Table 4.5.***

Table 4.5 Emissions Characteristics from Onshore Well Drilling & Flaring

SN	Parameter	Diesel Generators		Hydrocarbons Flaring	
1	Rating	1010 KVA	350 KVA	Elevated Flaring#	Test Flaring$
2	Average Fuel Consumption	140 kg/hr/DG set	49 kg /hr/DG set	4,000 kg/hour (emergency gas flaring)	0.105 MMSCMD = 4,000 kg/hr (in case hydrocarbon is observed, temporary Test flaring)
3	No. of units operative at any point of time	2 (1+1 standby)	1	1	1
4	Hours and Days of operation	24 hours per day for 45 to 90 days per drilling of a well	24 hours per day for 45 to 90 days per drilling of a well	Few hours during emergency situation – considered for max 8 hours per day)	24 to 48 hours per drilling of an exploratory/ appraisal well
5	Exhaust Gas Diameter	0.305 m	0.2 m	0.078 m flare dia (2.03 m effective stack dia)	0.078 m flare dia (2.03 m effective stack dia)
6	Stack Height above mean sea level	10.0 m	7.0 m	30m elevated flare	At ground level (~5 m)
7	Exhaust Gas Temperature	300 ^{o}C	310 ^{o}C	1000 ^{o}C	1000 ^{o}C
8	Exhaust Gas Flow	2,285 Nm^3/hour	800 Nm^3/hour	62,800 Nm^3/hour	62,800 Nm^3/hour
9	Exhaust Gas Velocity	16.7 m/sec	13.8 m/sec	20 m/sec	20 m/sec
10	Emission of pollutants				
	▪ Particulate matter (PM_{10})	0.044 g/sec (@ 0.2g/kw-hr)	0.0156 g/sec (@ 0.2g/kw-hr)	0.52 g/sec (@30 mg/Nm^3)	0.52 g/sec (@30 mg/Nm^3)
	▪ Sulphur Dioxide (SO_2)	0.004 g/sec (@ 0.005% of "S" in diesel)	0.0014 g/sec (@ 0.005% of "S" in diesel)	Negligible	Negligible
	▪ Oxides of Nitrogen (NOx)	0.89 g/sec (@ 4.0 g/kw-hr)	0.311 g/sec (@ 4.0 g/kw-hr)	2.52 g/sec (@< 145 mg/Nm^3)	2.52 g/sec (@< 145 mg/Nm^3)
	▪ Carbon Monoxide (CO)	0.78 g/sec (@ 3.5 g/kw-hr)	0.272 g/sec (@ 3.5 g/kw-hr)	6.1 g/sec## (< 350 mg/Nm^3)	6.1 g/sec## (< 350 mg/Nm^3)

Note: $ Temporary Test Flaring for 1 to 2 days at the end of drilling of an exploratory wells in case hydrocarbons presence observed at the end of drilling. # Elevated flaring during operation phase to be done only in the event of emergency situation considered to be for 8 hours in a day; ##= Flaring emissions calculated as per emission factors defined in AP-42.

The scenarios considered for additional emissions from onshore activities of drilling of wells and flaring include the following: *i.e.*

- Scenario 1: At onshore well pad WP-7 or WP-8, emissions from diesel generators [2 nos. 1010 kVA (1 operative + 1 standby) + 350 kVA for auximllary power use]. Emissions from existing onshore terminal are included in the existing baseline.
- Scenario 2: At onshore well pad WP-7 or WP-8 emission from one diesel generator [1010 kVA] and temporary test flaring (ground flaring). Emissions from existing onshore terminal are included in the existing baseline.
- Scenario 3: At onshore well pad WP-7 or WP-8 emission from diesel generator [350 kVA] and elevated flaring during emergency situation.

The background ambient air quality concentrations as observed AAQ results as monitored at various locations is presented in ***Section 3.7.***

Air Quality Model Inputs

Incremental ground level concentrations (GLCs) of air pollutants is made by using software AERMOD View approved by Environment Protection Agency (EPA) USA. ***Table 4.5*** covers Project related inputs for emission pollutants from one of the two onshore well pads**.** AERMOD uses profiles of vertical and horizontal turbulence variable with height and uses variations of surface charcteristics as per inputs given in ***Table 4.6***.

Table 4.6 Inputs for the Air Dispersion Modelling for Onshore Sources

S.N.	Input	Description
1	**Modelling Software Used**	AERMOD View – ISC-Prime – ISC Version 9.6.5
2	**Control Pathway**	
	▪ Dispersion Option	Default Options
▪	▪ Terrain	Flat
	▪ Dispersion Coefficient	Rural
	▪ Flagpole Receptors	No
3	**Meteorology Pathway**	
	▪ Met Input Data	WRF and MM1F generated data starting Jan 01, 2017, 00 hour to Dec 31, 2017, 23 hour for Amalapuram (16.48665 N; 82.09031 E)
	▪ Wind Speed Categories	A: 1.54 m/sec; B: 3.09 m/sec; C: 5.14 m/sec; D: 8.23 m/sec; E: 10.8 m/sec; F: No upper bound
	Latitude:	16.48665^{o} N
	Longitude:	82.09031^{o} E
	Datum	WGS 84
	Anemometer Height:	10 m
	Base Elevation:	0.89 m above mean sea level
4	**Receptor Pathways**	Uniform Cartesian Grid 1
	▪ No. of X axis Receptors	156
	▪ No. of Y axis Receptors	141
	▪ Spacing for X axis	200 m
	▪ Spacing for Y axis	200 m
	▪ Receptor Group	Onshore and surrounding villages Primary Receptors
5	**Emission Source Pathway**	Stationary Emission Sources considered as defined in ***Table 4.5.***

Air Quality Model Outputs

Incremental maximum GLCs at the baseline monitoring locations have been worked out for four pollutants in all the three scenarios for emissions from two well pad locations (WP-7 (RX-8) & WP-8 (RX-9). Predicted incremental and resultant GLCs at each receptor for PM_{10}, NOx, SO_2, and CO are presented in ***Tables 4.8 to 4.11***.

Predicted incremental isopleths of maximum GLCs for the three scenarios (for PM_{10}, NOx, SO_2, and CO) are presented in ***Figures 4.3 to 4.6***. The resultant ambient levels of PM_{10}, NOx, SO_2 and CO have been found to remain well within the corresponding National Ambient Air Quality Standard (NAAQS) at all the nearby receptor villages. Emissions of methane and other VOCs will occur but are expected to be small in relation to the amount of volatile hydrocarbons stored on the well pad sites and will not contribute significantly to local or global air pollution.

The resultant ambient air quality in the onshore area due to onshore activities is expected to remain well within the NAAQS. The impact of air emissions will remain within a few kilometer from the emission sources. The impact magnitude is assessed to be **moderate**.

Table 4.7 Predicted 24 Hourly Incremental & Resultant GLCs at Receptors - PM_{10} (for emissions from onshore Well Pads)

Receptor	Predicted Incremental 24 Hourly GLC (µg/m³) for scenarios & emissions from WP-7 or WP-8						98 percentile Baseline PM_{10} Concentration (µg/m³)	Resultant Concentration (predicted + baseline) (µg/m³) for scenarios & emissions from WP-7 or WP-8						NAAQS (µg/m³)
	Scenario 1		Scenario 2		Scenario 3			Scenario 1		Scenario 2		Scenario 3		
	WP-7	WP-8	WP-7	WP-8	WP-7	WP-8		WP-7	WP-8	WP-7	WP-8	WP-7	WP-8	
AQ1	0.15	0.11	0.14	0.10	0.06	0.08	55.3	55.5	55.4	55.4	55.4	55.4	55.4	**100**
AQ2	0.05	0.07	0.05	0.06	0.02	0.04	54.5	54.5	54.6	54.6	54.6	54.5	54.5	
AQ3	0.06	0.06	0.06	0.05	0.03	0.04	52.4	52.5	52.5	52.5	52.5	52.4	52.4	
AQ4	0.06	0.06	0.04	0.05	0.02	0.03	54.3	54.4	54.4	54.3	54.3	54.3	54.3	
AQ5	0.16	0.11	0.09	0.08	0.08	0.06	53.1	53.3	53.2	53.2	53.2	53.2	53.2	
AQ6	0.06	0.06	0.07	0.06	0.03	0.04	56.2	56.3	56.3	56.3	56.3	56.2	56.2	
AQ7	0.06	0.05	0.04	0.04	0.02	0.03	49.3	49.4	49.4	49.3	49.3	49.3	49.3	
AQ8	0.13	0.22	0.17	0.35	0.08	0.12	47.1	47.2	47.3	47.3	47.5	47.2	47.2	

Note: Scenrio 1 represents emissions during drilling of a well; Scenario 2 represents emissions during temporary test flaring for 1 to 2 days at the end of drilling of an exploratory wells in case hydrocarbons presence observed at the end of drilling; and Scenario 3 represents operation phase.

Table 4.8 Predicted 24 Hourly Incremental & Resultant GLC at Receptors – NOx (for emissions from onshore Well Pads)

Receptor	Predicted Incremental 24 Hourly GLC (µg/m³) for scenarios & emissions from WP-7 or WP-8						98 percentile Baseline NOx Concentration (µg/m³)	Resultant Concentration (predicted + baseline) (µg/m³) for scenarios & emissions from WP-7 or WP-8						NAAQS (µg/m³)
	Scenario 1		Scenario 2		Scenario 3			Scenario 1		Scenario 2		Scenario 3		
	WP-7	WP-8	WP-7	WP-8	WP-7	WP-8		WP-7	WP-8	WP-7	WP-8	WP-7	WP-8	
AQ1	3.1	2.3	2.3	1.7	1.3	1.3	16.4	19.5	18.7	18.7	18.1	17.7	17.7	**80**
AQ2	0.9	1.5	0.6	0.9	0.3	0.7	15.2	16.1	16.7	15.8	16.1	15.5	15.9	
AQ3	1.3	1.3	0.8	0.8	0.5	0.5	14.4	15.7	15.7	15.2	15.2	14.9	14.9	
AQ4	1.2	1.2	0.8	0.7	0.5	0.5	15.3	16.5	16.5	16.1	16.0	15.8	15.8	
AQ5	3.1	2.1	1.7	1.2	1.7	1.1	14.6	17.7	16.7	16.3	15.8	16.3	15.7	
AQ6	1.2	1.3	1.0	0.8	0.5	0.5	16.5	17.7	17.8	17.5	17.3	17.0	17.0	
AQ7	1.2	1.0	0.7	0.7	0.5	0.4	14.3	15.5	15.3	15.0	15.0	14.8	14.7	
AQ8	2.6	4.5	1.2	2.8	1.6	2.3	14.2	16.8	18.7	15.4	17.0	15.8	16.5	

Note: Scenrio 1 represents emissions during drilling of a well; Scenario 2 represents emissions during temporary test flaring for 1 to 2 days at the end of drilling of an exploratory wells in case hydrocarbons presence observed at the end of drilling; and Scenario 3 represents operation phase.

Table 4.9 Predicted 8 Hourly Incremental & Resultant GLC at Receptors – CO (for emissions from onshore Well Pads)

Receptor	Predicted Incremental 8 Hourly GLC (µg/m³) for scenarios & emissions from WP-7 or WP-8						98 percentile Baseline CO Concentration (µg/m³)	Resultant Concentration (predicted + baseline) (µg/m³) for scenarios & emissions from WP-7 or WP-8						NAAQS (µg/m³)
	Scenario 1		Scenario 2		Scenario 3			Scenario 1		Scenario 2		Scenario 3		
	WP-7	WP-8	WP-7	WP-8	WP-7	WP-8		WP-7	WP-8	WP-7	WP-8	WP-7	WP-8	
AQ1	6.3	4.9	5.1	3.4	3.1	3.0	253	259.3	257.9	258.1	256.4	256.1	256.0	2000
AQ2	2.4	3.2	2.1	2.1	1.1	1.6	231	233.4	234.2	233.1	233.1	232.1	232.6	
AQ3	2.2	3.2	2.1	2.0	1.2	1.4	223	225.2	226.2	225.1	225.0	224.2	224.4	
AQ4	3.2	3.1	2.1	1.9	1.2	1.3	242	245.2	245.1	244.1	243.9	243.2	243.3	
AQ5	8.2	5.6	4.7	3.3	4.5	3.5	225	233.2	230.6	229.7	228.3	229.5	228.5	
AQ6	3.1	3.3	3.3	2.5	1.3	1.3	261	264.1	264.3	264.3	263.5	262.3	262.3	
AQ7	3.0	2.7	1.9	1.8	1.2	1.0	235	238.0	237.7	236.9	236.8	236.2	236.0	
AQ8	7.1	8.7	3.9	7.2	4.7	4.2	223	230.1	231.7	226.9	230.2	227.7	227.2	

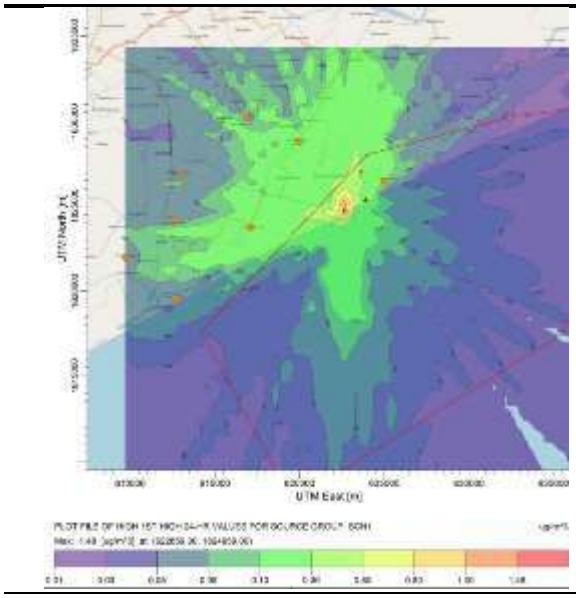
Note: Scenrio 1 represents emissions during drilling of a well; Scenario 2 represents emissions during temporary test flaring for 1 to 2 days at the end of drilling of an exploratory wells in case hydrocarbons presence observed at the end of drilling; and Scenario 3 represents operation phase.

Table 4.10 Predicted 24 hourly Incremental & Overall GLC at Receptors - SO_2 (for emissions from onshore Well Pads)

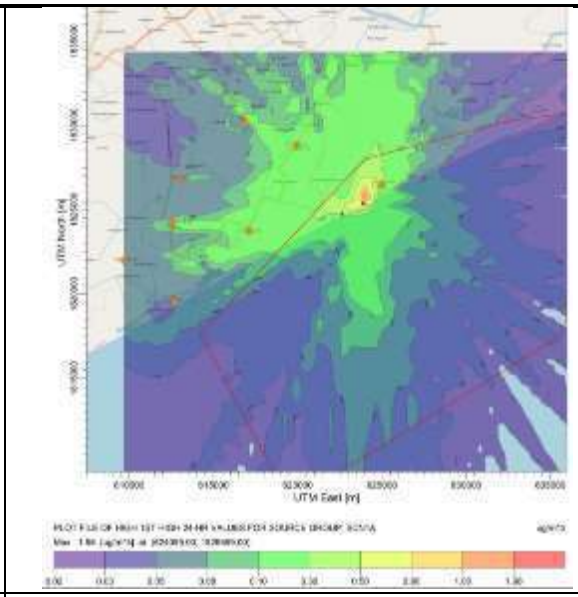
Receptor	Predicted Incremental 24 Hourly GLC (µg/m³) for scenarios & emissions from WP-7 or WP-8						98 percentile Baseline SO_2 Concentration (µg/m³)	Resultant Concentration (predicted + baseline) (µg/m³) for scenarios & emissions from WP-7 or WP-8						NAAQS (µg/m³)
	Scenario 1		Scenario 2		Scenario 3			Scenario 1		Scenario 2		Scenario 3		
	WP-7	WP-8	WP-7	WP-8	WP-7	WP-8		WP-7	WP-8	WP-7	WP-8	WP-7	WP-8	
AQ1	0.014	0.010	0.010	0.007	0.006	0.006	14.4	14.414	14.410	14.410	14.407	14.406	14.406	80
AQ2	0.004	0.007	0.003	0.004	0.002	0.003	13.1	13.104	13.107	13.103	13.104	13.102	13.103	
AQ3	0.006	0.006	0.003	0.003	0.002	0.002	12.5	12.506	12.506	12.503	12.503	12.502	12.502	
AQ4	0.005	0.005	0.003	0.003	0.002	0.002	13.1	13.105	13.105	13.103	13.103	13.102	13.102	
AQ5	0.014	0.010	0.008	0.005	0.008	0.005	12.7	12.714	12.710	12.708	12.705	12.708	12.705	
AQ6	0.005	0.006	0.004	0.004	0.002	0.002	14.5	14.505	14.506	14.504	14.504	14.502	14.502	
AQ7	0.005	0.005	0.003	0.003	0.002	0.002	12.1	12.105	12.105	12.103	12.103	12.102	12.102	
AQ8	0.012	0.020	0.005	0.011	0.007	0.010	11.6	11.612	11.620	11.605	11.611	11.607	11.610	

Note: Scenrio 1 represents emissions during drilling of a well; Scenario 2 represents emissions during temporary test flaring for 1 to 2 days at the end of drilling of an exploratory wells in case hydrocarbons presence observed at the end of drilling; and Scenario 3 represents operation phase.

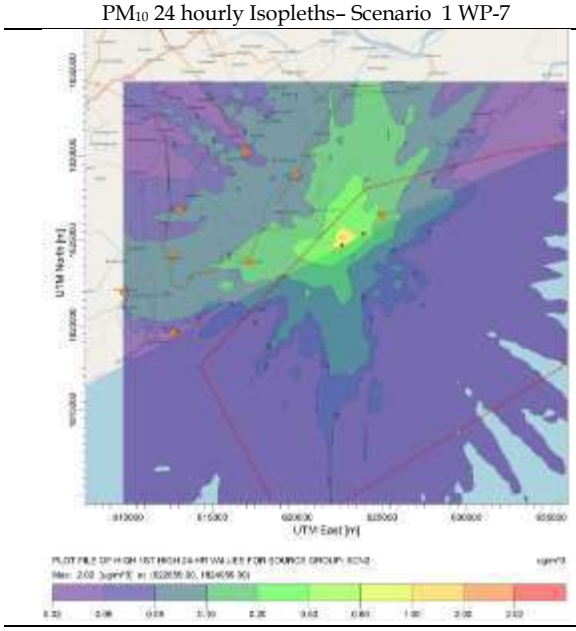
Figure 4.3 Incremental GLCs of PM_{10} Isopleths - Scenarios 1 to 3 for WP-7 & WP-8



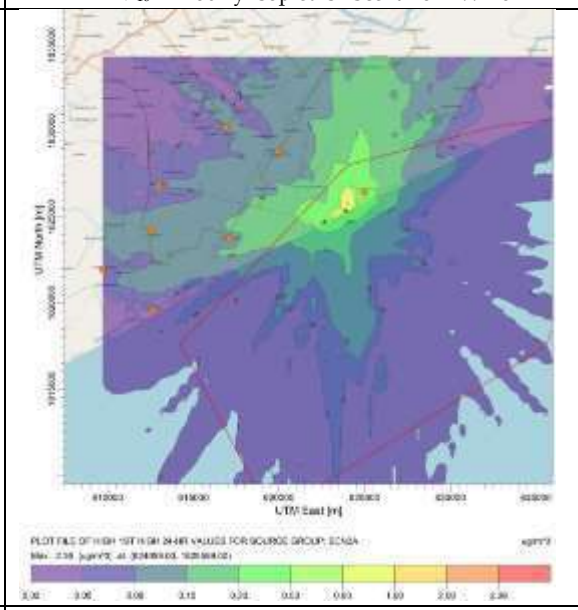
PM_{10} 24 hourly Isopleths– Scenario 1 WP-7



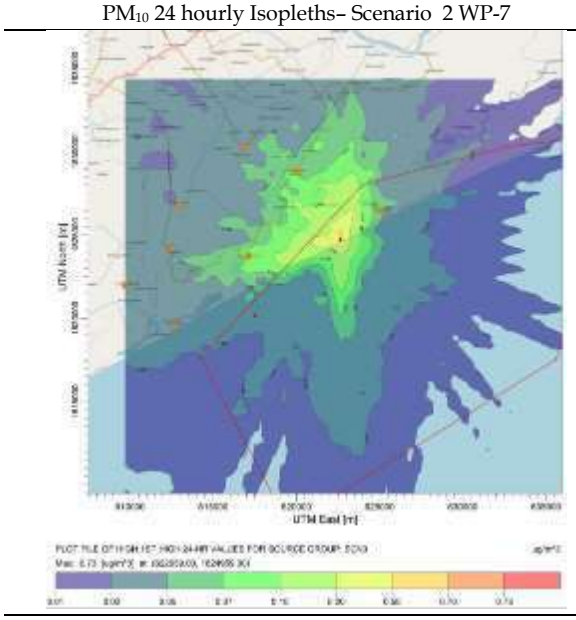
PM_{10} 24 hourly Isopleths– Scenario 1 WP-8



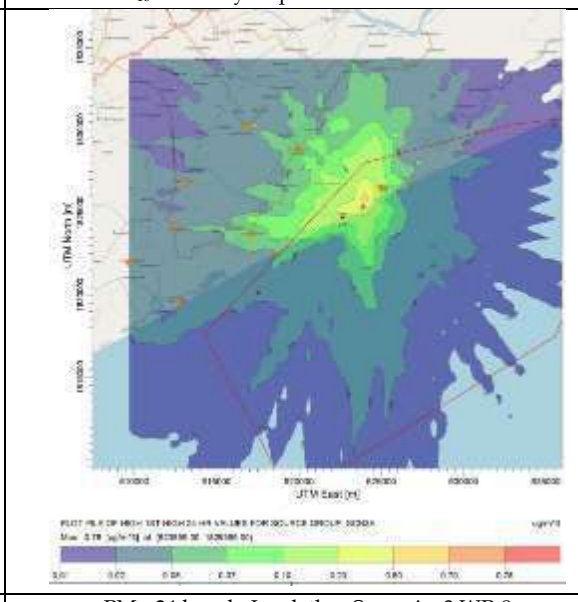
PM_{10} 24 hourly Isopleths– Scenario 2 WP-7



PM_{10} 24 hourly Isopleths– Scenario 2 WP-8

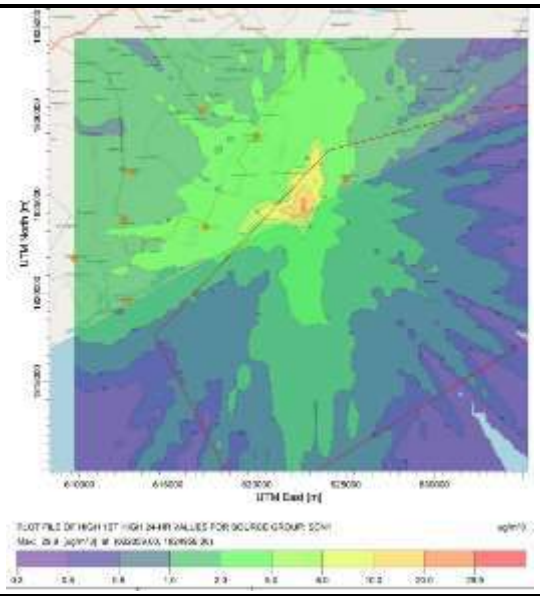


PM_{10} 24 hourly Isopleths– Scenario 3 WP-7

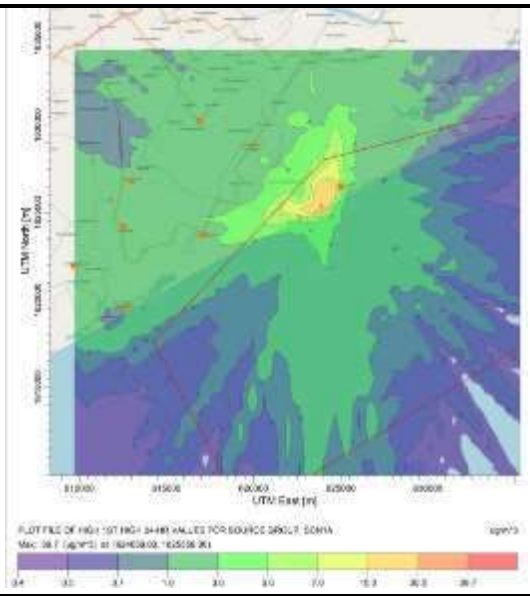


PM_{10} 24 hourly Isopleths– Scenario 3 WP-8

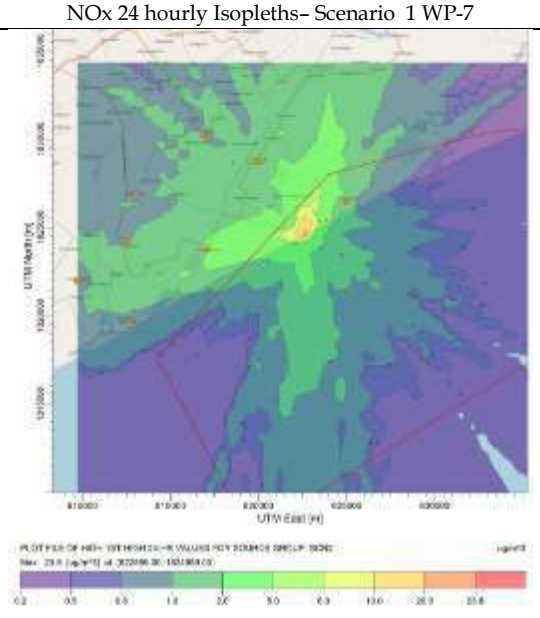
Figure 4.4 Incremental GLCs of NOx Isopleths - Scenarios 1 to 3 for WP-7 & WP-8



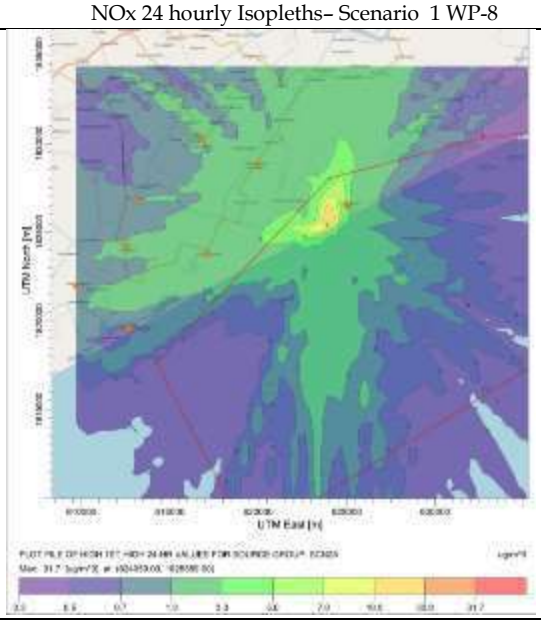
NOx 24 hourly Isopleths– Scenario 1 WP-7



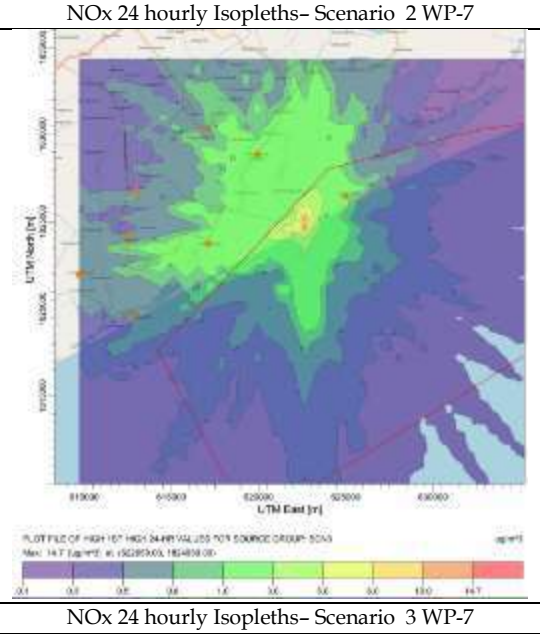
NOx 24 hourly Isopleths– Scenario 1 WP-8



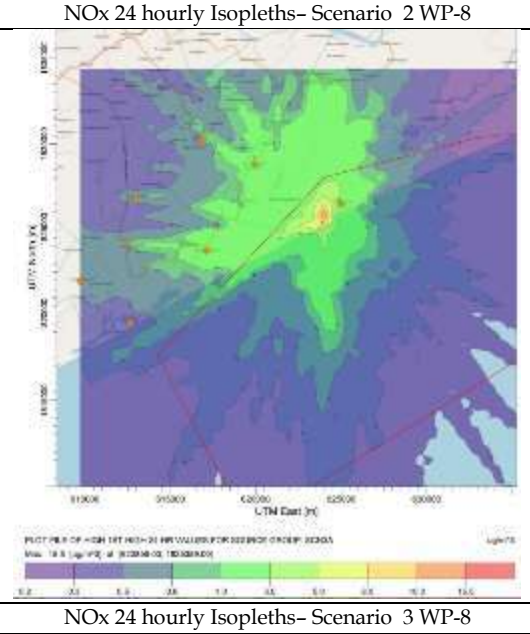
NOx 24 hourly Isopleths– Scenario 2 WP-7



NOx 24 hourly Isopleths– Scenario 2 WP-8

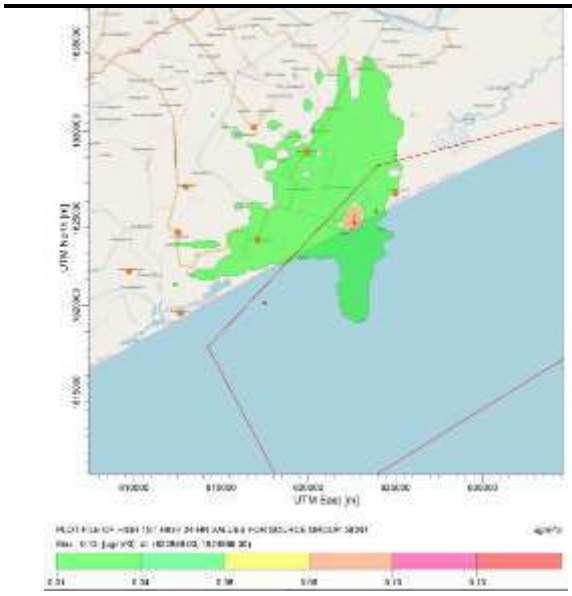


NOx 24 hourly Isopleths– Scenario 3 WP-7

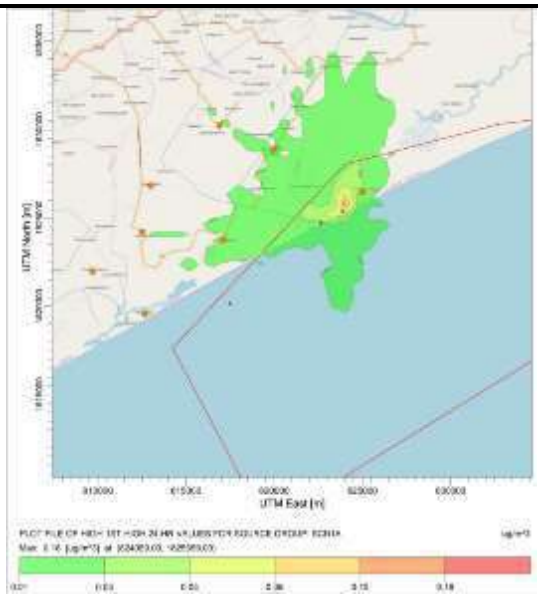


NOx 24 hourly Isopleths– Scenario 3 WP-8

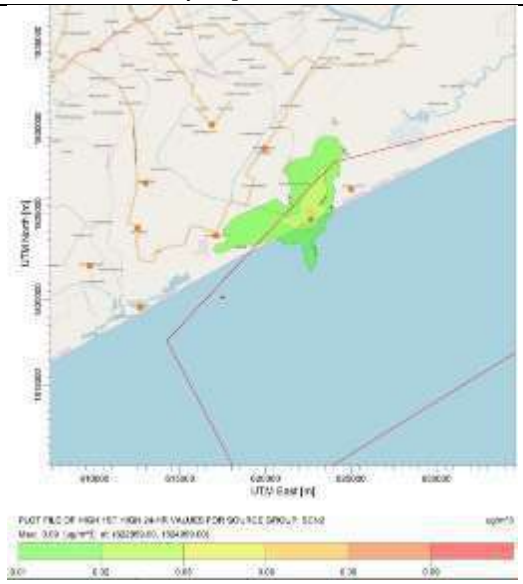
Figure 4.5 Incremental GLCs of SO_2 Isopleths - Scenarios 1 to 3 for WP-7 & WP-8



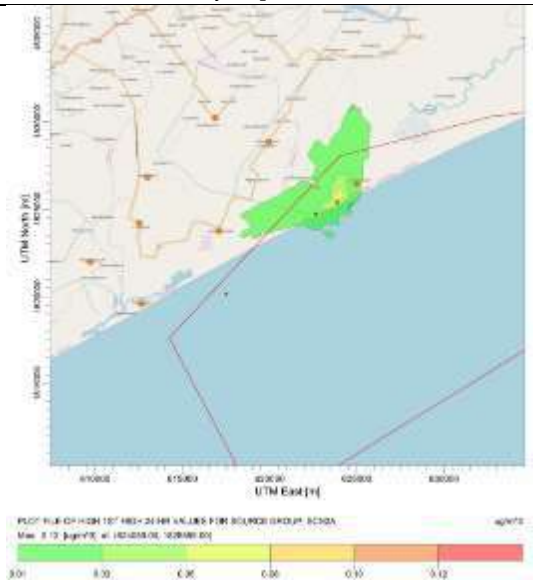
SO_2: 24 hourly Isopleths– Scenario 1 WP-7



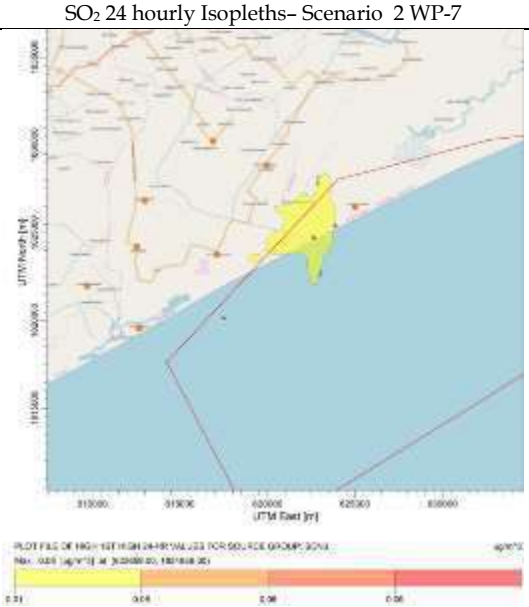
SO_2 24 hourly Isopleths– Scenario 1 WP-8



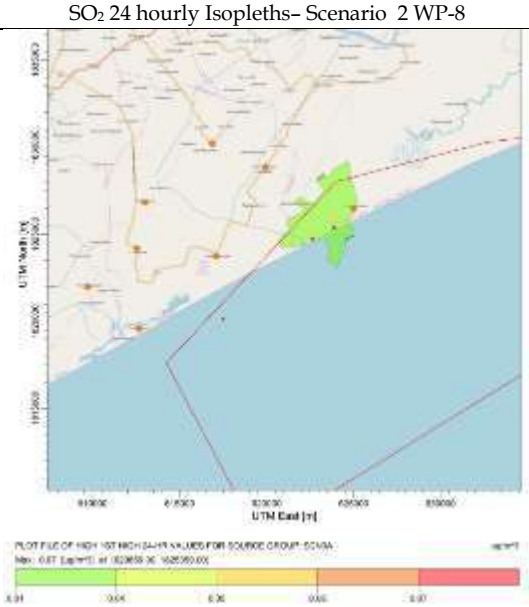
SO_2 24 hourly Isopleths– Scenario 2 WP-7



SO_2 24 hourly Isopleths– Scenario 2 WP-8

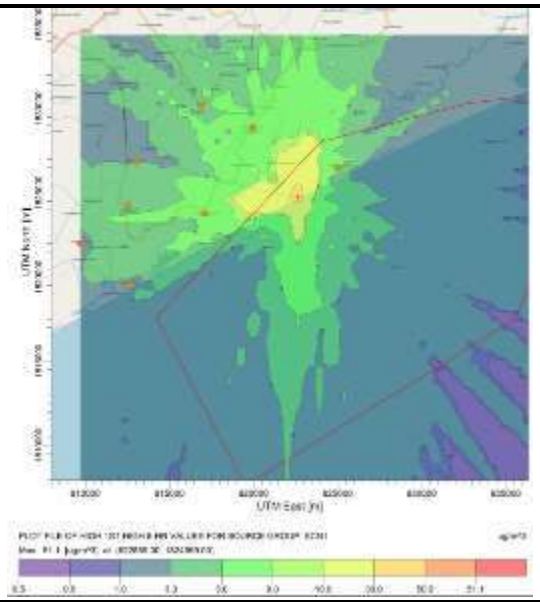


SO_2 24 hourly Isopleths– Scenario 3 WP-7

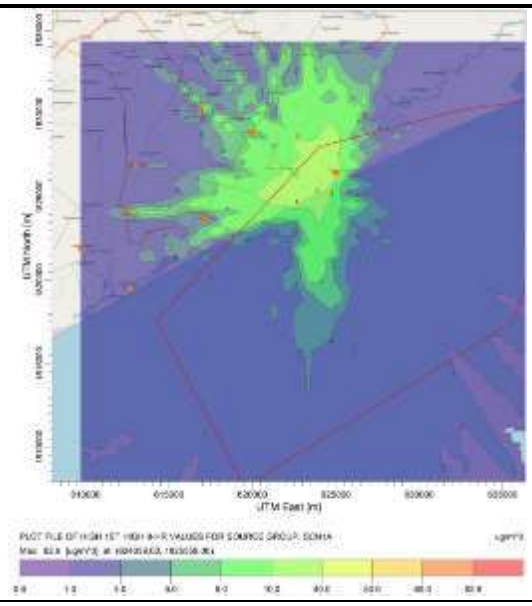


SO_2 24 hourly Isopleths– Scenario 3 WP-8

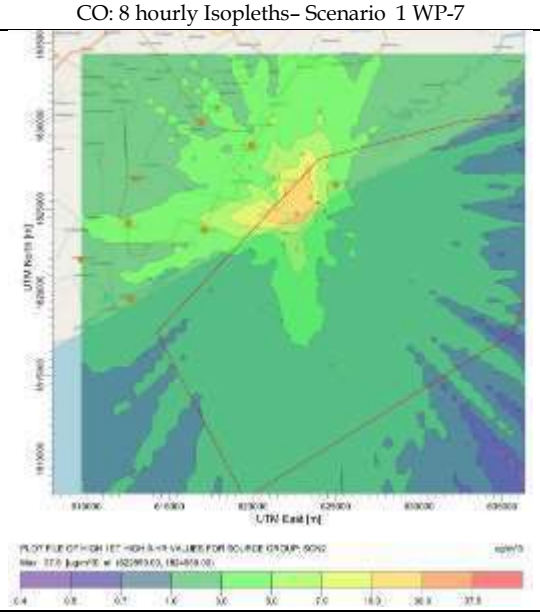
Figure 4.6 Incremental GLCs of CO Isopleths - Scenarios 1 to 3 for WP-7 & WP-8



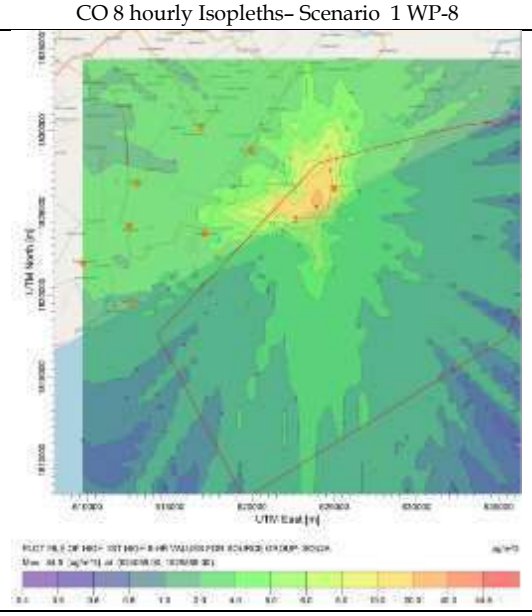
CO: 8 hourly Isopleths– Scenario 1 WP-7



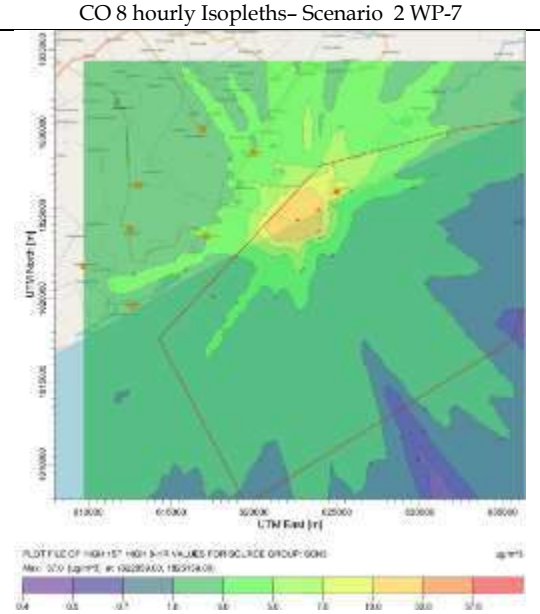
CO 8 hourly Isopleths– Scenario 1 WP-8



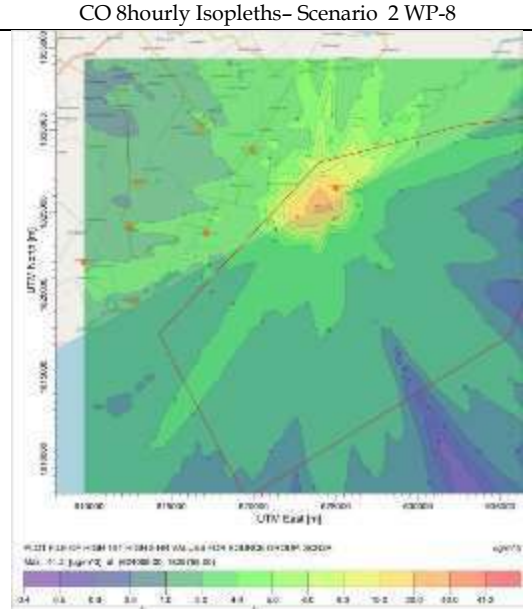
CO 8 hourly Isopleths– Scenario 2 WP-7



CO 8hourly Isopleths– Scenario 2 WP-8



CO 8 hourly Isopleths– Scenario 3 WP-7



CO 8 hourly Isopleths– Scenario 3 WP-8

Mitigation Measures

Following mitigations will be implemented for onshore component of the proposed Project:

f) Regular water sprinkling will be carried out at the site during dry season;
g) Stockpile will be maintained against the wall or obstruction, which will works as a windbreak;
h) Vehicle, equipment and machinery used for drilling would conform to applicable emission norms; regular preventive maintenance to be undertaken.
i) Drilling chemicals and materials would be stored in covered areas to prevent fugitive emissions;
j) DG set stacks / flare stacks would have adequate height, as per statutory requirements, to be able to effectively disperse exhaust gases;
k) Trucks used for transport of material during site preparation and decommissioning will be provided with impervious sheeting;
l) During construction, the approach road will be kept clean, free from mud and slurry to prevent any entrainment of dust;
m) VOC emissions from diesel fuel etc. will be reduced by appropriate storage and handling;
n) No cold venting to be resorted during well testing. The well test programme will be managed by dedicated team for prevention of trips in product supply to the flare and flame out. Many of the above measures including checking of methane emissions, which may occur during well testing, are incorporated into management of the drilling operations. The well testing procedure involves the dedicated observation of the flare and radio communication to well test manager. In the event that product pressure drops in the well test flare, diesel can be injected to maintain combustion otherwise the feed line would be shut off;
o) In event of H_2S encountered during drilling following controls are suggested
    a) Provision of H_2S detection alarm system on-board the rig. All personnel on-board the rig to be aware of H_2S inhalation related hazard. Key personnel to have H_2S trained certificate.
    b) Air inhalation of the compressor gearing will have H_2S/ CO air probe into device to ensure that the compressor once having the H_2S/ CO in air it will immediately shut down.
    c) The manifold system will be H_2S resistant
    d) The vent boom shall be so located that any H_2S and HC gas concentration on the platform remains within acceptable limits for personnel safety, under worst operating & environmental conditions.

Impact	**Impact on air quality due to onshore drilling activity**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impact

Considering the implementation of above mentioned mitigation measures, the significance of residual impact on ambient air quality is assessed as **Minor**.

4.4.5 Impact on Noise Quality

Impact Sources

The potential impacts on noise quality may arise out of the following:

- Pre-drilling phase, site development including strengthening of site approach roads, construction of well pads and pipeline laying:
  - Operation of machineries and equipment;
  - Vehicular traffic;
  - Operation of DG sets.
- Drilling phase:
  - Operation of diesel generators and drilling activities
  - Operation of machineries and equipment;
  - Vehicular traffic.
- Decommissioning phase:
  - Demobilization activity
  - Vehicular traffic.

Embedded Controls

The project embedded control measures are as follows:

- All vehicle and equipment involved in site development and drilling activity will be provided with noise control measures;
- Well maintained equipment and vehicles will be used;
- All DG sets would be provided with acoustic enclosures; and
- Appropriate PPEs (e.g. ear plugs) will be used by workers while working near high noise generating equipment.

Impact Assessment

The potential impact from above mentioned potential noise sources are discussed as following:

Construction machinery/equipment noise:

The construction stage activities such as transportation of raw materials for civil works, operation of heavy equipment and construction machinery, etc. are likely to cause increase in the ambient noise levels in and around the well pad sites. The noise generated is likely to be attenuated within 500m and may cause discomfort for the workers / villagers who are within 500m of the well pad sites.

Noise from Vehicular Traffic

As vehicles supplying, material and manpower to the sites will pass through site access and approach roads, it will result in increase in traffic density (compared to existing traffic) on such roads and resultant increases in noise levels at settlements along the road. The impact will be more significant for residents living adjacent to the approach road where houses are located close to the road. The noise pressure level caused by movement of a heavy truck, at a distance of about 5 m from the road, has been measured to be as high as 75- 80 dB(A), though it gets averaged out when expressed in Leq terms. This may cause considerable incremental noise disturbances to residents near site approach roads.

Operation of drilling rig and ancillary equipment:

Operational phase noise impacts are anticipated from operation of drilling rig and ancillary equipment *viz*. shale shakers, mud pumps and diesel generators. Studies indicate that noise generated from operation of drilling rig generally varies in the range of 88-103 dB(A). Other contributors of high noise level at the well site include shale shakers, mud pumps and diesel generators. The average equivalent noise levels of drilling rig and ancillary equipment is estimated to be 95 dB(A).

Noise Level Prediction

A noise modelling exercise has been undertaken to predict noise levels from drilling rig near sensitive receptors. A noise attenuation plot has been developed considering natural attenuation by distance and is expected to help in planning and decision-making. The principal noise sources considered for the modelling exercise has been listed in ***Table 4.12***.

Table 4.11 Noise Sources – Onshore Drilling

SN	Equipment	Noise Levels, dB(A)	Daiy Operations, % time
N1	Drilling Rig - Rotary table	100	80%
N2	Mud Pumps	90	80%
N3	Water Pumps	90	40%
N4	Mud Returns	90	80%
N5	Shale Shakers	75	60%
N6	Desander & Desilter	80	60%
N7	Diesel Generator 1	75	100%
N8	Diesel Generator 2	75	100%

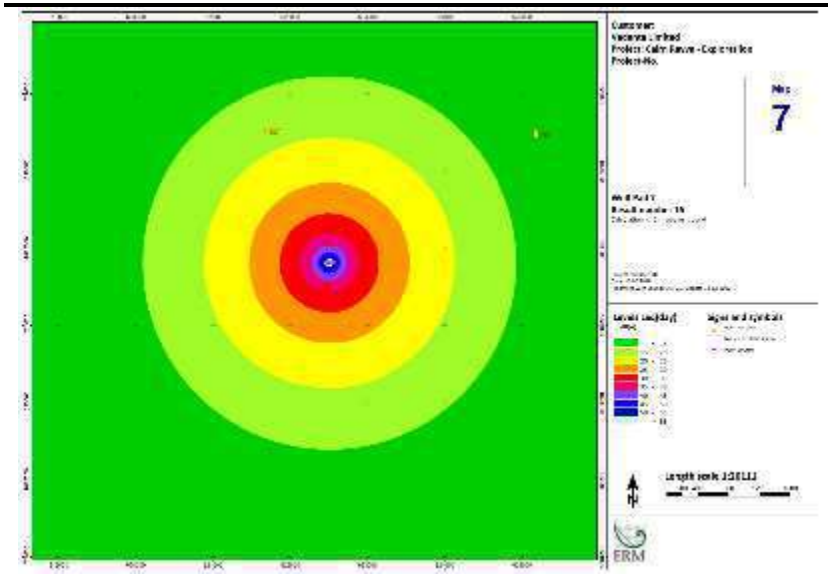
Further, considering drilling to be a continuous operation, noise generated from aforesaid equipment has the potential to cause discomfort to the local communities residing in proximity (within 500m) of the rig facility. Occupational health and safety impacts *viz*. Noise Induced Hearing Loss (NIHL) is also anticipated for personnel working close to such noise generating equipment unless they are wearing appropriate personnel protective equipment.

To understand the impact of the onshore drilling activities, noise modelling was carried out considering noise sources from the proposed well pad sites (WP-7 & WP-8) at the noise sensitive locations in the study area. The noise inventory established for the operational phase at different onshore well pad locations was used to populate the noise propagation model SoundPlan 7.2. The model was applied to simulate environmental noise levels over the noise calculation area (5 km x 5 km) at a grid resolution of 5 m and at 8 identified receptors. The propagation of noise was calculated according to ISO 9613-2:1996 (Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation) of the International Organisation for Standardisation (ISO) and makes use of air absorption parameters and equations for noise attenuation as well as the factors for barriers and ground effects. The results are presented in ***Table 4.12*** and ***Figure 4.7.*** The scale of impact of the above mentioned activities is considered to be **high** as the changes of baseline noise levels in the immediate vicinity of the well pad sites/production facilities are likely to exceed the standard. However as evident from the results of the noise modelling exercise, the extent of impact is considered as **local** as noise would be attenuated within 500m of the sites. The duration of impact is also considered as **medium-term** spread across several phases of the project lifecycle. The magnitude of impact assessed to be **medium**. The sensitivity of the receptors is **medium** with the consideration that human receptors are present beyond 0.5 km of all the well sites. The impact on ambient noise level is assessed to be **moderate**.

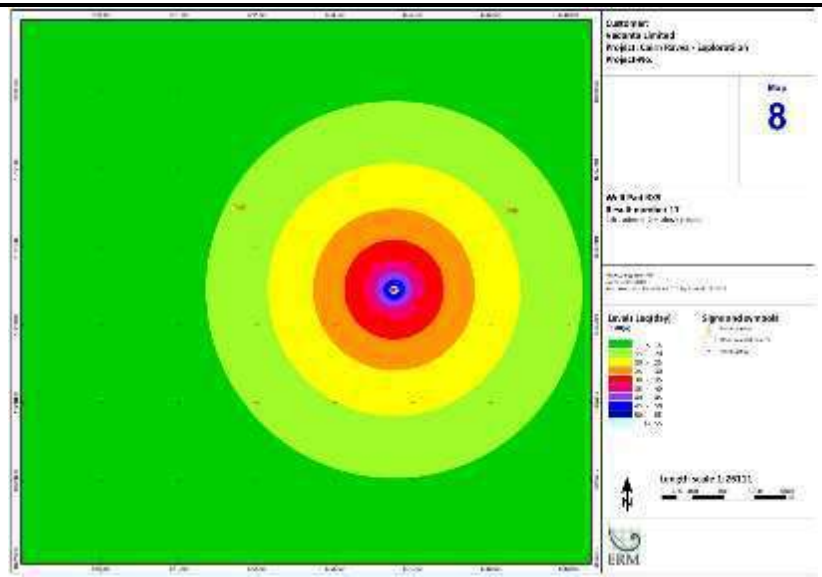
Table 4.12 Noise Levels Predicted at Receptor Locations due to Onshore Drilling from WP-7 & WP-8

Drilling @ Onshore Well Pads		Baseline Noise in dB(A)		Predicted Incremental Noise dB(A)				Resultant Noise (Baseline + Predicted) dB(A				Standard in dB(A)	
				WP-7 (RX-8)		WP-8 (RX-9)							
Receiver	**Receiver Name**	**Leq_{day}**	**Leq_{night}**	**Leq_{day}**	**Leq_{night}**	**Leq_{day}**	**Leq_{night}**	**Leq_{day}**	**Leq_{night}**	**Leq_{day}**	**Leq_{night}**	**Leq_{day}**	**Leq_{night}**
NQ1	Outside Ravva Terminal	57.1	48.1	-	-	-	-	57.1	48.1	57.1	48.1	65.0	55.0
NQ2	Living Quarter (LQ)	50.0	41.0	-	-	-	-	50.0	41.0	50.0	41.0	55.0	45.0
NQ3	Surasaniyanam Village	50.1	38.7	-	-	-	-	50.1	38.7	50.1	38.7	55.0	45.0
NQ4	S.Yanam Beach: Cyclone Shelter	49.0	39.7	-	-	-	-	49.0	39.7	49.0	39.7	55.0	45.0
NQ5	Challapalli Village	52.0	42.2	-	-	-	-	52.0	42.2	52.0	42.2	55.0	45.0
NQ6	Gopavaram Village	51.3	41.3	-	-	-	-	51.3	41.3	51.3	41.3	55.0	45.0
NQ7	Gachakayala Pora Village	48.0	38.7	18.1	18.1	15.5	15.5	48.0	38.8	48.0	38.7	55.0	45.0
NQ8	Cherriyanam Village	48.2	38.2	11.2	11.2	19.0	19.0.	48.2	38.2	48.2	38.2	55.0	45.0

Figure 4.7 Incremental Noise Levels during Onshore Drilling



Drilling @ Well Pad WP-7



Drilling @ Well Pad 8

The additional mitigation measures as proposed are as follows:

p) Provide noise barriers surrounding the high noise generating equipment at the well pad site.
q) All equipment involved for well pad development and drilling activity are to be provided with noise control measures. All diesel generators would be provided with acoustic enclosures;
r) Regular maintenance of vehicles and machineries;
s) Ensure low speed (less than 30 kmph) of vehicles plying through roads near villages;
t) Restrict unnecessary use of horns by trucks and vehicles near settlement areas;
u) Appropriate PPEs (e.g. ear plugs) will be used by workers while working near high noise generating equipment.

Impact	**Noise quality impact due to onshore activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impact

Considering the implementation of above mentioned mitigation measures, the residual impact on noise quality is assessed to be **Minor**.

4.4.6 *Impact on Road & Traffic*

Impact Sources

The source of impact is additional traffic load during:

- Predrilling phase, strengthening of site approach road and laying of pipeline
  - Transportation of construction materials and manpower;
  - Transportation of drilling rig and machineries;
- Drilling phase
  - Transportation of drilling chemical and fuel
  - Transportation of manpower
- Demobilization
  - Transportation of drilling rigs and machineries.

Impact Assessment

Daily ~10 trucks/trailers load materials during ~50 days of well pad construction will be transported during predrilling phase. During drilling activity 5 to 7 trucks/trailers load materials will be transported during mobilization and demobilization (each of 4 to 5 days) of a well drilling at a well pad site. Additionally, 10 to 15 light motor vehicles will be used for transport of site workers during drilling of a well.

Based on the traffic survey conducted (*Refer* ***Section 3.8)***, it is noted that Amlapuram-Surasaniyanam Road and village roads from Ravva Onshore terminal to Surasaniyanam and Challapalli ate the principal roads that will be used for transportation of construction material and drilling rig and machineries.

The increase of traffic during construction phase will cause perceptible changes in the existing road traffic volume. This may cause deterioration of existing road infrastructure. The increased traffic may also cause disturbance to community of the nearby villagers and at sensitive man-made habitat like schools. Impact on community health & safety is discussed in a subsequent section.

During drilling phase traffic movement would be primarily for the movement of manpower to the well pad sites.

The scale of impact considering traffic movement due to the proposed project is considered to be **medium** as the increase of traffic during construction phase will cause perceptible changes in the existing traffic load (however, no perceptible change to the existing traffic load is expected during drilling phase). The extent of impact is considered as **local** as impact will be mostly limited to the access and approach roads to the site. The duration of impact is considered as **short term**. The magnitude of impact assessed to be **medium**. The sensitivity of the receptors is also considered as **medium** as human receptors are present adjacent to the access routes and likely to be affected by the project. The potential impact on road and traffic due to project activities is assessed to be **moderate**.

Mitigation Measures

Following mitigations will be in place to minimize impact on road and

v) Avoid traffic movement during school hours and market times;
w) Ensure regular maintenance of access roads;
x) Deploy traffic marshals at important road junctions and near sensitive receptors (e.g. schools) for management of Project related traffic.

Impact	**Impact on road and traffic due to onshore activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impact

Considering the implementation of above mentioned mitigation measures, the residual impact disturbance/ discomfort to local communities due to increased traffic is assessed to be **Minor**.

4.4.7 Impact on Surface Water Quality

Impact Sources

Potential impact on surface water quality can arise due to the following activities;

- Predrilling phase, construction of well pads and site approach roads and laying of pipeline:
  - Surface runoff from construction site, spill area;
  - Hydrotest water from pipeline testing;
  - Generation and disposal of domestic waste water from construction camp.
- Drilling phase:
  - Discharge of drilling wash water;
  - Generation and disposal of domestic waste water from well pad sites;
  - Surface runoff from well pad sites;
  - Accidental discharge from waste pit.
- Demobilization
  - Surface runoff from site.

Embedded Controls

The embedded control measures are as follows:

- Each well pad site and camp site will have modular ETP for treatment of domestic waste water generated from the well pad sites. The treated water will be disposed as per CPCB discharge standard;
- Hydrotest water will be taken to the ETP at Ravva Terminal for treatment.

Impact Assessment

The potential impact due to above-mentioned activities has been discussed in following section.

Surface run-off from the site

The site development activity *viz*. site raising with soil/ sands during site construction may result in increase in soil erosion that might lead to an increased silt load in the surface run-off. The surface run off from drilling waste (cuttings and drilling mud) storage areas, hazardous waste (waste oil, used oil, etc.) storage areas and chemical storage areas is likely to be contaminated. To prevent these run-offs, waste pits, storm water drains and tankers (that will regularly carry the treated water) will be provided during the drilling phase. Further, the boundaries of the waste pits will be raised to prevent any runoff. All the onshore well pad are located within the backwater area. Any accidental runoff from well pad sites and production facilities will create an adverse impact upon the receiving streams (inland/estuarine water bodies). This situation is likely to be more pronounced considering high rainfall received in these areas. The surface run offs may contain high sediment load, oil residues, organic wastes, etc. The higher value of suspended solid and organic rich sediment load may affect the lowering of DO levels in the nearby water bodies and affect the aquatic ecology. Impact on aquatic ecology is discussed under the section on ecological impact assessment.

Discharge of drilling wastewater and domestic wastewater

The process wastewater and formation water will be generated during drilling activity. The process wastewater treated through ETP would meet the CPCB discharge standards before it is discharge / use for well recharge. Resultantly no significant change in the surface water

quality is envisaged. However, accidental discharge of untreated process effluent will adversely affect the surface water quality.

The domestic wastewater will be generated during all the phases of the project. The domestic wastewater will be treated through STP.

Discharge of Produced Water from Ravva Terminal

Produced water will be treated in ETP to comply with the CPCB discharge standards before discharging to sea/ used for recharge of well. The discharge of treated water in the sea is not expected to cause significant change in the surface water quality. However, accidental discharge of untreated water will adversely affect the surface water quality.

The estuarine habitat in the study area comprises of ecological sensitive areas in terms of fish habitat, breeding and nursing grounds for fishes and sea turtle's nesting site. The water quality of the river is fit the use of propagation of wildlife (CPCB Use Class category D) and also no major contamination was recorded (*Refer* ***Section 3.9*** *and* ***Section 3.12***).

Discharge of surface run-off, treated wastewater can cause reversible damage to water quality but likely to easily revert to earlier stage with mitigation, hence, scale of impact is ***medium***. The duration of impact will be **short term**; i.e. surface runoff may get discharged at the time of rainfall and formation water may get discharged accidentally. The extent of impact is ***regional*** as treated wastewater and surface run-off may reach beyond 0.5 km from the well pad sites**.** The potential impact on surface water quality is assessed to be ***moderate***

Mitigation Measures

The mitigation measures are as follows:

- Each well pad site will have modular ETP and STP for primary treatment followed by final treatment at Ravva Terminal/Living Quarters. The treated water will be disposed as per APPCB discharge standards;
- Hydro test wastewater for pipeline commissioning will be transferred to ETP at Ravva Terminal for treatment and final disposal.
- Construction activities viz. stripping, excavation etc., during monsoon season will be restricted to the extent possible;
- All surface runoff from the construction site will be channelized through storm water drainage system; adequate size double chambered sedimentation tank will be provided;
- Proper treatment of all wastewater and produced water discharges will be made to ensure that they comply with criteria set by the regulatory bodies (MoEFCC and SPCB);
- All chemical and fuel storage areas, process areas will have proper bunds so that contaminated run-off cannot escape into the storm-water drainage system;
- An oil-water separator will be provided at the storm water drainage outlet, to prevent discharge of contaminated run-off;
- Spill kits will kept available for removal of any oil or chemical spillage on site.

Impact	Impact on surface water quality due to onshore activities			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impact

Considering the implementation of above mentioned mitigation measures, the residual impact on surface water quality due to above mentioned activity is still assessed to be **Minor**.

4.4.8 Impact on Ground Water Resources

Impact Sources

Potential impact on ground water resource could arise due to:

- Predrilling phase, site development of well pad sites including strengthening of site approach roads and pipeline laying
- Drilling phase
  - Water requirement of approx. 60 m^3/day per well for a period of 50 days,
  - Generation of produce water during drilling activity.

Embedded Controls

- Proper engineering controls for the drilling and cementing operations.

Impact Assessment

The potential impact on groundwater resource has been discussed in following section.

Abstraction of ground water: Water requirement at the Ravva Terminal is met through groundwater resources. Vedanta Ltd (Cairn Oil & Gas) is withdrawing groundwater of 9,570 m^3/day through old deep wells reportedly drilled prior to 1998. Of the 9,570 m^3/day water requirement, 9,170 m^3/day is used for injection into reservoir to maintain reservoir pressure by filling the void created due to fluid extraction and remaining 400 m^3/day is fed to RO Plant for domestic use. Vedanta Ltd (Cairn Oil & Gas) has permission to withdraw groundwater from Andhra Pradesh State Water, Land and Tree Authority for extraction of 10,413 m^3/day of saline ground water from the existing six bore well. Additional requirement of ~7872 m^3/day is anticipated, for which necessary permission will be eobtained from Ground water Authority.

During onshore drilling activities the daily requirement per well will be 60 m^3/day. The required water for drilling activities will be sourced from the existing ground water source of Ravva Terminal.

Depth to groundwater level is varying from 1 to 12 m below ground level. The groundwater basins have wide lateral extent and aquifers occur under unconfined conditions beyond depths of 150 m.

As stated earlier, Vedanta Ltd (Cairn Oil & Gas)sponsored a study on groundwater abstraction at Ravva Terminal by by National Geophysical Research Institute (CSIR-NGRI), Hyderabad. The study was conducted in two different phases i.e. 2006-2008 (Phase I) and 2014-2016 (Phase II). The study highlights the following points:

- The groundwater study area covers about 250 sq. km with Bay of Bengal as Eastern boundary, Vainateyam, a branch of Godavari River as southern boundary, Amalapuram Town on the west and Anatavaram – Nimmakayala Kottapali area in north of Kunavaram drain as northern boundary. Godavari irrigation canal network is well spread out in the area and provides perennial irrigation to the paddy crop. Irrigation drainage in the area flows to Bay of Bengal through three important canals, viz., Vilastippa canal, Kunavaram canal and Pikaleru canal. Kunavaram and Pikaleru canals are passing close to the Ravva onshore terminal.
- There is freshwater aquaculture using the tail end canal water surround the Ravva onshore Terminal. The area is a flat alluvial terrain and ground elevations vary from 2 – 6 m (amsl) with some depressions representing the tidal flats, which receive sea water during high tidal fluctuations.
- Maximum depth to groundwater level has been reported from pumping wells inside the onshore terminal. The fluctuation of groundwater level from pre-monsoon to post monsoon is hardly < 2 m only. The groundwater level contours indicated that the groundwater flow is predominantly towards the Bay of Bengal and particularly towards the pumping wells inside onshore terminal as the water level is lowered due to continuous pumping from the onshore terminal wells.
- The groundwater pumping wells inside the onshore terminal are tapping the aquifer zones at depths < -70 m up to -140 m (amsl) for withdrawal of highly saline groundwater with salt concentration > 25,000 mg/l. The average TDS concentration in the Ravva onshore pumping wells in June 2006 was 22805 mg/l and it increased to 30411 mg/l in June 2016. Improved water quality was reported from one of the wells that was not being pumped during that period. The temporal decrease or increase in TDS concentration in Ravva wells is due to decrease or increase in groundwater pumping.The wells have been constructed in medium to coarse grained sands and casing has been provided to avoid overlying clay formations. The groundwater pumping rate has been sustained @ 600 m^3/hour since beginning of groundwater withdrawal and has been continuously injecting the salt water into the oil producing wells in the offshore.
- The groundwater quality for entire area exhibits seasonal dynamics showing increase total dissolved salts (TDS) concentration trends in non-monsoon and decreasing trends due to dilution after the monsoon for all parameters. The water quality of surface water drains connected to aqua ponds are highly saline having TDS >25000 mg/l and <1000 mg/l for Amalapuram canal and connected streams. The ionic ratio indicates the salinity in the area does not belongs to recent origin and may be of Palaeo origin.
- Overall, the comparison of water levels and water quality data from 2006 -2008 to 2014-2016 indicated in the area there is no decrease in groundwater levels and also observed slight rise in groundwater levels in the shallow aquifer. In the Ravva wells tapping deeper saline aquifer water levels are declined over the time. The groundwater quality in the shallow aquifer is not changing over the time but improvement was observed. This

concludes that there is no impact of Ravva pumping on shallow aquifer in this area. It is also observed that there is no seawater intrusion but there is seawater infiltration along the drains in the most downstream parts of the area.

- Regular monitoring of groundwater level & water quality was recommended for compliance as well as environmental protection of groundwater resources to remove the public apprehensions of groundwater pumping from Ravva onshore wells.

The groundwater abstraction at Ravva Terminal is resorted through deep aquifers in an area which receives recharge of about 12.5 mcm/year and the present pumping from onshore wells is about 5.1 mcm/year only.

As per NGRI report, with the continual water withdrawal, no significant change in drawdown in the pumping wells has been observed indicating no over exploitation of groundwater from onshore terminal wells. The water is drawn from saline aquifer, which is not used for irrigation, animal husbandry or domestic usage. This abstraction is not affecting any fresh water aquifer. Additional mitigations will incude the following:

y) Proper engineering controls including providing multiple steel casings and cementing which act as barrier between drilled sections and surrounding area.

z) Periodically monitor the groundwater levels in the surrounding area to ascertain any impact of groundwater withdrawal.

The proposed oil and gas development is to enhance declining production by maintaining production levels within the already approved capacities of Ravva Terminal and no additional water requirement has been reported by Vedanta Ltd (Cairn Oil & Gas), it is expected that abstraction of groundwater will not cause adverse impact on groundwater resource.

It needs to be noted that the additional water requirement for an onshore well is only 60 m^3/day as compared to a total extraction of 9,570 m^3/day for the terminal.

The quantity of formation water and the abstracted water is low compared to likely potential yields of aquifers hence the scale of impact is **low**. The geographical extent of potential impact due to withdrawal of water is anticipated to be **regional**, impact duration is expected to be **medium term i.e.** across some phases during the entire duration of the project. The impact on ground water resources is assessed to be **minor**.

Impact	**Impact on ground water resources due to onshore activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

4.4.9 Impact on Ground Water Quality

Impact Sources

Potential impact on ground water quality could arise due to contamination from fuel and chemical storage, hazardous waste storage, cuttings and waste mud storage and recharge of ground water.

Embedded Controls

The project embedded control measures are as follows:

- The drill cutting along with spent mud will be stored in HDPE lined pit.
- After the drilling activity, this waste pit will be capped by HDPE liner and soil will be put over it.
- Impervious storage area to be provided especially for fuel and lubricant, chemical, hazardous waste, etc.

Impact Assessment

The potential impact on groundwater quality is discussed below:

Contamination from fuel, lubricant & chemical storage areas, drill cutting & waste mud storage and disposal area: Fuels, chemical lubricant etc., would be stored at a designated paved area within well pad site. Thus, contamination of groundwater can happen only due to accidental spillage of fuel, lubricants and chemicals from storage areas and during the transfer of fuels and chemicals.

The drill cutting and the spent mud would be stored in HDPE lined pits at site. Improper lining system or any puncture in the liner system can lead to the potential leakage of chemical like cadmium, mercury, etc. (present of mud chemical) and has potential to contaminate soil and subsequently ground water. Leachate will be generated, if the rainwater percolates into waste disposal area. This leachate can pass through the any puncture in the liner system and will have potential to contaminate the ground water.

Contamination during drilling of wells: The other impact on the groundwater quality will be due to the drilling activity. Water based mud will only be used as discussed in ***Section 2.9***. However, eco-friendly synthetic based mud will also be used if required for deeper sections after providing intimation to the Andhra Pradesh Pollution Control Board. Possibility of contamination of subsurface and unconfined aquifers may also exist if the casing and cementing of the well is not carried out properly leading to infiltration or seeping of drilling chemicals or mud into porous aquifer regions.

Water Injection in the Reservoir: Currently, within Ravva field, a total of 13 water injection wells are operating with a daily water injection capacity of 100,000 barrels of water per day (BWPD) (i.e. 14570 m^3/day) @ 9000 kPa g. The present source of water for injection is from the five bore wells available in the onshore plant and treated produced water from induced gas floatation (IGF) unit of produced water reinjection (PWRI) system. PWRI system ensures that water for injection is treated to ensure oil in water content of less than 10 ppm before it is injected into the deep hydrocarbon reservoir.

The water injection wellheads are fitted with a cartridge type wellhead guard filter, rated for 40 microns. The chemical treatment of the injection water consists of primary biocide

hypochlorite, corrosion inhibitor, scale inhibitor and oxygen scavenger to prevent from scaling and corrosion.

The injection of treated produced water together with brackish groundwater tapped is to maintain hydrocarbon pressure of reservoir. This process is not expected to have any adverse impact on groundwater regime, subject to compliance of MoEFCC standards (injection of produced water into confined hydrocarbon reservoir structure at more than 1000 m with oil in water content of less than 10 ppm).

Considering project embedded control measures, the scale of impact is considered to be ***low***. The geographical extent of potential impact due to above activity is anticipated is ***local;*** however, impact duration of impact is considered to be ***long-term-*** contamination may spread beyond lifecycle of the project. The impact magnitude is assessed to be **low**. The sensitivity is **low**, as the water is unpolluted and provides services as, domestic uses. The impact on ground water quality assessed to be **minor.**

Mitigation Measures:
The proposed mitigation measures are as follows:

aa) Ravva Terminal, being an old facility, Vedanta Ltd (Cairn Oil & Gas) is to ensure periodic monitoring of groundwater quality surrounding all process and storage tank and hazardous waste storage areas, where required necessary mitigation of restoring integrity of that area.
bb) In case of any accidental spills, Vedanta Ltd (Cairn Oil & Gas) is to recover any spilled crude oil/chemical or fuel oil and adequately treat the area, thus to prevent any subsurface contamination; regular trainings in this regard is to be imparted to its staff.
cc) The drill cutting along with spent mud will be stored in HDPE lined pits.
dd) After completion of the drilling activity, all drilling waste will be disposed off to nearby CHWTSDF.
ee) Impervious storage area will be provided especially for fuel and lubricant, chemical, hazardous waste, etc.
ff) Spill of paint/fuel (if any) will be adequately managed by trained personnel;
gg) All fuel transfer operations will be conducted in paved areas;
hh) Periodic monitoring of ground water quality in the vicinity of well sites as part of six monthly reporting.

Impact	**Impact on ground water quality due to onshore activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impact:
Considering the implementation of above mentioned mitigation measures, impact on ground water quality is assessed to be **Minor**.

4.4.10 Impacts on Ecology

The project activity that can cause impacts on ecology are discussed hereunder:

Impact Sources
Construction activities at onshore well pads
- Habitat disturbance during strengthening of approach roads and laying of pipelines
- Noise generation during construction activities (drilling, movement of vehicles, etc)

The project will involve site development works to be done on the two existing well pad sites.

Embedded Controls
The project activity at the onshore well pads will be limited to the area of 3.83 ha (225m x 170m). Any tree cutting shall be avoided and existing roads will be used to the extent possible. Culverts and drainage will be maintained during site preparations.

Impact Assessment
The project well pads construction will require following activities
- Strengthening of approach road to these well pad locations ;
- Construction of pipeline from these well pad locations to the Raava terminals; and
- Man and material movement to the well pad locations

The potential impacts on ecology include the following:

a) *Habitat Disturbance during Onshore well pad construction:* The two onshore well pads are located adjacent lagoons which are potential wintering sites of migratory birds represented by 26 species mostly small waders. These bird species are listed as Least Concern as per IUCN Red list for threatened Category and Sch-IV of Wildlife Protection Act, 1972. There are sufficient wintering shallow water wading sites available in the study area. The construction activity will lead to temporary disturbance of habitats for such wading activities.

b) *Habitat Disturbance during strengthening of approach road and pipeline:* The approach road is required to connect each of the well pads to motor able approach. With regrd to the approach roads for the two onshore wellpad locations, existing road network will be utilized. Thess approach roads are not part of any critical habitats such as forest land and will not require removal of trees. Culverts and drainage channel will be maintained during site preparation. The pipeline will be laid along the approach road and will be below ground. The construction stage of pipeline may provide some barrier in movement.

c) *Noise generation during construction activities (drilling, movement of vehicles):* Noise generated from the construction activities, drilling and moving of machinery will lead to habitat disturbances to the surrounding avifaunal species (resident as well as migratory).

The construction activities planned at well pad location will have impact of ***medium*** scale and ***regional*** extent and ***short term*** as they will be limited to the construction phase. Impact Magnitude thus assessed is ***small.*** Resource sensitivity is ***low*** for Habitats as the construction areas are not part of any protected areas and ***low*** for species as the species observed are IUCN listed Least Concern and listed Sch.-IV species as per Wildlife Protection Act, 1972. The Impact on construction of Well Pads, Approach roads and pipelines is assessed as **minor.**

Receptor Sensitivity

The two onshore wellpads are located at the raised platforms (Refer ***Figure 4.8***). In past Vedanta Ltd (Cairn Oil & Gas) has developed these well pads but were not put to use. These two locations also located adjoining the lagoon. The construction areas represent shallow water levels which is a wintering site to migrator waders in the area.

Identified Olive Ridley Turtle (IUCN v.3,2017 listed Vulnerable/WPA, 1972 listed Sch I species) solitary nesting grounds have been identified by Forest Department at Surasaniyanam (S Yanam) and Gachykola Pora (GK Pora) respectively Fishing Cat (*Prionailurus viverrinus* IUCN v3, 2017 listed Endangered/WPA-1972 kited Sch.-I species) and Smooth Coated Otters (*Lutrogale perspicillata* IUCN v3, 2017 listed Vulnerable and /WPA-1972 kited Sch.-II species) also share their habitats within the study area.

Figure 4.8 Current Status of Proposed Onshore Wellpads Location

Coastal area outside PKGM-1: 616605 E, 1821719N

Coastal area outside PKGM-1: 616816E, 1822008N

Coastal area outside PKGM-1: 617244 E, 1822190N

Coastal area outside PKGM-1: 618677 E, 1822861N

Coastal area outside PKGM-1: 619271 E, 183176 N

Chirryanam Backwater in PKGM-1: 622300 E, 1824814 N

Existing Wellpad location WP-7 (RX-8)

Existing Wellpad location WP-8 (RX-9)

Source: Site & surrounding areas survey by ERM during 12-19 Dec 2017, 11th -17th April 2018

Mitigation Measures

Following mitigation measures will be in place:

ii) The project activity at the onshore well pads will be limited within the periphery of the well pad site. Spill-over of activities on adjoining or other lands will be avoided.

jj) Any tree cutting shall be avoided and existing roads will be used to the extent possible.

kk) The construction phase should avoid migratory season of birds (Oct-February)

ll) In case the migratory season cannot be avoided due to project schedules, early morning and evening activities should be avoided which usually experience peak bird activity

mm) Night activities to be avoided to the extent possible, if the same is unavoidable, then low lights and illumination used should be used.

nn) Vedanta Ltd (Cairn Oil & Gas)shall implement a Site Specific Conservation Plan & Wildlife Management Plan for Schedule I species (refer to **Annex 21** ***of EIA Volume 2***)

Impact	**Ecology impact due onshore well pads, approach roads & pipeline**			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity (Habitat)	Low	Medium		High

Resource/ Receptor Sensitivity (Species)	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact will be moderate			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Minor**			

Residual Impact

Considering the implementation of above mentioned mitigation measures, the residual impact on ecology due to above mentioned activity is still assessed to be **Minor**.

4.4.11 Impact on Socio-economic Environment

Impact Sources

Loss of private land by local people for well pads development

Impact Assessment

As discussed in ***Section 2.72***, the tentative land requirement for each onshore well pad is 3.83 ha. The two onshore well pads WP-7 and WP-8 are located at the previously developed well pad sites. The sites selected for onshore drilling are not having any settlements / structures. Therefore, resettlement and rehabilitation will not be applicable for this project.

Overall it is understood that the onshore drilling program will require an approximate area of 8 ha for two well pads. In addition, land of ~12 ha will be required for pipeline corridor of 8 km. The land for pipeline will beconsidered on Right of Use (RoU) basis and will be available for restricted land use. The exact magnitude of impact due to loss of land will be estimated subsequent to the completion of the land surveys.

If the identified lands are of private landowners then land lease mode will be applied and in case of govt. land, land allotment from Govt. to be applied. Initially lease will be taken for max. 3 years for exploration purpose and in case any discovery and/or permanent requirement, the same would be converted into long term lease up till life of the project

Embedded Control

Vedanta Ltd (Cairn Oil & Gas) will compensate all affected landowners for any loss of land resulting out of the proposed onshore drilling program In accordance with their Standard Operating Procedure (SOP) on direct land procurement/lease/renewal/surrender (SOP-VL Land-SOP-DP/LDL-A3 dtd 20 April 2018). More details on the SOP are given in Section 2.

Mitigation Measures

- Apart from the embedded control on follow up above mentioned SOP, Vedanta Ltd (Cairn Oil & Gas) should ensure that livelihood of local community, if any affected by the proposed land take are identified and compensated through adequate compensation and other livelihood restoration activities directly or indirectly through CSR activities.
- The pipeline route for the project has been identified in keeping with the safety and operational requirements of the pipeline and avoiding/minimizing to the extent possible, built-up areas, and perennial water logged areas wherein frequent aquaculture activities

are carried out. Similarly, to avoid the congested settlement area (N. Kothapalli and Gachakayala Pora), Vedanta Ltd (Cairn Oil & Gas)has proposed to construct alternative route to access the well pad sites near Chirrayanam.

Impact Significance

Based on the above context and embedded measures, the significance of impact is assessed as follows

Impact	**Impact due to loss of land**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impact

The residual impact significance, post implementation of mitigation measures is assessed as minor.

<u>Impacts due to Labour Influx</u>

Impact Sources

- Labour influx of workforce from outside during well pad development, approach roads construction and laying of pipelines in 8 km long pipeline corridor

Impact Assessment

As discussed in the ***Section 2.13,*** approx. 80-120 workers will be required at well pad sites which will comprise of technical personnel, skilled workers and support staff. While the technical personnel and skilled workers are expected to be migrant, the unskilled workers (especially required during site and approach road development activities) will most likely be local community members. While the engineers and skilled workers directly hired by Vedanta Ltd (Cairn Oil & Gas) will be accommodated at the existing living quarters, the contractors will provide accommodation to their workers by hiring rooms and residences on rent in the surrounding villages.

This influx of labour into the project area is thus likely to create both positive and negative impacts on the local community. This migrant workforce is to be hired through contractors and is likely to be comprised of male workers from neighbouring eastern states. In keeping with this, the major potential risks and impacts due to labour influx in the area due to the project include:

- Conflicts with local community due to difference in socio-cultural behaviours between the local community and migrant workforce;

- Increase in prostitution and transmission of Sexually Transmitted Diseases
- Increase in pressure on local resources (water, food items etc.) and infrastructure (road, local public transportation system etc.);
- Resentment amongst the local community due to competition for employment opportunities in the project;
- Increase in economic opportunities for the local community as the migrant workforce will hire rooms on rent; purchase from local shopkeepers daily provisions and supplies etc.

Embedded Controls

Vedanta Ltd (Cairn Oil & Gas)'s policy on local content will be implemented for the Project. As per Cairn, wherever possible, engagement of local contractors and workers during the construction/ development phase will be preferred.

Mitigation Measures

- A code of conduct should be developed for all laborers involved in the project to prevent them from being involved in illegal and immoral activities. This code of conduct should make the workers aware about the local cultural sensitivities and should be made aware about the Sexually Transmitted Diseases and HIV/AIDS;
- Ensure that the Grievance Mechanism allows for the local community to report any concern or grievance regarding the conduct of the migrant workers.

Impact Significance

The construction activities will be of short duration and will be completed within approximately two months per well pad, and all the outside work force will be temporarily stationed in the campsite. The scale impact of influx will be low, keeping in mind follow up of embedded controls and mitigation measures. The impact significance due to potential influx of workforce will be as follows

Impact	**Impact due to labour influx**				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Low	Medium	High		
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **Minor**				

Residual Impact

The residual impact due to influx of workforce from outside is assessed as **Minor**.

Impact on Livelihoods and Economic Opportunities

Impact Sources

- Impact on livelihoods and economic opportunities for local people.

Impact Assessment

As discussed in the previous sections, while no direct additional permanent employment is expected to be generated, temporary employment and contract related opportunities will be created during the construction phase of the project. It will include opportunities for semi-skilled and unskilled labour during the construction phase of the project (construction of well pads, site approach roads and laying of pipelines), economic opportunities due to influx of migrant workers during the construction phase and income generation due to expenditure on supplies and equipment, which together with rentals etc. will provide minor inputs to the local economy.

Other than this, the only socio-economic interactions will be with fishermen of the area. The proposed development may result in an impact on fishing activities . The fishing activities in the area include for sustenance and household consumption, capture of molluscs and crabs. The activities within Ravva Field are ongoing and movement of fishermen within the block are restricted only near exiting structures (exclusion zone) in the block.

Embedded Controls

Vedanta Ltd (Cairn Oil & Gas)'s policy on local content will be implemented for this Project. As per Vedanta Ltd (Cairn Oil & Gas), wherever possible, engagement of local contractors and workers during the construction/ development phase will be preferred.

Mitigation Measures

Vedanta Ltd (Cairn Oil & Gas) should ensure that livelihood of fishermen, if any affected by the proposed development are identified and compensated through other livelihood restoration activities directly or indirectly through CSR activities. Issues of livelihood disruption due to restricted movement through the exclusion zone and proposed drilling of exploratory wells as well as damage of any equipment (including nets) /boat due to project activities should be captured through Grievance Redress process and regular stakeholder engagement.

Impact Significance

Impact	**Impact on livelihoods and economic opportunities**				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Low	Medium	High		
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/Receptor Sensitivity	Low	Medium	High		
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **Minor**				
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large	
Impact Significance (With Mitigations)	Significance of impact is considered **Negligible**				

Residual Impacts

The adverse impact significance on livelihood and economic activities is assessed as Minor. There are positive impacts in terms of employment and contract related opportunities for local people.

Impacts on Community Health and Safety

Impact Sources

Community Health and Safety due to proposed well pads development, pipeline laying, exploration and production activities.

Impact Assessment

The receptors for impacts on community health and safety include the settlements in close proximity of the onshore locations. It is understood that the community within a 2 km radius is most likely to interact with the onshore locations, including villages such as Chirrayanam and Surasaniyanam.

The major community health and safety risks for the onshore operations include the following

- Risks associated with movement of construction vehicle and equipment
- Potential exposure to spills, fires and explosions
- Contact with hot components, equipment failure
- Hazards due to operational pipelines and abandoned infrastructure
- Exposure to air and noise pollution
- Improper waste management
- Exposure to migrant labour

The users of the existing roads and backwaters adjacent to the onshore locations are the key receptors of any safety risks due to the project construction activities and any incidences of spills, fires or explosions. The construction activities are likely to generate large quantities of dust and noise as discussed earlier and these impacts would be limited to the population adjacent to the site access and approach roads. The increase concentration of dust and noise in the ambient environment would have health related impacts. In addition to the health impact caused by the construction activities, the movement of the construction vehicle and equipment also pose safety related risks. The development of the two existing well pads may restrict movement of local community and fishermen in the vicinity due to the establishment of exclusion zones.

Embedded Controls

The location of the well pad sites is selected in order to allow for safe operation. Fences and warning signs will be put up at appropriate places. Public Access Control will be implemented on the facility in terms of security measures and adequate signages. A Grievance Redress process is in place at the Ravva Terminal/ onshore Living Quarters and the CSR team is primarily responsible for ensuring all grievances received are addressed.

Mitigation Meausres

oo) Fences and warning signs will be put up at appropriate places. Public access control through deployment of adequate security will be implemented for the facility;

pp) A community emergency preparedness and response plan that considers the role of communities and community infrastructure will be developed. As part of this, community

consultations to be done to educate on do's and don'ts to be followed. Clear guidance on access and land use limitations in safety zones or pipeline ROW will be provided.

qq) A grievance redressal mechanism will be in place. Vedanta Ltd (Cairn Oil & Gas)will regularly monitor grievances and their solutions during the proposed Project activities.

Impact Significance

The community health and safety releated risks will be minimized through implementation of embedded controls and mitigation measures follow up Vedanta Ltd (Cairn Oil & Gas)and its contractors during Project each stage of implementation, hence the scale of impacts on community health and safety is assessed as low. The impact significance is assessed as follows:

Impact	**Impact on community health and safety**				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Low	Medium	High		
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/Receptor Sensitivity	Low	Medium	High		
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **Moderate**				
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large	
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**				

Residual Impact

With the implementation of mitigation measures, the significance of the residual impacts is assessed as **Minor**.

4.4.12 Impact on Visual Quality

Impact Sources

Setting up of well pads in the onshore region and lighting during night time will have impacts related to visual impairement.

Impact Assessment

Physical presence of rig and associated equipment by setting up of rig, diesel generators and other machineries on well pads will create an impression of an industrial setup. The well pad sites are all located in rural settings. The industrial setup is likely to cause visual impacts for the surrounding settlements.

There will be potential impact due to light and visual intrusion during drilling of wells round the clock drilling over average ~50 days and requires use of strong lighting to illuminate drilling rig at night. Well testing will be conducted at the end of exploratory drilling through ground flaring, thus will have minimum impact of light and visual intrusion.

Laying of interconnected pipelines and strengthening of site approach roads along the sea beach. The trenching activity in 8 km of running length, the storage of soil and materials on

the Right of Use (RoU) of the pipeline/road and the temporary storage of pipelines will create visual disturbance and will be aesthetically displeasing.

Mitigation Measures

Following mitigation measures will be in place

- Storage facility for construction materials will be provided in enclosed sheds within proposed well pad sites;
- Labour camp with sanitation facility, solid waste collection facilities will be set up in within well pad sites.
- All construction activities will be restricted within designated sites;
- Appropriate shading of lights to be arranged to prevent scattering;
- Along the coast, trenching for pipelines once laid will be covered immediately with burrowed soil and levelled as per the surrounding land.
- On completion of work all temporary structures, surplus materials and decommissioning wastes will be completely removed from site and disposed at a designated area.

Impact Significance

Impact	**Visual quality (impairement)**			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity (Habitat)	Low	Medium		High
Resource/ Receptor Sensitivity (Species)	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact will be minor			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Minor**			

Residual Impacts

The residual impact significance of visual impacts due to the onshore well developments and related activities is assessed as **Minor.**

4.5 IMPACT ASSESSMENT OF OFFSHORE DRILLING & ASSOCIATED ACTIVITIES

4.5.1 Impact on Air Quality

Impact Sources

Potential impacts due to air emissions will result in increase in pollutant concentration in ambient air, which causes health hazards to human and biological/ecological receptors. The atmospheric emissions during drilling of developmental or exploratory/appraisal wells will result from:

- Power generation on-board Rig through diesel generators resulting in air emissions due to combustion of diesel (hydrocarbons) during well drilling;
- Flaring of hydrocarbon during well testing;
- Dust generation during loading of bulk solids; and

The emission from each of the diesel engines on-board rig will be due to combustion of diesel equivalent to 320 kg per hour per engine (average consumption of 7.68 MT per day). There will be a total of three engines each of 1650 KVA capacities attached to the drilling rig. The DG sets will meet the power requirement on-board Rig on an average of 45 days for development well drilling and 55 days for exploratory well drilling. In no case, even with mobilization and demobilisation, time line for drilling of a well is expected to exceed 90 days.

Test Flaring will be done only for Exploratory/Appraisal well drilling. The emission from the test flaring will be done only for a short period of 1 to 2 days per exploratory/appraisal drilling location in case presence of hydrocarbons is observed. The emission characteristics from power generation due to diesel combustion and test flaring are summarised in ***Table 4.13.***

Table 4.13 Emissions Characteristics during Offshore Well Drilling

S.N	Parameter	Diesel Generators	Well Test Flaring $
1	Rating	1603 KW (2000 KVA)	-
2	Fuel Consumption,	320 kg hour^{-1} *i.e.7.68* tonnes per day	101.952 tonnes eq fuel$ per test flare for 2 dyas i.e. 2,124 kg/hour
3	No. of units operative at any point of time	(2+1 standby)	1
4	Hours and Days of operation	24 hours per day for 45 to 90 days per drilling of a well	24 hours per day for 2 days per drilling of a well
5	Exhaust Gas Diameter	0.60 m	1.5 m Effective Flare Diameter above the Stack Tip of 0.457 m
6	Stack Height above mean sea level	30 m (amsl)	2.2 m above cellar deck and 27 m amsl
7	Exhaust Gas Temperature	310^{o}C	45^{o}C before the flare tip and 1,000^{o}C above the flare tip
8	Exhaust Gas Flow	8400 Nm3/hour (20,688 m3/hour)	33,350 Nm3/hour
9	Exhaust Gas Velocity	16.1 m/sec	60 m/sec inside tip of the flare
10	Emission of pollutants		
	▪ Particulate matter (PM_{10})	< 75 mg/Nm^3 (0.175 g/sec)	0.278 g/s
	▪ Sulphur Dioxide (SO_2)	100 mg/Nm^3 (0.233 g/sec)	0.03 g/sec
	▪ Oxides of Nitrogen (NOx)	1320 mg/Nm^3 (3.082 g/sec)	1.89 g/sec#
	▪ Carbon Monoxide (CO)	150 mg/Nm^3 (0.350 g/sec)	9.286 g/sec#

Note: $ = Assuming composition of test hydrocarbons having an oil to gas ratio (by weight) of 80:20; 2) # = calculated as per emission factors defined in EEMS Atmospheric Emission Calculations Issue 1.8 UKOOA 2004. $ Temporary Test Flaring for 1 to 2 days at the end of drilling of an exploratory wells in case hydrocarbons presence observed at the end of drilling.

The main emissions considered for modelling include pollutants PM10, NOx, SO_2, and CO from diesel power generators operating during well drilling and temporary well test flaring from exploratory/appraisal wells. For exploratory/appraisal drilling of wells, test flaring of hydrocarbon will be carried out for 1 to 2 days at the end of the drilling operation in case hydrocarbons are discovered. ***Table 4.14*** describes the emission characteristics assumed for the modelling exercise from diesel generators and well test flaring from two offshore wells located close to shore area i.e. E-8 and E-39 offshore wells. Therefore, modelling exercise for is done for the following scenarios *i.e.*

- Scenario 4: when diesel generators (2 nos.) alone are in operation at E-8 or E-39 well; and
- Scenario 5: when diesel generator (1 no.) is operating with test flaring at E-8 or E-39 well.

The background ambient air quality concentrations as observed AAQ results as monitored at various locations is presented in ***Section 3.7.***

Air Quality Model Inputs

Inputs for the air quality modelling of emissions from the Ravva Terminal include as per the ***Table 4.14.***

Table 4.14 Inputs for the Air Dispersion Modelling for Offshore Sources

S.N.	Input	Description
1	**Modelling Software Used**	AERMOD View – ISC-Prime – ISC Version 9.6.5
2	**Control Pathway**	
	▪ Dispersion Option	Non Default Options
	▪ Terrain	Flat
	▪ Dispersion Coefficient	Rural
	▪ Flagpole Receptors	No
3	**Meteorology Pathway**	
	▪ Met Input Data	WRF and MM1F generated data starting Jan 01, 2017, 00 hour to Dec 31, 2017, 23 hour for Amalapuram (16.48665 N; 82.09031 E)
	▪ Wind Speed Categories	A: 1.54 m/sec; B: 3.09 m/sec; C: 5.14 m/sec; D: 8.23 m/sec; E: 10.8 m/sec; F: No upper bound
	Latitude:	16.48665° N
	Longitude:	82.09031° E
	Datum	WGS 84
	Anemometer Height:	10 m
	Base Elevation:	0.89 m above mean sea level
4	**Receptor Pathways**	Uniform Cartesian Grid (UCART1)
	▪ No. of X axis Receptors	63
	▪ No. of Y axis Receptors	57
	▪ Spacing for X axis	500 m
	▪ Spacing for Y axis	500 m
	▪ Receptor Group	Onshore and surrounding Ravva Terminal for Primary Receptors
5	**Emission Source Pathway**	Stationary Emission Sources considered as defined in ***Table 4.13.***

Prediction of GLCs is made by using software AERMOD View approved by Environment Protection Agency (EPA) USA. AERMOD is a Gaussian Plume based model and is run using stability classes developed by Pasquill and Gifford and information as described in the above ***Table 4.14.*** Incremental and resultant GLCs of PM_{10}, NOx, SO_2 and CO have been worked out for pollutants both for Scenarios 1 and 2 as described in ***Tables 4.16 to 4.19***. Figure.

Table 4.15 Outputs for Air Dispersion Modelling for Offshore Sources for PM_{10}

Receptor	Predicted Incremental 24 Hourly GLC PM_{10} (µg/m³)				98 percentile Baseline PM_{10} Concentration (µg/m³)	Resultant Concentration (predicted + baseline) PM_{10} (µg/m³)				NAAQS PM_{10} (µg/m³)
	Scenario 4		Scenario 5			Scenario 4		Scenario 5		
	E-8	E-39	E-8	E-39		E-8	E-39	E-8	E-39	
AQ1	0.28	0.16	0.15	0.09	55.3	55.6	55.5	55.4	55.4	**100**
AQ2	0.10	0.11	0.05	0.06	54.5	54.6	54.6	54.6	54.6	
AQ3	0.07	0.09	0.04	0.05	52.4	52.5	52.5	52.4	52.4	
AQ4	0.13	0.06	0.07	0.03	54.3	54.4	54.4	54.4	54.3	
AQ5	0.16	0.03	0.09	0.02	53.1	53.3	53.1	53.2	53.1	
AQ6	0.06	0.10	0.03	0.06	56.2	56.3	56.3	56.2	56.3	
AQ7	0.18	0.06	0.10	0.03	49.3	49.5	49.4	49.4	49.3	
AQ8	0.05	0.32	0.03	0.19	47.1	47.1	47.4	47.1	47.3	

Table 4.16 Outputs for Air Dispersion Modelling for Offshore Sources for NOx

Receptor	Predicted Incremental 24 Hourly GLC NOx (µg/m³)				98 percentile Baseline NOx Concentration (µg/m³)	Resultant Concentration (predicted + baseline) NOx (µg/m³)				NAAQS NOx (µg/m³)
	Scenario 4		Scenario 5			Scenario 4		Scenario 5		
	E-8	E-39	E-8	E-39		E-8	E-39	E-8	E-39	
AQ1	4.9	2.8	2.5	1.5	16.4	21.3	19.2	18.9	17.9	**80**
AQ2	1.8	2.0	0.9	1.0	15.2	17.0	17.2	16.1	16.2	
AQ3	1.2	1.6	0.6	0.8	14.4	15.6	16.0	15.0	15.2	
AQ4	2.4	1.1	1.2	0.6	15.3	17.7	16.4	16.5	15.9	
AQ5	2.9	0.6	1.5	0.3	14.6	17.5	15.2	16.1	14.9	
AQ6	1.0	1.8	0.5	0.9	16.5	17.5	18.3	17.0	17.4	
AQ7	3.2	1.1	1.7	0.6	14.3	17.5	15.4	16.0	14.9	
AQ8	0.8	5.7	0.4	3.0	14.2	15.0	19.9	14.6	17.2	

Table 4.17 Outputs for Air Dispersion Modelling for Offshore Sources for SO_2

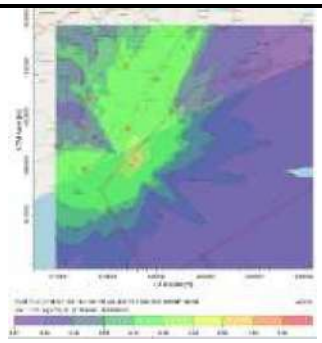
Receptor	Predicted Incremental 24 Hourly GLC SO_2 (µg/m³)				98 percentile Baseline SO_2 Concentration (µg/m³)	Resultant Concentration (predicted + baseline) SO_2 (µg/m³)				NAAQS SO_2 (µg/m³)
	Scenario 4		Scenario 5			Scenario 4		Scenario 5		
	E-8	E-39	E-8	E-39		E-8	E-39	E-8	E-39	
AQ1	0.37	0.21	0.19	0.11	14.4	14.8	14.6	14.6	14.5	**80**
AQ2	0.14	0.15	0.07	0.07	13.1	13.2	13.2	13.2	13.2	
AQ3	0.09	0.12	0.04	0.06	12.5	12.6	12.6	12.5	12.6	
AQ4	0.18	0.08	0.09	0.04	13.1	13.3	13.2	13.2	13.1	
AQ5	0.22	0.04	0.11	0.02	12.7	12.9	12.7	12.8	12.7	
AQ6	0.07	0.14	0.04	0.07	14.5	14.6	14.6	14.5	14.6	
AQ7	0.24	0.08	0.12	0.04	12.1	12.3	12.2	12.2	12.1	
AQ8	0.06	0.43	0.03	0.22	11.6	11.7	12.0	11.6	11.8	

Table 4.18 Outputs for Air Dispersion Modelling for Offshore Sources for CO

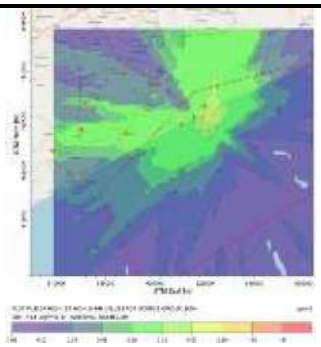
Receptor	Predicted Incremental 8 Hourly GLC CO (µg/m³)				98 percentile Baseline CO Concentration 8 hourly (µg/m³)	Resultant Concentration (predicted + baseline) CO (µg/m³)				NAAQS CO 8-hourly (µg/m³)
	Scenario 4		Scenario 5			Scenario 4		Scenario 5		
	E-8	E-39	E-8	E-39		E-8	E-39	E-8	E-39	
AQ1	1.4	0.9	1.5	0.8	253	254.4	253.9	254.5	253.8	**2000**
AQ2	0.6	0.7	0.8	0.6	231	231.6	231.7	231.8	231.6	
AQ3	0.4	0.5	0.7	0.5	223	223.4	223.5	223.7	223.5	
AQ4	0.6	0.4	1.1	0.5	242	242.6	242.4	243.1	242.5	
AQ5	0.8	0.2	0.8	1.0	225	225.8	225.2	225.8	226.0	
AQ6	0.3	0.6	1.1	0.6	261	261.3	261.6	262.1	261.6	
AQ7	1.0	0.4	0.9	1.0	235	236.0	235.4	235.9	236.0	
AQ8	0.3	1.6	0.9	3.6	223	223.3	224.6	223.9	226.6	

The ambient levels of PM_{10}, NO_x, SO_2 and CO emission from offshore sources suggest that the air quality will remain well within the NAAQS limits at the nearby onshore receptor villages. There are no receptors sensitive to the emission of combustion products in the vicinity of the operations apart from the crew of the rig in the offshore region. The increase in concentration of PM_{10}, NO_x and SO_2 and CO is relatively low in comparison with the background on the rig in offshore region and will only persist for a short period during drilling of wells.

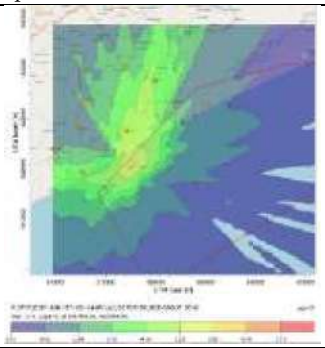
Figure 4.9 Incremental GLCs of PM_{10} Isopleths: Scenarios 4 to 5 for Offshore Drilling & Well Testing



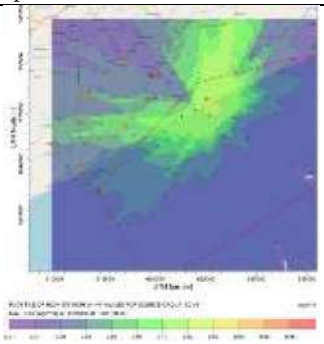
PM_{10} 24-rly Isopleths: Scenario 4 E-8 Offshore Well Drilling



PM_{10} 24-rly Isopleths: Scenario 4 E-39 Offshore Well Drilling

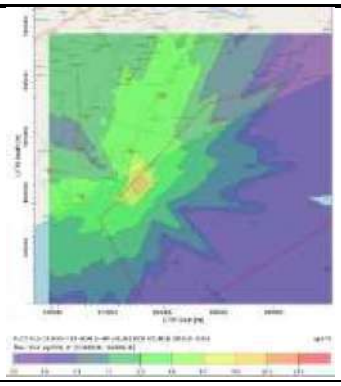


PM_{10} 24-hrly Isopleths: Scenario-5 E-8 Offshore Well Testing

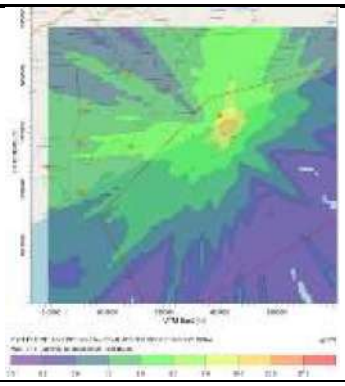


PM_{10} 24-hrly Isopleths: Scenario-5 E39 Offshore Well Testing

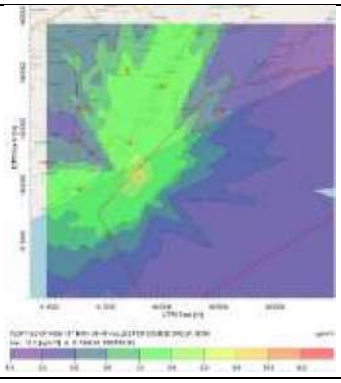
Figure 4.10 Incremental GLCs of NOx Isopleths: Scenarios 4 to 5 for Offshore Drilling & Well Testing



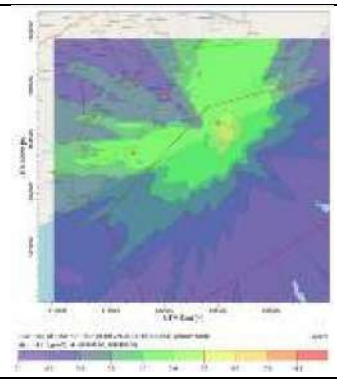
NOx 24 hrly Isopleths: Scenario-4 E-8 Offshore Well Drilling



NOx 24 hrly Isopleths: Scenario-4 E-39 Offshore Well Drilling



NOx 24 hrly Isopleths: Scenario-5 E-8 Offshore Well Testing

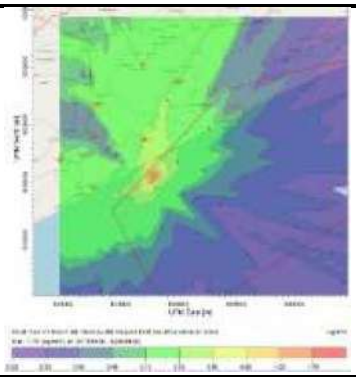


NOx 24 hrly Isopleths: Scenario-5 E-39 Offshore Well Testing

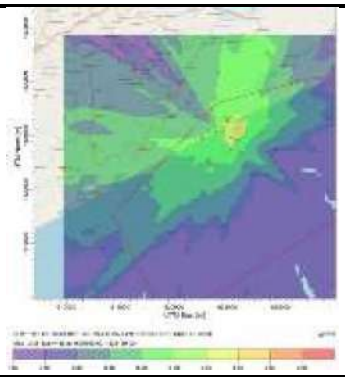
From the air quality modelling, it is inferred that the resultant ambient air quality remains well within the NAAQS and will not affect receptors at onshore due to emissions from on-board power generation and test flaring. Emissions of methane and other VOCs will occur but are expected to be small in relation to the amount of volatile hydrocarbons stored onboard the

platform and will not contribute significantly to local or global air pollution. The impacts from methane and VOCs are considered to be negligible.

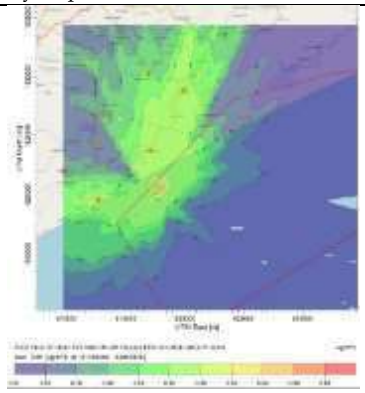
Figure 4.11 Incremental GLCs of SO_2 Isopleths: Scenarios 4 to 5 for Offshore Drilling & Well Testing



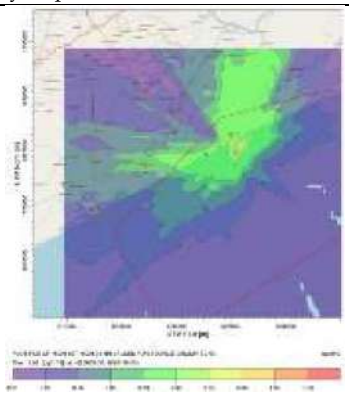
SO_2 24 hrly Isopleths: Scenario-4 E-8 Offshore Drilling



SO_2 24 hrly Isopleths: Scenario-4 E-39 Offshore Drilling

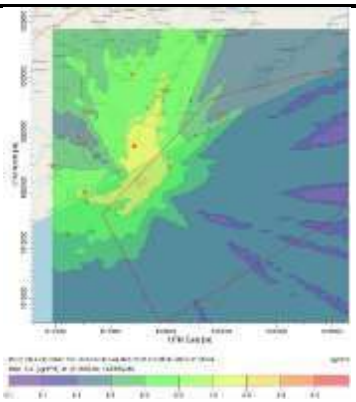


SO_2 24 hrly Isopleths: Scenario-5 E-8 Offshore Well Testing

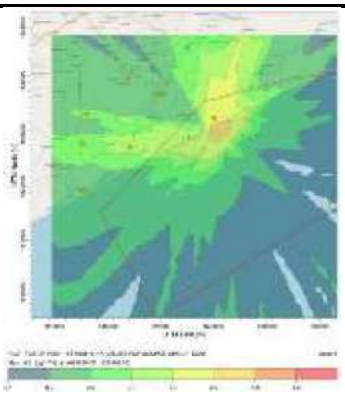


SO_2 24 hrly Isopleths: Scenario-5 E-39 Offshore Well Testing

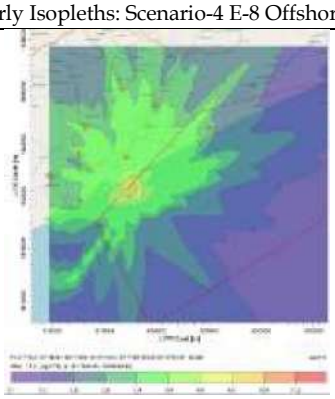
Figure 4.12 Incremental GLCs of CO Isopleths: Scenarios 4 to 5 for Offshore Drilling & Well Testing



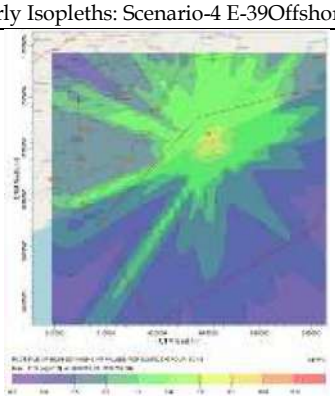
CO 8 hourly Isopleths: Scenario-4 E-8 Offshore Drilling



CO 8 hourly Isopleths: Scenario-4 E-39Offshore Drilling



CO 8 hourly Isopleths: Scenario-5 E-8 Offshore Well Testing



CO 8 hourly Isopleths: Scenario-5 E-39 Offshore Well Testing

Fugitive dust emissions potentially occur during mud preparation (related bentonite, barite etc. handling). With mitigation measures insignificant amounts of dust may be discharged into the atmosphere. Impacts on personnel will be negligible.

Provided systems are adequately maintained, possibility of significant losses of HCFC are predicted to be small in relation to the total inventory handled or used onboard the rig and the impacts are also considered to be negligible.

Mitigation Measures

Mitigation measures will be in place to minimize potential adverse impacts of air emissions on health of receptors. Receptors of air quality include coastal birds and human receptors, which will not be resident in the offshore region. Following mitigations will be in place:

rr) Diesel power generators to be maintained to achieve efficient combustion, fuel efficiency and therefore reduce emissions;

ss) No cold venting to be resorted during well testing;

tt) The vent boom shall be so located HC gas concentration on the platform remains within acceptable limits for personnel safety, under worst operating & environmental conditions.

uu) Although the crude found in the block is sweet. H_2S gas detectors will be provided onboard the rig to ensure that the exposure to personnel is managed by used of appropriate personnel protective equipment (PPEs).

vv) Other fugitive emissions will be reduced by appropriate storage and handling;

ww) Loss of ozone depleting materials from the rig's systems will be kept to a minimum by preventive maintenance of all relevant equipment.

Impact Significance

Impact	**Impact on surface water quality due to offshore activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impacts

The impact significance due to air emission and their impacts (with mitigations) has been worked out as **Minor**.

4.5.2 *Impact on Noise Quality*

Impact Sources

Potential impacts due to noise generation from offshore oil and gas drilling activities can result in increase in ambient and underwater noise levels, which can cause health hazards to human and biological/ecological receptors. The noise generation during offshore drilling of developmental or exploratory / appraisal wells will result from:

- Offshore drilling of development and exploratory wells
- Vessels movement

Impact Assessment

Underwater Noise from Support Vessel: Support vessels that will be used to support drilling activities will maintain their position by using thrusters when manoeuvring close to jack up rig for supporting drilling activities. Support vessels generate underwater noise by maintaining their dynamic positioning. Noise produced is typically broadband noise, with some low tonal peaks.

Underwater Noise from Drilling Activity: Drilling of developmental and exploratory wells generates underwater noise as the drill bit penetrates into the seabed strata.

It is to be noted that noise from routine helicopter flights during landing and take-off from rig and machinery noise generated from power generating units on-board will have insignificant underwater noise propagation.

Typical subsea noise levels from offshore drilling operations are shown in **Table 4.19.**

Table 4.19 Indicative Sound level likely to be Produced during Well Drilling

Source	Noise Source Level dB re 1 µPa at 1 m#	Peak Frequency Band – Indicative Ranges (Hz)##
Supply Vessels	180	10 to 1,000
Rig Operation	174 to 185	10 to 10,000

Note# =Sound pressure is expressed on a decibel scale (dB) and referenced to 1 micro Pascal at 1 m from the source [dB re 1 µPa @ 1m]; ## = Sound frequency is expressed in Hertz. Only the approximate range of peak frequencies is presented, frequencies outside this range are likely to exist but be lower in sound level.

The increase of underwater noise level may have impact on marine mammals, marine fish population and sea turtles. The impact on ecological environment has been discussed in ecological impact section.

As per ***Table 4.19*** above, underwater noise level in range of 174 to 185 dB re 1 µPa is expected from the proposed drilling in Ravva Field and 180 dB re 1µPa is expected from support vessel. None of the noise sources from the Project are capable of causing instantaneous injury because the source levels are not high enough, even at very short ranges. Richardson *et al.* (1995) reported that broadband levels did not exceed ambient levels beyond 1 km from a well drilling operation, although weak tones were received at approximately 18 km away. Generally noise from rig activities is at a similar level to noise from shipping activities, although rig is generating these noise levels when stationery. Considering the underwater noise level varying in the range of 130 to 185 dB re 1 µPa from drilling and 180 dB re 1 µPa from support vessel, the required underwater noise level of 120 dB re 1 µPa will be achieved at distances as given in the ***Table 4.20.***

Table 4.20 Estimated Distances to achieve Target Noise Level from Noise Sources

SN.	Noise Source Level at 1 m, dB re 1 µPa	Target Noise Level at Receptor, dB re 1 µ Pa	Distance (m) required to achieve Target Noise Level,dB re 1µPa	Threshold for Behavioural Effects on Fish dB re 1µPa	Distance (m) required to achieve Threshold Noise Level, dB re 1µPa
1	185	120	1,778.3	160	17.8
2	180	120	1,000.0	160	10.0
3	175	120	562.3	160	5.6
4	170	120	316.2	160	3.2
5	165	120	177.8	160	1.8
6	160	120	100.0	-	
7	150	120	31.6	-	

Note: The above target noise levels have been calculated assuming free-field spherical radiation from point source, with no bottom reflection effects or linear absorption using spherical noise spreading equation of Lr = Ls - 20 log R, where Lr is the level received, Ls is the source level and R is the range.

From well drilling, the maximum noise generation will be 185dB re 1µPa. Considering, a noise source of 190 dB re 1µPa from drilling, the background noise level of 120 dB re 1µPa will be achieved within 3.2 km while threshold for behavioural effects on fish at 160 dB re 1 µPa will be achieved at 31.6 m from source.

For operation of support vessel, the maximum noise generated will be 185 dB re 1 µPa. The background noise of 120 dB re 1 µPa will be achieved at 1.77 km while distance for threshold for behaviour effects on fish at 160 dB re 1 µPa will be achieved at 17.8 m from source. The behaviour effect is also related with the fact that animal is to remain for 30 minutes or more at this threshold noise level for deafness or behavioural effects. The high underwater noise level can cause physical injury to marine mammals or fish or disturbance during migration and breeding season, considering this scale of impact is assessed to be medium. The duration will be short term and extent will be regional, beyond 0.5 km. Godavari estuarine area has fish breeding ground and as well as marine turtle breeding and nesting ground. However, the offshore area proposed for well pad sites is away from Sacramanto Island (Sea turtle nesting site) and Godavari Estuary. Resultantly the rceptor sensitivity is considered to me medium. The impact on underwater noise quality is assessed to be moderate.

Mitigation Measures:
To minimise the effects due to underwater noise generation, following mitigation measures will be in place.

- Avoid sudden loud noises, such as from the moving and putting down of heavy equipment, when cetaceans are observed in the region;
- Maintain the vessel and all noise generating equipment in good working order.
- Vessels to maintain a minimum distance of 350 m from marine fauna when sighted.

Impact Significance

Impact	Impact on under water noise quality due to offshore activities			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impact

The impact significance due to noise emission and their impacts (with mitigations) has been worked out as **Minor.**

4.5.3 *Ambient Noise Quality*

The typical noise generation sources for offshore drilling of well operations will be as per **Table 4.21.**

Table 4.21 Noise Generation Sources on-board Rig during Well Drilling in Offshore PKGM-1 Block

S.N	Source	Noise Level dB(A) at 1 m	Daiy Operations, % time
1	Helideck during Helicopter Landing and Take-off (LTO)	105	5%
2	Drilling area	100	80%
3	Pumps at the Rig	95	60%
4	Miscellaneous	85	80%
5	Upper Decks	70	80%
6	Control Room	60	100%
7	Diesel Generator area	90	100%
8	Living Quarters (on-board rig)	60	100%

The helicopters and supply vessels movement will prevail on daily basis to provide support to rig(s) for drilling activities. Helicopters will transport personnel with major route to be followed between Ravva Living Quarters (onshore) and rig with expected one side distance of approximately 10 km and time of approximately 15 minutes per landing and take off (LTO). Daily two sorties each of helicopter movement during morning and evening are expected.

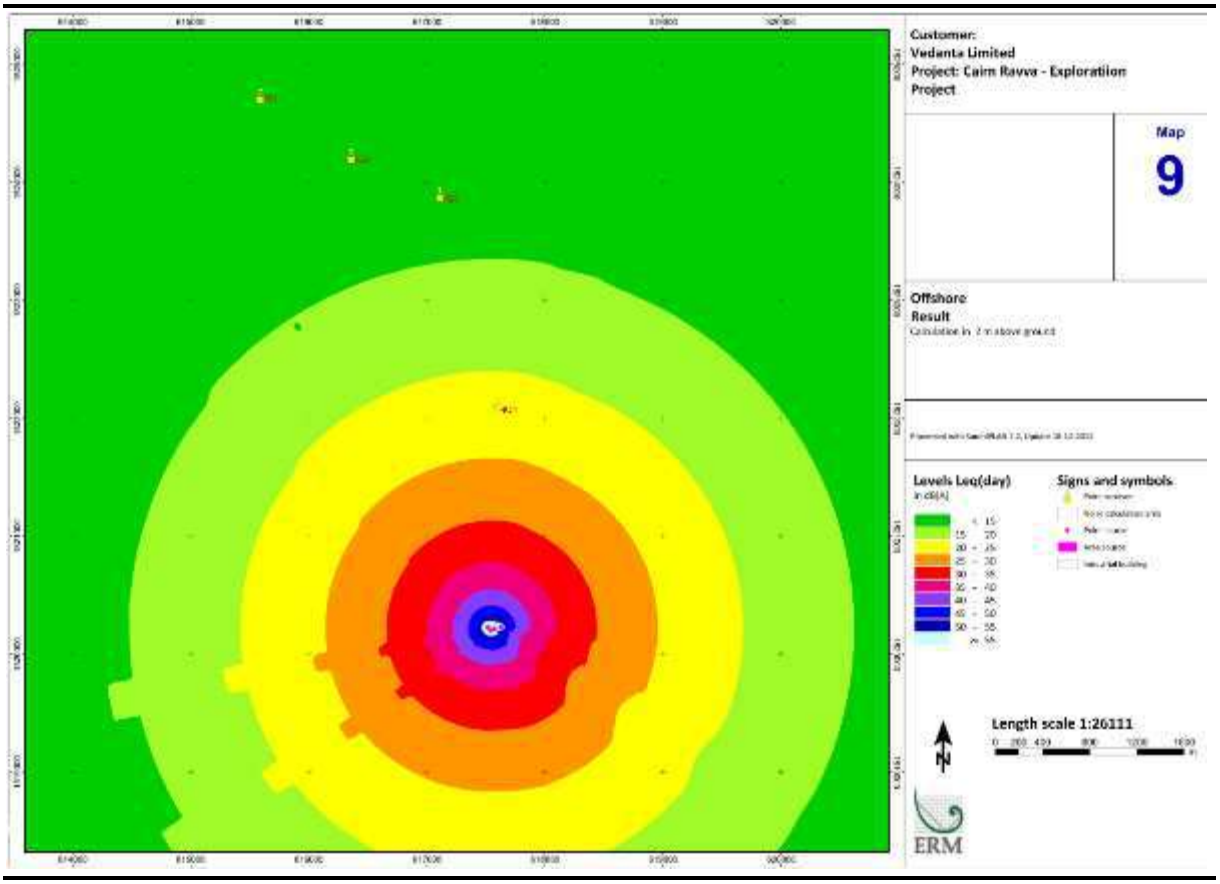
For offshore ewell drilling activities, there will be requirement of 3 support vessels and one supply vessel. Supply vessel will move approximately 40 km from Kakinada Port to rig location in Ravva Field. Drilling of a well will be completed within average 45 days for development well and average 55 days for exploratory wells. Maximum days for drilling of a well with mobilization and demobilization will be 90 days.

For estimating dispersion of noise in the ambient environment from a source point in offshore part of PKGM-1 Block at location nearest to coast has been considered (i.e. E-8 well location). Using the SoundPlan 7.2, the contours of noise levels are described in ***Table 4.22*** and shown in
Figure 4.13.

Table 4.22 Predicted Incremental & Resultant Noise Levels at Receptor Villages

S. N	Receptor Villages	Incremental Predicted Noise dB(A)	Baseline Day time dB(A)	Baseline Night timedB(A)	Resultant Day time dB(A)	Resultant Night timedB(A)	Standard Leq Day dB(A)	Standard Leq Night dB(A)
1	Outside Ravva Terminal	7.6	57.1	48.1	57.1	48.1	65	55
2	Living Quarters (LQ)	10.5	50.0	41.0	50.0	41.0	55	45
3	Surasaniyanam Village	12.4	50.1	38.7	50.1	38.7	55	45
4	S.Yanam Beach Cyclone Shelter	21.8	49.0	39.7	49.0	39.8	55	45
5	Challapalli Village	0	52.0	42.2	52.0	42.2	55	45
6	Gopavaram Village	0	51.3	41.3	51.3	41.3	55	45
7	Gachakayala Pora Village	0	48.0	38.7	48.0	38.7	55	45
8	Cherriyanam Village	0	48.2	38.2	48.2	38.2	55	45

Figure 4.13 Isopleths of Incremental Noise Levels during Offshore Drilling



The noise generation from above mentioned activities may cause disturbance to local community near Cairn Living Quarters. The high noise level from helicopters and support vessels movement will have potential to cause disturbance to coastal birds. Impact on coastal birds has been discussed in impact on biological section. The impact on ambient noise quality is assessed to be Moderate.

Mitigation Measures

For Drilling Activity

- Diesel generators located at the rig are housed in an enclosure at the deck and the exhausts are provided with silencers.

For Transportation through Helicopters

- Helicopters must maintain a minimum in-transit flying altitude of 500 m;
- Adhere to direct flight paths between Ravva Living Quarters (onshore) and rig and do not hover over or circle any marine fauna or coastal areas with birds; and
- All pilots and crew to be aware that deviations to flight paths are not permitted unless for technical or safety reasons.

Impact Significance

Impact	**Impact on ambient noise quality due to offshore activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impacts

With the implementation of mitigation measures, the significance of residual impact is assessed as Minor.

4.5.4 *Impact on Seabed and Sediment Quality*

Impact Sources

The potential source of impact on sediment is as follows:

- Positioning of drill rig;
- Discharge of drill cuttings and spent mud.

Impact Assessment

Positioning of Rig for Wells Drilling:

Positioning of the rig due to anchoring at a drilling location may result in temporary physical seabed disturbances and can result in increased turbidity in the water column causing disturbance to benthic and marine faunal health in localised and limited area surrounding the footprint of jack up rig and support vessels near the selected drilling location. A small area of approximately 0.1 km x 0.1 km (0.010 km^2) is expected to be disturbed due to positioning of the rig at a drilling location. As the area is shallow in water depth varying from 10 m to 20 m, it is likely that the majority of organisms would be mobile to re-establish themselves in close

proximity. Suspended sediment due to seabed disturbance could lead to the smothering of benthic fauna. The disturbance at seabed is expected to be **short-term** during positioning of rig. These exposed populations are of low sensitivity and are expected to recover relatively quickly. It is likely that at any given point of time no wells will be drilled simultaneously at other locations in close proximity.

Discharge of Drill cuttings and Spent Mud:
Vedanta Ltd (Cairn Oil & Gas) is proposing use of water based mud (WBM) for the upper sections and use of synthetic base mud (SBM) for deeper more difficult formations. WBM typically consists of water, bentonite, polymers and barite. At the end of drilling of a well almost the entire amount of the SBM, if used will be collected for re-use in next drilling operation, while WBM will be discharged offshore. It is proposed that approximately 150 m^3 (240 tonnes) per well of WBM of low toxicity will be disposed offshore. As per MoEFCC Guidelines, offshore discharge permitted is at a rate of 50 bbl $hour^{-1}$ (8 m^3 $hour^{-1}$ i.e. 12.8 tonnes $hour^{-1}$ @ 1.6 tonnes/m^3 density of drilling fluid), offshore discharge of drilling fluid of 240 tonnes will require approximately 20 hours per well.

Vedanta Ltd (Cairn Oil & Gas) is proposing drilling of 17 developmental (production) wells and 73 exploratory/ appraisal wells at the selected locations offshore, the total WBM generation is expected to be approximately 13,500 m^3 (i.e. 150 m^3 per well x 90 nos. of wells) for the whole drilling programme which is expected to last for approximately 10 years. All SBM generated will be recovered for reuse. There will be sufficient time between two drilling of wells, thus recovery of the water column to normal conditions is expected before drilling of next well at another location. The offshore discharge of cuttings and residual WBM will be designed to discourage the generation of suspended solids. This will be achieved by:

- maximising the cohesiveness of the solids; and
- encouraging the development and persistence of a density flow.

Drill cutting consists of inert geological material. The amount of drill cuttings created is estimated at 220 m^3 (484 tonnes) per well. It is estimated that about 4% by weight of drilling mud will remain on the cuttings after treatment. Based on this estimate 19.4 tonnes of drilling fluid will be lost on cuttings. In total it is therefore anticipated that a mass of 504 tonnes of drilling cuttings will be discharged per well. As per MoEFCC Guidelines, offshore discharge is permitted is at a rate of 50 bbl $hour^{-1}$ (8 m^3 $hour^{-1}$ i.e. 17.6 tonnes $hour^{-1}$); offshore discharge of drill cutting of 504 tonnes will thus require approximately 30 hours per well. Drill cuttings treated from shale shakers and centrifuges to separate mud from cuttings from the reservoir rock may have presence of hydrocarbon residues. Vedanta Ltd (Cairn Oil & Gas) to ensure that drill cutting associated with high oil content (oil content >10 g/kg) from hydrocarbon bearing formation are not disposed offshore.

The cumulative drilling of wells in a year is not expected to exceed 8 to 9 nos. per year. The maximum period of disturbance for discharge of drill cuttings will be 30 hours x 9 = 270 hours per year on intermittent basis while for drilling mud it will be 20 hours x 9 = 180 hours per year on intermittent basis.

For 17 developmental and 73 exploratory/appraisal wells, the total quantity of drill cutting is expected to be 19,800 tonnes (220 m^3 per well x 90 nos of wells) for the whole drilling programme, which is expected to last for 10 years. Drill cutting generated out of the

WBM/SBM of low toxicity will be washed, separated and disposed offshore. While in case of SBM usage is not of low toxicity it will be separated, washed and collected on-board and shipped for disposal to onshore at approved CHWTSDF.

The coast in the study area is very exposed. It runs perpendicular to the wind directions that prevail during the Southwest and Northeast Monsoons and is open to the Indian Ocean to the south. The cuttings will settle on the seabed where they will initially accumulate. If the cuttings are not disturbed it will consolidate thus the resistance of the resulting pile to movement (shear resistance) will increase with time if the sediments are not disturbed by currents.

Mitigation Measures

Disposal of Drill cuttings & mud: To minimise impacts of disposal of drill cuttings and drilling fluid following mitigations will be adopted:

- Vedanta Ltd (Cairn Oil & Gas)will comply with MoEFCC Guidelines for Disposal of Drill Cuttings and Drilling Fluid for Offshore Installation notified as per GSR 546 (E) dated 30 August 2005;
- Before offshore disposal of drill cuttings and unusable drilling mud (WBM only), Cairn (Oil & Gas) will ensure prior laboratory composition testing as well as their low toxicity testing of 96 hour survival for LC-50 value >30,000 ppm), thereby ensuring use of low toxicity chemical additives for preparation of drilling fluids;
- Only WBM/SBM with low toxicity drilling mud additives shall be used in the programme. Vedanta Ltd (Cairn Oil & Gas)will ensure that toxicity of chemical additives used in the drilling fluid (WBM or SBM) should be biodegradable having bio assay test be conducted (of 96 hours LC50 value of > 30,000 mg/litre as per mysid toxicity or toxicity test conducted on locally available sensitive sea species) with Hg < 1 mg/kg and Cd < 3 mg/kg. Cairn (Oil & Gas) will also ensure that no Cr^{+6} or chrome lignsulphonate additives are used. If otherwise, both drill cuttings and used drilling mud are to be brought onshore for disposal at a secured landfill;
- As required by MoEFCC Guidelines after laboratory reports showing safe for offshore disposal, used WBM/SBM and thoroughly washed drill cuttings can be discharged offshore intermittently (to avoid turbidity and reduction in transmittance) at a rate of 50 bbl/hour/well (i.e. 8 m3 hr−1 well-1) for effective dispersion and dilution preferably at a location which is much beyond from shoreline and sufficiently away from any ecologically sensitive areas.
- Offshore discharges to be done at 3 to 5 m below the sea surface. For offshore disposal within 4.8 km from shore line, prior approval from APPCB will be obtained.
- Spent SBM will be brought onshore for disposal to CHWTSDF;
- Management of drilling fluid including its losses is routinely undertaken as part of the standard operational procedures of rig.
- The percentage of drilling fluids on cuttings will be reduced as far as is practical by correct operation and maintenance of the cuttings treatment equipment. The production of excess drilling fluid requiring disposal will also be reduced through recycling of mud;
- Drill cuttings treated from shale shakers and centrifuges to separate mud from cuttings from the reservoir rock may have presence of hydrocarbon residues. Cairn (Oil & Gas) to ensure drill cutting associated with high oil content (>10 g/kg) from hydrocarbon bearing formation should not be disposed offshore; and

- Vedanta Ltd (Cairn Oil & Gas) to ensure that well wise record of data on quantity and quality of drilling fluid and drill cuttings generation and disposal options used are offshore along with effluent quality is maintained and submitted to MoEFCC every six monthly as part of the compliance report.
- As per MoEFCC conditions, Vedanta Ltd (Cairn Oil & Gas) is also required to monitor the petroleum hydrocarbon and heavy metal concentration in the marine fish species regularly and submit the report to MoEFCC regularly.

Impact Assessment

Impact	**Impact on seabed & sediment quality to offshore activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impacts

With the implementation of mitigation measures, the significance of residual impact due to seabed and sediment quality is assessed as Minor.

4.5.5 *Impact on Marine Water Quality*

Impact Sources

The potential source of impact on marine water is as follows:

- Drilling Waste
  - Discharge of drill cuttings and spent mud.
- Waste water from support facility
  - Disposal of sanitary waste water from rig, barge, tugs, support vessel;
  - Wash water and deck drainage runoff including WBM/SBM spills;
  - Bilge water discharge;
  - Cooling water;
- Solid & Hazardous Waste
  - Solid waste
  - Kitchen waste
  - Hazardous waste
  - Bio-medical waste

Impact Assessment

Impact on marine water quality due to above mentioned activities has been discussed in the following section:

Discharge of Drilling Waste:
Drilling process generates spent drilling mud and drill cuttings as described in ***Section 2.9***. The drill cuttings from the drilling fluid (mud) are separated in shale shakers, desanders and desilters. Waste and mud residues if discharged offshore, these will have potential to cause an increase in suspended solids in the water column and also have toxic effects due to mud additives.

Vedanta Ltd (Cairn Oil & Gas) is proposing use of water based mud (WBM) for the upper sections and use of synthetic base mud (SBM) for deeper more difficult formations. At the end of drilling of a well almost the entire amount of the SBM, if used will be collected for re-use in next drilling operation, while WBM will be discharged offshore. It is proposed that approximately 150 m^3 (240 tonnes) per well of WBM of low toxicity will be disposed offshore.

Drill cutting consists of inert geological material. It is estimated that 504 tons drill waste (cuttings- 484 tons + residue mud -20 tons) per will be disposed in the sea. Drill cutting generated out of the WBM/SBM of low toxicity will be washed, separated and disposed offshore. While in case of SBM usage is not of low toxicity it will be separated, washed and collected on-board and shipped for disposal to onshore at approved CHWTSDF.

As per MoEFCC Guidelines, offshore discharge permitted is at a rate of 50 bbl $hour^{-1}$ (8 m^3 $hour^{-1}$ i.e. 12.8 tonnes $hour^{-1}$ @ 1.6 tonnes/m^3 density of drilling fluid), offshore discharge of drilling fluid of 240 tonnes will require approximately 20 hours per well. Dispersion of drilling cuttings and spent mud has been assessed through modelling study *(Refer* ***Section 7.4*** *on Additional Stuidies*).

The drill mud composition will be of low toxicity, disposal of drilling discharges offshore will result in temporary increase in SPM concentration which will be revived to background level in short duration i.e. once drilling discharges are discontinued. The expected drill cutting disposal will take 30 hours per well while e regional. drilling mud will take 20 hours per well at MoEFCC prescribed discharge rate of 50 bbl hour-1. Drill cutting and unusable drilling mud discharges will be of low toxicity as to be observed prior to disposal through test reports.

Discharge of wastewater from support facility:
Sanitary wastewater from Rig: Jack up rig operations will typically result in the generation of 30 m^3 per day of sewage and wastes from the kitchen, shower and laundry area (black and grey water). Approximately 12 m^3/day (at 100 litres per person per day on-board) of black water (sewage) and 18 m^3/day (at 150 litres per person per day on-board) of grey water will be generated. Black water will be released to the marine environment after treatment in an on-board Sewage Treatment and Disposal Plant. The treated wastewater discharge, in accordance with Indian discharge requirements and MARPOL, will not consume dissolved oxygen from marine water and will have high dilution, thus will not impact on marine water quality and marine fauna.

Sanitary wastewater from Barge, Tugs, Support Vessels:
Tugs and support vessels used for the drilling program will generate sewage and wastes from the kitchen, shower and laundry area (black and grey water). Black water will be released to the marine environment at the locations of the support vessels, tugs and barges after treatment in accordance with Indian discharge requirements and MARPOL.

Wash water and deck drainage runoff:
Wash water and deck drainage runoff including WBM/SBM spills will be recycled to mud system or recirculated in mud preparation. Excess wash water of approximately 200 m^3/ well will be treated to ensure oil and grease content of less than 15 ppm as per Indian discharge requirements as well as MARPOL requirement before offshore discharge at 0.6 m from sea surface.

Bilge water discharge:
Water that accumulates in the drains and bilges of the Rig and other support vessels would likely to become contaminated with low levels of hydrocarbons and other chemicals. Unmanaged discharge of this water to the sea represents a potential impact on local water quality and marine organisms. The total volumes of drainage water produced by Rig and support vessels will be dependent upon weather conditions (i.e. rainfall) and deck cleaning and other activities that create run-off. It is expected that approximately 10 m^3/well bilge water will be treated on board and discharged offshore at 0.6 m from sea surface complying with Indian discharge requirements as well as MARPOL requirement of 15 ppm of oil and grease content. Oily water or bilge water containing more than 15 ppm of oil & grease content will not be discharged offshore and will be treated and oil will be collected in dirty oil tank and waste oil will be brought to shore for treatment and disposal.

Cooling water: Seawater is pumped on board the Rig, where it is deoxygenated and sterilised by electrolysis (by release of chlorine from the salt solution) and then circulated as coolant for various plant, including air conditioning condensers and air compressors. The discharge cooling water (approximately 200m^3 hour-1) will be heated up to 4 to 5^oC above ambient temperature. The anticipated temperature at the sea surface will be in the vicinity of 3^oC above ambient temperature within 15m from point of discharge and less than 0.5^oC above ambient temperature within 100 m from point of discharge. No adverse impact is expected from the discharge of cooling waters during the drilling of the wells given the fact of rapid dilution of cooling water and relatively smaller volume of cooling seawater involved.

The above offshore discharges will be treated as Indian discharge requirements and MARPOL and will not have toxic constituents, hence will have minimum impact on water quality and marine fauna.

Disposal of Solid & Hazardous Waste

Solid Waste: The solid wastes like Packaging materials, paper, plastic, tins, glass, etc.; will be generated from the offshore drilling facility. It is proposed to segregate these waste and store it on-board storage facility and disposed in the land based disposal facility. However, if these waste disposed in the sea will be potential hazard to seabirds and other marine life through accidental ingestion and if it contains chemical toxins -it can cause poisoning. It also constitutes a visual pollutant as flotsam, either at sea or when it ends up on the shore or the seabed.

Kitchen waste: Kitchen waste comprises biodegradable food waste. Kitchen waste will be disposed as per MARPOL requirement. Kitchen discharges include food scraps which will be macerated to less than 25 mm particle size and discharged offshore (beyond 3 NM i.e. 5.4 km from shore). If these wastes disposed without maceration can pose an issue of food floating on surface and choking in marine fishes consuming food waste.

Hazardous Wastes: The hazardous wastes like oily rags, used oil, and oily waste (bilge oil from surface water drainage and waste engine oil) will be generated from offshore drilling activity. As per MARPOL disposal into sea is prohibited. Vedanta Ltd (Cairn Oil & Gas)will arrange for its disposal in an onshore disposal facility (APPCB approved recycling agency or CHWTSDF). Accidental discharge of these hazardous waste will affect the marine water quality.

Biomedical Waste: Biomedical wastes like stained bandages, used syringes, blades, etc will be generated from offshore activities. These waste will be collected in specific bins provided with biomedical containing sealable bags for disposal onshore to APPCB approved vendors.

The scale of impact due to above mentioned activities is assessed to be medium. Duration of impact will be short term and extent will be regional. The impact on marine water quality is assessed to be moderate.

Mitigation Measures:
Drill Cutting & Drilling Mud: Vedanta Ltd (Cairn Oil & Gas) will comply with MoEFCC Guidelines for Disposal of Drill Cuttings and Drilling Fluid for Offshore Installation notified as per GSR 546 (E) dated 30 August 2005.

Liquid Wastes: Treatment and discharge to be undertaken in accordance with APPCB standards and MARPOL requirements:

- Vedanta Ltd (Cairn Oil & Gas) is also to ensure that marine water discharges are in accordance with the standards prescribed under the Environment (Protection) Rules, 1986. Treatment and discharge to be undertaken in accordance with MARPOL standards :
  - Oil content in machinery space bilges: Less than 15 ppm;
  - For vessels >= 400 gross tons, requirement of provision of oil discharge monitoring and control system and oil filtering equipment to be operating.
  - For sewage discharge from an IMO approved sewage treatment plant
    - Suspended solids: 35 mg/l above suspended solids content of ambient water used for flushing purposes
    - BOD5: 25 mg/l; COD: 125 mg/land and pH : 6.0 to 8.5

xx) Rig deck and drainage system will include coamings around the main decks to contain leaks, spills and contaminated wash-down water to minimise the potential for uncontrolled overboard release. A closed drain system will collect hazardous fluids from process equipment in hydrocarbon service; if the deck becomes contaminated, oily deck drainage will be contained by absorbents or collected by a pollution pan for disposal to onshore;

yy) Oil discharge monitors are used to ensure oil in water content targets are not exceeded. Records will be maintained of all discharges with oil content to verify controls in place are working effectively. Regular monitoring of drainage discharge for oil content to be analysed to ensure compliance with standards;

zz) For well testing, Vedanta Ltd (Cairn Oil & Gas) has a procedure to monitor the production and evaluate the performance of each well by providing a Test Separator along with associated instrumentation and piping on each platform. The Test Separator is a horizontal vessel designed for 3-phase separation of gas, oil and water by gravity. An internal weir plate provides a 2-phase interface zone for separating water and oil. Oil flows over the

weir and is withdrawn from the other side. Well fluid from the flow line of the particular well to be tested is routed to the Test Separator through the Test Header. Gas, oil and water flow is measured by the respective metering system provided on each outlet line and the three streams are then combined and routed back to the Production Header. Test Separator is one of the sources for the Instrument/ Utility gas system. A sand jet connection is provided on the Test Separator to flush the accumulated sand into the closed drain header. This will be done using the injection water.

aaa) For any offshore discharges within 4.8 km from shore line, prior approval from APPCB will be obtained;

bbb) Staff to be suitably trained to deal with spills and discharges;

- Recording of spills and irregular discharges as incidents, in accordance with required incident report procedures as described in Vedanta Ltd (Cairn Oil & Gas)'s Oil Spill Contingency Plan (refer to ***Annex 6 of EIA Volume 2***);

ccc) Provision of screen at the intake pipe of cooling water lift to prevent any entrainment of fish; and

ddd) The movement of Jack up Rig is required to be monitored to ensure that its movement avoids any MARPOL demarcated sensitive areas en-route to the drilling location in Ravva Field.

Hazardous Waste: To ensure minimum impact on marine water quality, following mitigation measures are suggested:

- No garbage would be disposed of to the sea;
- Wastes are required to be segregated and stored on-board in appropriate containers and transported back to shore where they will be either recycled or disposed of at an approved landfill or other disposal site. As these wastes are not proposed to be discharged to the marine environment, no adverse environmental impacts on marine environment are anticipated associated with the storage and handling of solid, hazardous and biomedical wastes.
- Organic food wastes generated will be macerated to pass through a 25 mm mesh and discharged beyond 3 NM from land with no floating solids or foam. For offshore discharge of food waste within 4.8 km from shore line, prior approval from APPCB will be obtained.
- Complying with MARPOL standards before disposal. No plastic to be disposed to sea.
- Plastic, scrap metal and other non-combustibles should be segregated and disposed onshore;
- Adhere to Waste Management Plan. Residual solid waste and rubbish generated on the drilling and support vessels (including incinerator ash) should be segregated, weighed and documented in waste manifests prior to disposal at appropriate facilities onshore;
- Biomedical waste is to be collected in specific collection bins provided with collection bags for onshore disposal; and
- All hazardous waste (e.g. fluorescent tubes, batteries, oily rags and spent fuel etc.) will be collected and retained on-board for disposal at suitable onshore reception facilities.

Impact Significance

Impact	**Impact on marine water quality due to offshore activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impacts

With implementation of the suggested mitigation measures, the impact siginificance on marine water quality due to proposed exploration, development and production activities in offshore part of the PKGM-1 Block is s assessed as **Minor**.

4.5.6 Impacts on Ecology

Impact Sources

The project involve development of 83 number of exploratory wells and 40 number of Development wells in the offshore region of PKGM-1 Block. the impact sources identified on marine ecology include the following:

- Seabed disturbances
- Underwater noise
- Offshore discharges

Impact Assessment

a) Impacts due to sea bed disturbances:

Positioning of the rig due to anchoring at a drilling location may result in temporary physical seabed disturbances and can result in increased turbidity in the water column causing disturbance to benthic and marine fauna health in localised and limited area surrounding the footprint of jack up rig and support vessels near the selected drilling location. A small area of approximately 0.1 km x 0.1 km (0.010 km^2) is expected to be disturbed due to positioning of the rig at a drilling location. As the area is shallow in water depth varying from 10 m to 20 m, it is likely that the majority of organisms would be mobile to re-establish themselves in close proximity. Suspended sediment due to seabed disturbance could lead to the smothering of benthic fauna. The disturbance at seabed is expected to be **short-term** during positioning of rig at a selected drilling location during installation of subsea infrastructure in **localised** area at each of the selected drilling locations within which exposed populations are of low sensitivity and are expected to recover relatively quickly. It is likely that at any given point of time no wells will be drilled simultaneously at other locations in close proximity.

b) Impacts due to underwater noise

Movement of support vessel and drilling of development and exploratory wells are the main source of the underwater noise. The potential impact of underwater noise on marine fauna are discussed in ***Table 4.23.***

Table 4.23 Potential Impacts of Underwater Noise on Marine Fauna

Marine Fauna	Possible Impacts
Marine invertebrates	Marine invertebrates lack sensory organs to perceive sound pressure, but many do have organs or tactile hairs that are sensitive to hydrostatic disturbances (McCauley, 1994).
Fishes	Lethal injury is established at 240 dB re 1 µPa. Threshold for behavioural effects on fish has been measured at a received sound level of 160 dB r 1µPa from a strong stationary noise pulse (Thomson et al, 2000). Fish returned to normal behaviou within 20 to 60 minutes after the noise source was removed. According to Turnpenny and Nedwe (1994), egg and larval damage occurs at noise level of 220 dB re 1 µPa, which is beyond the expecte noise generated by the proposed drilling. Sound is perceived by fish through ears and lateral line (the acoustico-lateralis system) which is sensitive to vibration. In addition, some species of bony fish have a gas filled sack called a swim bladder that can also be used for sound detection. The swim bladder is sensitive to the pressure component of a sound wave, which it resonates as a signal that stimulates the ears (Hawkins, 1993). Some groups of fish, e.g. flatfish and elasmobranchs or cartilaginous fish such as sharks and rays, do not possess a swim bladder and so have a reduced hearing ability.
Sea turtles	Sea turtles are considered to be less sensitive to noise than marine mammals (Thomson et al., 2000) and are unlikely to be affected by sound levels expected from the proposed drilling in Ravva Field.
Marine mammals (Cetaceans)	Marine mammals are more tolerant of stationary noises, such as drilling, than mobile ones, and this is consistent with the probable response threshold varying with perceived relevance of the source (Richardson et al., 1995). McCauley (1994) suggested that auditory injury of marine mammals could occur around 220 dB and injury is expected to become more severe with an increase in sound levels. Behavioural reactions of marine mammals to noise from drilling rigs was found to begin at broadband levels of 115 to 120 dB re 1 µPa @ 1 m (cited in Hurley and Ellis, 2004). However, marine mammals are unlikely to intentionally approach operations producing continuous or semi-continuous sounds that are powerful enough to lead to auditory damage. At lower sound levels there may be behavioural changes such as changes to diving patterns and avoidance behaviour, particularly when the noise source is intermittent. Continued exposure often results in habituation to the sound, followed by a recommencement of normal behaviour. Marine mammals are known to occur in water depths of 50 m and more. The proposed drilling will be in water depths of approximately 10 m. The water depth of 50 m and more occurs beyond 15 km from shore. Therefore no effect of noise on these species is anticipated.

c) Impacts due to disposal of drilling waste

About 250 m^3 / well drill cuttings containing oil, 200 m^3/well of residual drilling mud, sludge and other drilling waste and 10m^3 of used lubricating oil will be generated from the drilling operations. The major liquid, solid waste discharges anticipated due to drilling operations include spent drilling mud and drill cuttings.

Receptor Sensitivity

The main receptors are:

- **Phytoplankton:** 15 genera of phytoplanktons were identified in the study area, with average composition of Chlorophyceae (64%), Cyanophyceae (20%) and Bacillariophyceae (16%).
- **Zooplankton** species and represented by 2 species of Copepods, 2 species of Cladocerans, 1 species of Rotifer and one species of Protozoa within the block area;

- **Benthos** were composed of a wide variety of species with mainly polychaete foraminiferans, cnidarians, molluscs, crustaceans etc. living in burrows in the sediment or on the sediment surface.
  - Meiobenthic community is represented by Copepods, Nematodes, Turbellarians, Nemertins, Foraminifera, Kinorynchs, Halacarids etc.
  - Macrobenthic community is represented by Polychaetes, Molluscs, Cumceans Amphipods, Isopods, Cnidarians, Oligochaetes and Tanaidacea etc. which will be directly impacted by seabed disturbances.
- **Marine Fishes** 11 species of cartilaginous skeleton fishes without swim bladder and 37 species of fishes with boney skeleton and swim bladder were enumerated from the secondary data. Of these Whale Shark is listed as Endangered as per IUCN v2017.3 and Sch-I as per WPA,1972.
- **Marine Turtles:** Olive Ridley's Turtles (*Lepidochelys olivacea*) are listed as Vulnerable by IUCN Red list of Threatened Species and listed as Schedule I of Wildlife Protection Act 1972 is known to solitarily nest at 4 locations close to the PKGM-1 Block
- **Marine Mammals;** Four species of cetaceans are reported from the coastal waters of Andhra Pradesh. This includes 2 Dolphin species and 2 whale species. While Whales will require at least 50 m depth for movement, Dolphins are reported to use near shore waters at a depth of 5m.

Impact Significance

The impact duration will be **short term** as it will be limited to the construction phase, impact extent is **regional** as the geographical extent of impact in offshore region. Impact scale will be **medium** as there will be perceptible change from baseline conditions but well within acceptable norms. Impact magnitude thus calculated is **small.** The resource sensitivity will be **low** for habitats and **high** for species as globally threatened species have been listed from the PKGM-1 Block. Impact significance for habitats thus calculated will be **negligible** for habitats and **moderate** for species.

Mitigation Measures

The mitigation measures to minimize the above-mentioned impacts are as follows:

- Contractor to visually inspect the area before start of activities;
- Avoid sudden loud noises, such as from the moving and putting down of heavy equipment, when cetaceans are observed in the region;
- Maintain the vessel and all noise generating equipment in good working order.
- Dedicated and independent Marine Mammal Observers (MMO) should watch the Exclusion Zone (EZ) for 30 min before the beginning the soft start procedure (120 min for highly sensitive species).

Mitigation suggested for for sea bed disturbance is given as per ***Section 4.5.3***. while for drill cutting disposal is given as per ***Section 4.5.4.***

Impact Significance

Impact	**Ecology impact due to offshore drilling**			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity (Habitat)	Low	Medium		High
Resource/ Receptor Sensitivity (Species)	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Negligible** for Habitats and **Moderate** for species.			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **minor.**			

Residual Impacts

With the implementation of mitigation measures, the significance of residual impact due to seabed and sediment quality is assessed as Minor.

4.5.7 *Impacts on Community Health and Safety*

Impact Source

The receptors for impacts on community health and safety include the settlements in near shore areas and fishermen likely to interact with the offshore sites. It is understood that the community within a 2 km radius is most likely to interact with the onshore locations, including villages such as Chirrayanam and Surasaniyanam.

Impact Assessment

The major community health and safety risks for the offshore operations include the following:

- Potential exposure to spills, fires and blowouts
- Accidents involving fishermen and fishing vessels
- Hazards due to operational pipelines and abandoned infrastructure
- Exposure to noise pollution
- Improper waste management

In the event of a serious oil spill, significant and long lasting impacts can be anticipated on socio-economic resources in the areas impacted. In the event of a serious oil spill there is the potential for significant and long term (potentially in excess of 5 years) impacts to occur on socio-economically important resources, particularly fisheries/aquaculture resources sites.

Embedded Controls

In conducting its drilling operations, Vedanta Ltd (Cairn Oil & Gas) is committed to the prevention of pollution in Indian waters. Risk scenarios have been identified for jet fire; pool

fire and flash fire (refer to Section 7). As per the consequence modelling results, the effect zones are expected to remain within the 200 m. Clearly, the most effective pollution prevention measure is adequate precaution to avoid the possibility of an oil-spill occurring. Such prevention requires state-of-the-art equipment, properly operated by trained personnel.

Mitigation Measures

Notification of the location of offshore facilities (including subsea hazards) and the timing of offshore activities should be provided to local and regional maritime authorities, including fishery groups. The position of fixed facilities and safety exclusion zones should be marked on nautical charts. Clear instructions regarding access limitations to exclusion zones should be communicated to other sea users.

Subsea pipeline routes should be regularly monitored for integrity and if required should be repaired in a timely manner.

A spill response plan should be formulated. This plan should include arrangements for the Public training to warn of existing hazards, along with clear guidance on access and land use limitations in safety zones or pipeline rights of way. The plans thus formulated should be effectively communicated to the fishing community.

The grievance redressal process should be regularly tracked and monitored as part of the management function.

Impact Significance

Based on the above context and embedded measures, the significance of impact is assessed as follows:

Impact	**Impact on community health and safety**				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Low	Medium	High		
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/Receptor Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
	Significance of impact is considered **Minor**				

Residual Impact

With the implementation of mitigation measures, the significance of the residual impacts is assessed as Minor.

4.6 POTENTIAL IMPACTS DUE TO OPERATIONAL ACTIVITIES

4.6.1 Impact on Air Quality

There will be no modifications/ alterations at the onshore Ravva Terminal as the processing facilities and utilities have adequate capacity to handle the already approved production capacity of 50,000 BOPD of crude and 2.32 MMSCMD of natural gas. The present production is approximately 15,000 BOPD of crude and 1.40 MMSCMD of natural gas. After proposed development, Ravva terminal will be operated as per approved capacity. During full phased operation period of the terminal, the source of air emission will be due to flaring and point sources. The emission details and impact on ambient air quality has been discussed in ***Section 4.4.5.***

4.6.2 Impact on Ground Water Resources

Water requirement at the Ravva Terminal is being met through groundwater resources. Vedanta Ltd (Cairn Oil & Gas) is withdrawing groundwater of 9,570 m^3/day through old deep wells reportedly drilled prior to 1998. Of the 9,570 m^3/day water requirement, 9,170 m^3/day is used for injection into reservoir to maintain reservoir pressure by filling the void created due to fluid extraction and remaining 400 m^3/day is fed to RO Plant for domestic use.

Impact on ground water resources (ingression of saline water) has been discusses in *Section 4.4.9*.

4.6.3 Impact on Ground Water Quality

Impact Sources

Potential impact on ground water quality could arise due to:

- Injection of water in the reservoir (bore well water comingled treated produce water);
- Spillage of fuel and chemical storage, hazardous waste storage.

Embedded Controls

The project embedded control measures are as follows:

- Produce water will be treated to meet the CPCB discharge standard;
- Impervious storage area within the Terminal for fuel and lubricant, chemical, hazardous waste, etc.

Impact Assessment

The potential impact on groundwater quality is discussed below:

Water Injection in the Reservoir: Produced water up to 90,000 barrels per day (14,310 m^3/day) is comingled with ~9,170 m^3/day of saline groundwater withdrawn from deep aquifers of existing deep bore wells at the Ravva Terminal. Comingled produced water is filtered to remove oil and suspended solids and chemically treated to prevent from scaling, corrosion and to avoid sulphur reducing bacterial (SRB) growth before it is sent to all platforms for re-injection into confined hydrocarbon reservoirs.

Impact on ground water quality in relation to water injection in the reservoir has been discusses under *Section 4.4.9*.

Spillage of fuel, chemical and hazardous waste: The other potential impact on groundwater can be through contamination of groundwater quality through potential spills of lubricating oil, fuel oil and chemicals and untreated discharges on land. Fuels, chemical lubricant etc., would be stored at a designated paved area storage area within the terminal. Thus, contamination of groundwater can happen only due to accidental spillage of fuel, lubricants and chemicals from storage areas and during the transfer of fuels and chemicals.

Accidental leakage & spillage from crude pipeline: The well fluid (oil, gas & produce water) from producing well will the transported to Ravva onshore terminal for processing. The contamination of soil and ground water can happen only due to accidental leakage and spillage of well fluid from pipeline.

Considering project embedded control measures, the scale of impact is considered to be ***low***. The geographical extent of potential impact due to above activity is anticipated is ***local;*** however, impact duration of impact is considered to be ***long-term*** as contamination may spread beyond lifecycle of the project. The impact magnitude is assessed to be **low**. The sensitivity is **low**, as the water is unpolluted and provides services as, domestic uses. The impact on ground water quality assessed to be **minor.**

Mitigation Measures:
The proposed mitigation measures are as follows:

- The injection water is treated in injection water treatment system to meet the required water quality of oil in water content of less than 10 ppm.
- All storage facilities have been provided with adequate containment system to prevent contamination of soil and subsurface aquifer due to potential spills of lubricating oil, fuel oil and chemicals.
- Ravva Terminal, being an old facility, Vedanta Ltd (Cairn Oil & Gas) is to ensure periodic integrity testing of areas surrounding all process and storage tank and hazardous waste storage areas. If required necessary mitigation measures of restoring integrity of such aread shall be undertaken on urgent basis.
- Vedanta Ltd (Cairn Oil & Gas) will to ensure periodic integrity testing of well fluid transport pipeline.
- In case of any accidental spills at the onshore Ravva Terminal, Vedanta Ltd (Cairn Oil & Gas) is to recover any spilled crude oil/chemical or fuel oil and adequately treat the area to prevent any subsurface contamination. Cairn (Oil & Gas) is to ensure that regular training is imparted to its staff on avoiding spillages and take necessary actions if any spill happens.
- Vedanta Ltd (Cairn Oil & Gas) is to periodically monitor the groundwater quality in the surrounding area to ascertain any impact on groundwater quality.

Impact Significance

Based on the above context and mitigation measures, the significance of impact is assessed as follows:

Impact	**Impact on ground water quality due to operational activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impact:

With the implementation mitigation measures, impact on ground water quality is assessed as **Minor**.

4.6.4 *Impact on Surface Water Quality & Aquatic Ecosystem*

Impact Sources

Potential impacts sources on surface water (inland & marine) quality include the following:

- Discharge of domestic waste water from Ravva Terminal;
- Discharge of untreated effluent;
- Discharge of produce water;
- Accidental discharge of well fluid from pipelines.

Embedded Controls

The project embedded control measures are as follows:

- Domestic water will be treated and reuse in gardening and landscaping;
- Efluent and produced water will be treated to meet the CPCB discharge standards;

Impact Assessment:

The potential impact on surface water quality is discussed below:

*Sewage Treatment and Disposal***:** Sewage generated from Living Quarters is partially treated at source and discharged to Ravva Terminal in a Sewage Treatment Plant of 175 m^3/day capacity. The STP comprises of primary settlement pits, aeration tank (through surface aerator), dual filtration – i.e. sand and activated carbon filtration system and finally treated water is collected in a holding tank. The treated sewage meets the discharge quality criteria of APPCB and is used in plantation/ greenbelt development at Ravva Terminal. No untreated sewage is discharged from Ravva Terminal on land or surface water body.

*Effluent Treatment and Disposal***:** Produced water generated during hydrocarbon fluid handling and its stabilization, is treated in Produced Water Re-Injection System (PWRI). Treated produced water from PWRI is re-injected into confined hydrocarbon aquifers (as discussed in

previous Section 4.6.3) to fill up the void created due to hydrocarbon extraction and maintain reservoir pressure. The drained residual produced water from the process units that is not routed through PWRI is routed to the API separator. The API separator is provided with a slotted pipe type free oil collection and removal system. Sufficient settling time for separation of oil from water and for the gravity settling of oily sludge and inert sediments is provided. Treated water from the API separator is pumped to the equalization tank of the Effluent Treatment Plant.

An Effluent Treatment Plant (ETP) of 3,000 m^3/day capacity has been operating at Ravva Terminal. The ETP consists of primary, secondary and tertiary treatment system. The primary treatment involves free and floating oil separation and gravity settling of heavier sediments. The secondary treatment is an aerobic activated sludge biological treatment to reduce BOD levels. The tertiary treatment involves polishing the treated effluent through a dual media filtration process.

The treated wastewater is discharged into the sea complies with the marine water discharge standards as stipulated by APPCB and as required to be complied under the Environment (Protection) Rules, 1986. The treated effluent from ETP is discharged through 20 inches pipeline leading to marine outfall located at 0.54 km from shore (coordinated of discharge point 82°06'22"E and 16°28'17"N). The water quality assessed around the marine outfall in course of this study, showing quality complying with reference to controlled and other monitoring locations.

Treated Effluent Quality: The treated wastewater is discharged into the sea complies with the marine water discharge standards as stipulated by APPCB. The quality of treated effluent from ETP as monitored by Vimta Labs during January to December 2019 is shown in ***Table 2.5 (in Secton 2.4.1.11)***.

*Treated Effluent Disposal:*The treated effluent from ETP is disposed of by discharging it through 20 inches pipeline leading to marine outfall located at 82°06'22"E and 16°28'17"N. The effluent pipeline at the marine outfall is ended with T-shaped 2 port diffuser (of diameter 3 inches each, 3.5 m length each at 90^o) which is submerged at 5 m depth (1 m above seabed) at 540 m from the shore.

Predicted Concentration from Marine Outfall Discharge: The predicted scenario covered wastewater disposal through marine outfall with discharge rates of 2,000 m^3/day and 3,000 m^3/day with varying sea currents of 0.1 m/s to 0.5 m/s for discharge parameters of suspended solids (100 mg/l), BOD (30 mg/l) and oil and grease (10 mg/l).

The calculation is based on working out total dilution (D_T) composed of initial dilution at the discharge location (D_1), dispersion dilution (D_2) and decay dilution (D_3) such that $D_T = D_1*D_2*D_3$. The model outcome concentration of C_o will be C_o*D_T (modelled as proposed by *Pearson and Metcalf & Eddy*). The model outcome of the results show that rapid dilution is available within far field 540 m at the shore as indicated in the following ***Table 4.25***.

Table 4.24 Resultant Values for Effluent Discharge from Marine Outfall

S.N.	Ambient Sea Currents (m/s)	Effluent Discharge Quantity	Estimated Incremental Conc. (mg/L) at 540 m [dilution factor]	
			For Input Effluent SS of 100 mg/L	For Input Effluent O&G of 10 mg/L
1	0.1	0.02315m^3/sec	1.10	0.11
		2,000 m^3/day	[91.29]	[91.29]
2	0.3	0.02315m^3/sec	0.27	0.027
		2,000 m^3/day	[364.35]	[364.35]
3	0.5	0.02315m^3/sec	0.13	0.013
		2,000 m^3/day	[743.62]	[743.62]
4	0.1	0.03472m^3/sec	1.64	0.164
		3,000 m3/day	[60.86]	[60.86]
5	0.3	0.03472m^3/sec	0.41	0.041
		3,000 m^3/day	[242.92]	[242.92]
6	0.5	0.03472m^3/sec	0.20	0.020
		3,000 m^3/day	[495.84]	[495.84]
Incremental Concentration Range			0.13 to 1.10	0.01 to 0.16
Monitored Baseline Concentration			8.0 to 9.0	Less than 1.0
Resultant Concentration			9.13 to 10.1	1.01 to 1.16

Note: Considering Ambient Density of seawater as 1,022kg/m^3 & Discharge Effluent Density of 1,010kg/m^3

From the above Table, the following is inferred:

a) Incremental Concentration of Suspended Solids (SS)

1) Discharge of treated effluent of 0.02315 m^3/s (i.e. 2,000 m^3/day) with suspended solid concentration of 100 mg/l at marine outfall with sea currents ranging from 0.1 to 0.5 m/s, there will be incremental SS concentration ranging from 0.13 mg/l to 1.10 mg/l at shore (540 m) with dilution factor varying from 91.29 to 743.62.
2) Discharge of treated effluent of 0.03472 m^3/s (i.e. 3,000 m^3/day) with suspended solid concentration of 100 mg/l at marine outfall with sea currents ranging from 0.1 to 0.5 m/s, there will be incremental SS concentration ranging from 0.20 mg/l to 1.164 mg/l at shore (540 m) with dilution factor varying from 60.86 to 495.84.

With the above incremental concentrations of suspended solids and baseline varying from 8.0 mg/l to 9.0 mg/l (monitored in April 2018 at MW-8 near marine outfall as per ***Table 3.20***). The resultant concentrations of suspended solids are expected to range from 9.13 mg/l to 10.1 mg/l.

b) Incremental Concentration of Oil & Grease (O&G)

1) Discharge of treated effluent of 0.02315 m^3/s (i.e. 2,000 m^3/day) with O&G concentration of 10 mg/l at marine outfall with sea currents ranging from 0.1 to 0.5 m/s, there will be incremental O&G concentration ranging from 0.01 mg/l to 0.11 mg/l at shore (540 m) with dilution factor varying from 91.29 to 743.62.
2) Discharge of treated effluent of 0.03472 m^3/s (i.e. 3,000 m^3/day) with O&G concentration of 10 mg/l at marine outfall with sea currents ranging from 0.1 to 0.5 m/s, there will be incremental O&G concentration ranging from 0.02 mg/l to 0.16 mg/l at shore (540 m) with dilution factor varying from 60.86 to 495.84.

With the above incremental concentrations of oil and gas and baseline of less than 1.0 mg/l (monitored during January to December 2019 at MW-8 near marine outfall as per ***Table 3.20***).

The resultant concentrations of suspended solids are expected to range from 1.01 mg/l to 1.16 mg/l.

Based on the above assessment, the treated effluent discharge into sea through marine outfall will be sufficiently diluted under various ambient conditions posing minimum impacts on receptors at the shore.

Accidental discharge of hydrocarbon from well and pipeline: The well fluid (oil, gas & produce water) from producing well will the transported to Ravva onshore terminal for processing. The contamination of surface water can happen only due to accidental leakage and spillage of well fluid from well and pipeline. The accidental discharge of hydrocarbon may have adverse impact on surface water quality and can impact marine and aquatic ecology.

Mitigation Measures:
The proposed mitigation measures are as follows:

- All wastewater generated at Ravva Terminal will continue to be treated through primary, secondary and tertiary three stages treatment at ETP to comply with the applicable standards as prescribed by APPCB before treated wastewater discharge offshore through existing marine outfall.
- Produced water comingled with saline groundwater will continue to be treated in PWRI system before its injection into hydrocarbon reservoirs to maintain reservoir pressure.
- Staff to be suitably trained to ensure adequate treatment and monitoring of discharges from Ravva Terminal.
- Vedanta Ltd (Cairn Oil & Gas) will to ensure periodic integrity testing of well fulid transport pipeline.
- In case of any accidental spills at the onshore Ravva Terminal, Cairn (Oil & Gas) is to recover any spilled crude oil/chemical or fuel oil and adequately treat the area to prevent any subsurface contamination. Vedanta Ltd (Cairn Oil & Gas) is to ensure that regular training is imparted to its staff on avoiding spillages and take necessary actions if any spill happens.

Impact Significance
Considering project embedded control measures, the scale of impact is considered to be ***low***. The geographical extent of potential impact due to above activity is anticipated as ***regional;*** however, impact duration of impact is considered to be ***short-term***. The impact magnitude is assessed to be **low**. The sensitivity is **high**, as the water is provided habitat for commercial fishes and aquatic fauna. The impact on ground water quality assessed to be **moderate.**

Impact	Impact on surface water quality & aquatic ecology due to operational activities			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impact

Considering the implementation of above mentioned mitigation measures, impact on surface water quality and aquatic ecology is assessed to be **minor**.

4.7 *IMPACT ASSESSMENT OF SITE DECOMMISSIONING*

Pursuant to Clause 14.9 of the Production Sharing Contract (PSC), on expiry /or termination of contract, or relinquishment of part of the contract area, the contractor (Ravva JV) shall remove all equipment and installation from the relinquished area as per agreed abandonment plan and perform all necessary site restoration activities in accordance with good international petroleum industry practice and take all other action necessary to prevent hazards to hman life or to the property of others or the environment.

At the end of the production life, the project will be decommissioned and abandoned to restore the site to a safe condition that minimises potential environmental impacts. The decommissioning activities will cover:

- Offshore facilities
  - Production and injection wells
  - Floating production, storage and offloading facilities
  - Sub-sea facilities- pipelines, Riser
- Onshore facilities
  - Production wells
  - Pipeline
  - Ravva terminal

Vedanta Ltd Cairn (Oil & Gas) has prepared a decommissioning procedure for its production facilities. The decommissioning issues of onshore and offshore facilities are as follows:

- Onshore Oil & gas facilities
  - Land use management
  - Soil & ground waer contamination
  - Social & Communities

- Offshore oil & gas facilities
  - Energy use and emission to air
  - Seabed disturbance
  - Underwater noise generation and impact on marine fauna
  - Discharge to sea and impact on marine water quality
  - Generation of waste and impact on marine environment
  - Socio-economic impact- fishermen communities.

4.7.1 Impact on Air Quality

Impact Sources

The decommissioning programme's direct and indirect energy requirements will result in the emission of air pollutants like:

- Fugitive particulate emission from onshore well side and terminal;
- Gaseous combustion of fuel including, PM, HC, NOx, SO_2 and VOCs.

Impact Assessment

These emissions will include components that have the potential to contribute to dry deposition of particulate and photochemical pollution, or to impact upon local air quality. The prevailing meteorological conditions in the study area are expected to be rapidly dilute and disperse the airborne contaminants. The impacts are assessed to be short-term, regional and of low scale.

Mitigation Measures:

- Prior to mobilisation, vessels for offshore and trucks and dumpers (onshore) will be audited to ensure proper maintenance and efficiency of both diesel generator and engine;
- Fuel used for mobilised vessels and onshore traffic will be monitored and will comply with local regulatory/MARPOL requirements, in particular with regard to low sulphur content;
- Decommissioning activities will be planned to minimise vessel and traffic use;
- Planned, preventative maintenance systems will be required for all vessels and vehicles; it will be ensured that all equipments (combustion and mechanical/electrical) are maintained at peak operating efficiency.

Impact Significance

Impact	**Impact on air quality due to decommissioning activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Resudual Impact
With the implementation of mitigation measures, impact on air quality is assessed to be **Minor**.

4.7.2 Impact on Noise Quality

*Impact Source*s
The sources of noise emission are as follows:

Surface Noise: The operation of vessels will account for the majority of surface-generated noise. The following categories of vessel noise have been identified:

- Propeller noise;
- Flow noise: the action of water passing the hull;
- The use of thrusters for dynamic station-keeping; and,
- Machine noise: the operation of engines, generators, winches etc.

Underwater noise: Specialist tools, separately deployed from surface vessel(s) will be used like cutting tools and water-jetting.

Impact Assessment
Sound is important for numerous species of marine organisms, fishes and in particular marine mammals having developed a range of complex mechanisms for both the emission and detection of sound. Cetaceans use sound for navigation, communication and prey detection. Thus anthropogenic underwater noise has the potential to impact on marine mammals. Underwater noise may cause animals to become displaced from activities, potentially interrupting feeding, resting and/or migration. This may impact body condition and reproductive success of individuals and ultimately the health of a population. Feeding may also be affected indirectly if noise disturbs prey species.

The underwater noise levels anticipated to be generated from the intermittent and short duration use of underwater cutting and water-jetting tools are likely to exceed the threshold at which they will result in a behavioural response but will not be sufficient to result in physiological damage. Depending on background noise levels, marine mammals in the vicinity of the activities may be disturbed and swim away.

Given the relatively short duration of the decommissioning activities and the relatively low density of marine mammals recorded in the study area, the scale of the impact has been assessed to be low.

Mitigation Measures:
The following measures will be adopted to ensure that noise levels, and their effects upon potential receptors, are minimised to 'as low as reasonably practicable':

- Machinery, tools and equipment will be in good working order and well-maintained (as required under the contract with the subcontractor);
- The vessels work programme will be carefully planned to optimise use; and,
- The number of required cuts will be minimised consistent with operational (including safety) considerations.

Impact Significance

Impact	**Impact on noise quality due to decommissioning activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impact
With the implementation of above mentioned mitigation measures, impact on noise quality is assessed as **Minor**.

4.7.3 Impact on Benthos & Benthic Habitat

Impact Sources
The principal planned activities of the decommissioning programme includes water-jetting of sediments, the lifting of materials, and the temporary placement of objects on the seabed.

Impact Assessment
There may be two types of primary seabed disturbance: the loss or removal of substrate caused either by its displacement or by placing an object directly upon it, and the smothering of substrate caused by the resettlement of suspended sediment. The suspension of sediment will lead to increased suspended solid concentrations (and to increased turbidity) in the water column.

Displacement/removal and smothering will result in the loss or impairment of existing habitats and the physical injury or death of benthic fauna. The ease with which sediments will become suspended by decommissioning activities, and the speed at which they will settle out of the water column will depend upon the nature of the sediments and the prevailing sediment transport system.

In any given hydrodynamic regime, larger particles will settle out of the water column more quickly than smaller particles; therefore, sediment suspension will be easier and is likely to persist for longer periods in areas with a high percentage of fine sediments compared to areas with coarse sediment composition.

In addition to the direct impacts to marine fauna as a result of increased turbidity assessed above, it is important to consider the indirect impacts. Increased turbidity may cause physiological impacts on fish and can potentially impair their ability to locate food, which in turn can impact the physical condition of individuals.

The activities which may lead to maximum disturbance of the seabed is the water jetting of sediment and the lifting of sections of pipeline and umbilical. Once these activities are completed, it is expected that the seabed and its associated ecosystem will rapidly recover. The impacts have been assessed as being short-term and of low significance.

Mitigation Measures

The following measures will be adopted to ensure that seabed disturbance and its impacts are minimised to 'as low as reasonably practicable':

- All activities which may lead to seabed disturbance will be planned, managed and implemented in such a way that disturbance is minimised;
- The careful planning, selection of equipment, and management and implementation of activities (especially water-jetting); and,
- A debris survey will be undertaken at the completion of the decommissioning programme. Any 'foreign' material, identified as resulting from decommissioning activities will be recovered from the seabed where possible.

Impact Significance

Impact	**Impact on benthic habitat & benthos due to decommissioning activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impact

With the implementation of above mentioned mitigation measures, impact on benthic habitat and benthos is assessed as **minor**.

4.7.4 *Impact on Marine Water Quality & Marine Ecosystem*

Impact Sources

The use of specialist and support vessels, unbolting and cutting (breaking containment), and lifting activities are likely to result in generation and release of following materials:

Surface discharges and releases from specialised and support vessels

- Planned (operational) discharges (ballast water, bilge water, general shipboard drainage; treated sewage and grey water from accommodation and amenities;
- Planned discharge of marine growth removed from the well head protection structures (WHPS), pipeline and umbilical sections, and concrete mattresses and grout bags recovered to surface; and,

- Unplanned releases of hydrocarbons or chemicals (e.g. from diesel bunkering).

Seabed and water column discharges from Unbolting and cutting, and lifting

- Planned discharge (post-cleaning), upon breaking containment of the umbilical, of residual concentrations of production chemicals and of hydraulic fluid at the seabed, and through the water column during recovery;
- Planned discharge (post-cleaning), upon breaking containment of spool
- pieces/pipeline, of residual concentrations of production chemicals (corrosion inhibitor and methanol), and hydrocarbons and solids at the seabed, and through the water column during recovery; and,
- Planned discharge of marine growth during cleaning of WHPS, and pipeline/umbilical surfaces to allow access for unbolting and cutting.

Impact Assessment

Planned operational discharges to sea from vessels will be subject to on-board control measures designed to secure compliance with the Indian discharge requirements as well as MARPOL requirements. The planned discharge during decommissioning phase will be controlled and minimised using operating procedures and systems for optimum performance, including planned preventative maintenance systems for peak operating efficiency of on-board systems for the management of effluent, ballast water and bilge water.

It is possible that technical problems or operator error may lead to unplanned small volume releases of diesel or other hydrocarbons (e.g. through the drainage system). The likelihood of such releases is considered quite low. While marine water quality will be affected at immediate time and location, the effects of routine vessel discharges and any small volume unplanned releases will be minimised due to the expected rapid dilution and dispersal of contaminants under ambient hydrodynamic conditions. It is considered unlikely that impacts beyond those associated with normal shipping activities will occur. The significance of the impacts from these discharges and releases has therefore been assessed as low.

During its cleaning, the pipeline will first be pigged and then flushed with inhibited seawater. Upon cutting, the contents of the pipeline (wash waters including residual hydrocarbons) will begin to be discharged, initially at the seabed. Upon lifting of cut pipeline sections, further and complete discharge of contained wash waters is expected to occur through the water column en route to surface.

It is expected that the wash water contained within the sections of the pipeline being decommissioned in-situ will be lost to the surrounding sediment and water column over time as its structure gradually deteriorates. The discharge of any residual hydrocarbons to sea is therefore not expected to result in a detectable impact on the surrounding water quality. The significance of the impact of residual concentrations of hydrocarbons being discharged in this manner has therefore been assessed as low.

Mitigation Measures

The following measures will be adopted to ensure that seabed disturbance and its impacts are minimised 'to as low as reasonably practicable':

- Procedures and systems for the minimisation of waste and effluent generation (maintained as required under the contract with the subcontractor);

- Procedures and systems for the management of ballast and bilge water (maintained as required under the contract with the subcontractor);
- Accident prevention measures will be in place in order to minimise the potential for accidental spillages of hydrocarbons or other polluting materials;
- Vessels will be selected and audited to ensure that effective operational systems and onboard control measures are in place; and,
- Vessels' work programmes will be optimised to minimise use.

Impact Significance

Impact	**Impact on marine water quality and ecology due to decommissioning activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impact:
With the implementation of above mentioned mitigation measures, impact on marine water quality and marine ecology is assessed as **Minor**.

4.7.5 Impacts on Soil & Sediment Quality

Impact Sources
The decommissioning will generate hazardous and non-hazardous waste that will need to be managed to ensure best use is made of the material.

It is intended that recovered infrastructure will be returned to shore and transferred to a waste management facility, which will have all necessary approvals and licenses in place and possess the capability to reuse or recycle majority of the recovered material.

The minimisation of waste arising from the decommissioning will be of particular significance at the engineering stage, where opportunities for reuse will be considered initially prior to any other disposal route selection.

Impact Assessment
The decommissioning programme will generate both hazardous and non-hazardous waste materials. Wastes will be segregated according to characteristics and their disposal routes will be determined according to the waste hierarchy, taking account of the potential for recycling or recovery for reuse. Landfill disposal of waste will only be used as a last resort.

Naturally occurring radioactive material is not expected to be present. If contaminated items are identified, appropriate handling measures will be employed.

Waste management activities will be conducted in full compliance with all relevant legislation and regulatory controls, including shore side regulations for those wastes transferred ashore for treatment or disposal. Impact on soil and sediment quality due to waste generation and handling is assessed to be minor.

Impact Significance

Impact	**Impact on soil & sediment quality due to decommissioning activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

4.7.6 Socio-economic Impacts

Impact Sources

The potential sources of socio-economic impacts are as follows:

Denial of Access and Interference with Navigation: The physical presence of vessels engaged in decommissioning activities may temporarily deny commercial fishing vessels access to fishing grounds, or cause shipping vessels (whether utilising recognised shipping lanes or involved in servicing energy industry related activities, etc.) to alter their course.

Contribution to the Economy: Vessels will require the use of a range of port facilities and will also need to purchase a variety of local goods and services. The light processing (cleaning, cutting etc.) of recovered materials will be undertaken at a local shore base.

Impact Assessment

The impact (loss of opportunity) associated with any denial of access to, or navigation through, an area of sea is a function of the requirement of third parties to access or transit that area, and the time over which their free access or navigation will be denied.

Removal and recovery operations at the Ravva offshore area are estimated to short duration and zone of exclusion will be around the offshore decommissioning area.

Given the localised, short-term or infrequent nature of the activities, the significance of the impact with regard to denial of access or free navigation has been assessed as low.

Specialist vessel management services (including shore base and waste management services) will be required to support the decommissioning programme. Such services may be sourced from the Kakinada port and in doing so will support offshore and onshore employment.

Given the relatively small scale and duration of decommissioning operations, the significance of this impact (though beneficial) has been assessed as low.

Impact Siginificance

Impact	**Impact on socio-economic environment due to decommissioning activities**			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Short Term	Medium Term	Long Term	
Impact Extent	Local	Regional	National	
Impact Scale	Low	Medium	High	
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium	High	
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor.**			

Residual Impacts

With the implementation of mitigation measures, the residual impact is assessed as Minor.

Note: The impacts assessment for decommissioning related activities are assessed based on currently available information on Project activities, resources and receptors prevailing within the area of influence of physical, biological and social environmental components. Detailed impacts assessment for the decommissioning activities will have to be done before any decommissioning activities both for onshore and offshore project components and related infrastructure are taken up as per the requirement of then prevailaing legal and administrative framework.

4.8 CUMULATIVE IMPACTS

Cumulative impacts are incremental impacts that are caused on resources or receptors together with other third party planned or reasonably defined developments (that are known at the time of risks or impacts identification process is conducted) and that take place simultaneously in time and space within the same area of influence (study area) of a project under consideration. Thus, the cumulative impacts are combined effects together with other past, present and reasonably foreseeable future projects.

Impacts of all existing activities of Vedanta Ltd (Cairn Oil & Gas)'s in offshore part of the PKGM-1 Block and onshore Ravva Terminal as well of other third parties projects (having common study areas) on physical, biological and social components of environment have been captured through baseline data collected for this EIA as well continually being monitored by Vedanta Ltd (Cairn Oil & Gas) as part of environmental performance assessment of Project activities.

There is no new project that is known to be developed or currently proposed within the study area of PKGM-1 Block. As no new third party project is envisaged in the area of influence, no cumulative impacts are anticipated in the Project and area surrounding Ravva Terminal operations.

5 ANALYSIS OF ALTERNATIVES

5.1 BACKGROUND

Alternative analysis was carried out considering the technical and operational feasibility. The PKGM-1 block is allocated by the Government of India under the Production Sharing Contract (PSC). ONGC is the Licensee and Vedanta Ltd. (Cairn Oil & Gas) is the Operator.

5.2 ALTERNATIVE LOCATIONS

The location of proposed offshore wells will remain within the existing PSC boundary of the Ravva Field in PKGM-1 Block. It is proposed to construct 2 numbers of onshore well padswithin the PKGM-1 Block. An analysis of alternatives for locations for the proposed oil and gas developments is given in following section.

5.2.1 Locations of Proposed Offshore Exploratory/Appraisal & Development Wells

It is proposed to drill 14 exploratory/appraisal wells and 17 development wells from existing 8 offshore platforms. It is also proposed to drill 59 exploratory/appraisal wells from standalone offshore locations. Offshore drilling locations are proposed based on geo-scientific information and alternate sites cannot be considered for the proposed project facilities due to the following reasons:

- The locations identified for drilling are tentative with a flexibility of 200m radius, however larger deviations are not possible as oil and gas development and exploration are based on the information generated from the seismic surveys conducted in Ravva Field. Identification of locations for drilling of wells is determined based on data suggesting presence of oil and gas in the area. It is therefore implied that the location for drilling cannot be altered.
- No additional component installation is proposed in Ravva Terminal. Hence, no change in hydrocarbon fluid stabilization with the proposed oil and gas development in Ravva Terminal are envisaged as already existing facilities will be sufficient to cater to enhance production due to ageing of existing confined hydrocarbon aquifers.
- The location of the existing platforms optimizes the evacuation potential for well fluid and supply of reservoir support lift gas and injection water.
- The exploratory drilling is proposed with the fact that a new prospective structure will be explored within the Ravva Field at deeper depth of up to 6500 m.

5.2.2 Location of Proposed Onshore Exploratory/Appraisal & Development Wells

From onshore well pads 10 exploration wells and 23 developmental wells will be set up in near shore areas as a part of the proposed oil and gas program. Drilling of onshore wells will be done through two well pads WP-7 (RX-8) and WP-8 (RX-9), which were previously developed in 2006-07 inside PKGM-1 Block.

At the proposed onshore well pad sites, the onshore well pad dimensions represent a typical size of 225 m x 170 m, however, exact configuration may change depending upon the land

availability. As stated earlier, larger deviations are not possible as oil and gas development and exploration are based on the information generated from the seismic surveys conducted in Ravva Field. Identification of locations for drilling of wells is determined based on data suggesting presence of oil and gas in the area.

It is to be noted well pads (WP-1 to WP-5) that were proposed outside the PKGM-1 Block have been dropped from this proposal. The well pad WP-6 located near the mouth of Chirrayanam Creek was decided not to developed to avoid hinderance to backwater flow. All 33 nos. of onshore wells (10 exploatory + 23 developmental) will be drilled from WP-7 and WP-8.

5.2.3 New Pipelines

Onshore pipelines

Three new interconnecting pipelines in onshore pipelines corridor of 15 m width revised to ~8 km length (as against 15 km proposed earlier) connecting onshore well pads with existing pipelines network to Ravva Terminal have been proposed as per the following arrangement:

- 8" sub surface well fluid pipelines connecting onshore well pads to Ravva Terminal;
- 6" sub surface gas lift pipeline of connecting onshore well pads to Ravva Terminal.
- 14" sub surface injection water pipeline connecting onshore well pads to Ravva Terminal.

The location of the new pipelines poses no risk to the existing facilities including existing platforms and pipelines. The incidental operations (including existing pipeline crossings and free span correction) shall be addressed at the time of construction, however, the onshore pipeline routing shall be optimized to have minimum crossings and interference with existing pipelines.

Offshore Pipelines

For hydrocarbon transportation from new development wells from existing offshore platforms to Ravva Terminal, no new pipelines are proposed in coastal area, only existing pipelines within offshore Ravva Field to Ravva Terminal will continue to be used.

5.2.4 Options on Methodologies available for Pipeline Installation

The proposed pipelines corridor (revised to ~8 km) covers 87.9% of coastal area open lands incuding land under Casurina plantation while ~5% is passing through the creek/backwater and remaining 7.1% is aquaculture area. The onshore pipelines corridor route does not cross CRZ 1A area. The proposed pipeline laying method has been discussed in following section.

Trenching method

It is proposed to lay pipeline passing along the existing road and open land through trenching method. Before starting any construction work, a detailed route survey will be undertaken to document the existing condition of the pipeline route and the access roads. These records will be used as the standard against which the quality of the restoration work will be judged when the construction work is completed. The exact route of the pipeline will first be pegged out, while simultaneously staking out the width of the work strip on both sides of the route.

Manual or excavated methods will be used to dig the trench for laying the pipeline. The topsoil will be removed segregating the remaining backfill material. The topsoil will be

replaced in its position during the backfilling operation. The pipeline will be generally buried to a minimum depth of 1m.

HDD Method

With the proposed pipeline likely to traverse through creek and backwater area, appropriate construction techniques viz. Horizontal Directional Drilling (HDD) will be utilized by Vedanta Ltd (Cairn Oil & Gas). Approximately 1 km pipelines corridor (of 8 km length) will be laid under the creek/backwater and aquaculture area. In this regard, specific work procedures and method statements will be developed and implemented by Vedanta Ltd (Cairn Oil & Gas) to prevent and/or minimize any potential significant impact on the water bodies viz. enhanced sediment load, disturbance to ecological flow etc.

Further special considerations will be required as per OISD-STD-141 for submerged crossings generally characterized by their perennial nature, meandering course, steep and potentially erodable banks, potentially scouring bed, both during the design and installation of such crossings. In case of creek/backwater, which are prone to scour and erosion, adequate safe cover (minimum 1.5 m) shall be provided below the predicted scour profile expected during the lifetime of the pipeline.

5.2.5 Pipeline Route Alternatives

Two alternative routes for the proposed pipeline for connecting the onshore well pads to the Ravva terminal (approx. 8 Km) has been considered and are presented as follows**.**

Pipeline Alternative #1
Ravva terminal is the terminal point for the onshore pipelines corridor. The take-off point is located about 20 km South of Amlapuram Town and is best approached through road leading from Amalapuram till Surasaniyanam Village.

The proposed pipelines corridor route (of ~8 km) passes mostly through coastal land (landward side of the beach and Casuarina plantation) while about 1 km passes through backwater and aquaculture fields.

Pipeline Alternative #2
The alternate route is routed entirely through the water logged area / backwater thereby making it difficult to lay pipeline construction wise as well as is prone to environmental challenges.

Recommended Option: Pipeline alternative #1 is the recommended alignment as it avoids water logged area as much as possible and is routed on the landward side of the beach thereby causing minimum disturbance in the beach side area. Also this pipeline route is selected based on constructability point of view as it will increasingly difficult to lay pipelines along the route alternative 2 in view of the fact that almost the entire stretch is passing through perennial water logged areas and aquaculture fields wherein fish / prawn farming activity is carried out.

5.3 OPTIONS FOR USE OF DRILLING MUD

The options available on use of drilling mud include water based drilling mud or non – aqueous drilling muds i.e. synthetic based drilling mud. To make drilling safe and environmentally acceptable, drilling mud selection depends upon conditions of well bore, geological formation, gas hydrate, lubricate, mud density, etc.

Water Based Drilling Muds are safe for environment as it generally contains biodegradable constituents however its offshore disposal is subject to its toxicity. As per the Environment (Protection) Rules, GSR no. 546 dated 30 August 2005 (for description refer to ***Annex 9 of EIA Volume 2***), which specifies amongst other the toxicity of chemical additives used in the drilling fluid (DF) (WBM or OBM or SBM) should be biodegradable (mainly organic constituents) and should have toxicity of 96 hours LC50 value of > 30,000 mg/litre as per mysid toxicity or toxicity test conducted on locally available sensitive sea species.

The composition of WBM depends on density to be maintained. Typically by weight, WBM consists of 75% of water, 15% barite, 7% bentonite and remaining salts and additives. In comparison to WBM, the SBM reduces drill solids and liquid waste volumes and recyclable. SBM allows faster drilling rates and reduces drilling problems.

As upon completion of drilling, all SBM will be reused for next drilling and will not be discharged offshore, option of use of WBM for upper depths (400 m to 800 m) and SBM for deeper depths. Vedanta Ltd (Cairn Oil & Gas) will ensure compliance required mitigation measures for disposal of drill cuttings and drilling mud as specified in ***Annex 9 EIA Volume 2***.

5.4 SAFETY CONSIDERATIONS

Leakage from Machinery

The drilling rig will be designed for zero discharge having safeguards in place; including preventative maintenance, manned operations and the presence of drip pans/bunds.

Hazardous Chemicals

A variety of potentially hazardous materials and chemicals will be stored on board rig and support vessels (for offshore wells) and dedicated storage area within well pad (for onshore well) and these include glycol and their components of spotting spills such as surface active agents, emulsifiers and gelling agents, weighted with barite; cementing fluid chemicals (cement, surfactants, defoamers, lignins, inorganic salts, bentonite, barite) and lubricating oils, cleaning and cooling chemicals. All chemicals will be screened on both their technical requirements and environmental performance. Where technically practicable, the most environmentally acceptable options will be preferentially selected.

Drilling Mud Chemical Transfer

Drilling muds will be mixed in mud tanks on-board rig (for offshore well) and mud tank with well pad (onshore well). All chemicals will be preloaded on board the rig before it goes at the selected location. Fluids and components used in mud will be non-toxic. Barite and bentonite may contain some heavy metal concentrations, but not in a readily bio-available form. Utmost care is to be adopted during any transfer of drilling mud from supply vessels to avoid spills.

Diesel Transferring – Refuelling

The rig will be designed for a fuel storage capacity (of approximately 600 m^3). Any additional, refuelling will be carried out using standard industry practices. Spills caused by hose rupture, coupling failures, and tank overflow will be controlled by shutdown of pumps and automatic closure of safety valves. In the unlikely event of mishap, the spill would be limited due to automatically actuation of inbuilt safety valves in the fuel transfer / handling system and practicing of standard procedures during the time of refuelling and diesel transferring activities.

Vessel Collisions

Vedanta Ltd (Cairn Oil & Gas) has Oil Spill Contingency Plan to cover events resulting from vessel collisions. The rig will have communication systems as well as trans-receivers, beacons, public address, portable radios and telephone systems for radio contact at Ravva Terminal. Other support and supply vessels will have VHF, UHF and other communication systems.

Blowouts

The probability of a blow-out will be minimised by testing the BOP before starting the operation and regularly during the operation, pressure testing of casing strings, continuous monitoring for abnormal pressure during drilling and providing mandatory training for the drill crew in safety procedures.

Primary well control is at first achieved by the implementation of a properly prepared drilling programme, based on pressure predictions. If primary control is lost and if there is an indication of a possible kick occurring, Vedanta Ltd (Cairn Oil & Gas) has in place a procedure for well shut-in by operating of safety equipment (Blow Out Preventers) and by circulating the influx through a closed loop system (choke manifold) to re-establish the normal well conditions.

Key personnel such as Rig Managers, Tool pushers, Drillers, Assistant Drillers, Subsea Engineers will have fundamental knowledge on kick and blow-out control techniques and will also hold valid Well Control Certificate issued by an accredited industry training institute recognized by Governmental bodies and Vedanta Ltd (Cairn Oil & Gas).

5.5 NO PROJECT SCENARIO

The energy demand of India is much higher than the available resources, it is imperative to continuously exploit and explore and identify new viable sources of hydrocarbon reserves to reduce the burden of oil import. Moreover, the Ravva Field is operative for last 25 years.

The proposed oil and gas development Project intends to supplement an existing Field by enhancing declining production due to ageing of the existing confined reserves. The exploration and subsequent exploitation of hydrocarbon from identified prospects will help in increased production of oil and gas from the block. As there are no immediate alternatives available for replacement for petroleum hydrocarbon therefore a No Project Scenario is not viable.

The overall analysis of alternative suggests that the available alternatives are not better than the proposed project and therefore the proposed project shall be considered as the best available option.Environmental Monitoring Programme Monitoring is one of the most important components of a management system. Continuous monitoring needs to be carried out for regulatory requirements, to monitor the environmental quality and to determine performance of proposed mitigation measures. Monitoring indicators have been developed for each of the activity considering the mitigation measures proposed.

The monitoring programme has been developed taking into consideration of the following activities proposed in the Block:

1. Drilling of 123 wells covering 33 onshre wells (10 exploratory/ appraisal wells + 23 developmental) from two onshore well pads within onshore part of PKGM-1 Block and 90 offshore wells (14 exploratory/ appraisal wells +17 development wells) from existing offshore platforms and 59 offshore exploratory/ appraisal wells from stand alone locations within offshore part of PKGM-1 Block.
2. Construction of two onshore well pads WP -7 &WP-8 (dropping of well pads#1 to 5 & 6);
3. Laying of ~8 km of onshore pipelines corridor;
4. Strengthening of existing approach road to two onshore well pads site access and approach roads.

Monitoring results will be documented, analyzed and reported internally to Health, Safety and Environment (HSE) department of Vedanta Ltd (Cairn Oil & Gas). Monitoring requirements have been described in the following ***Table 6.1.*** Frequency of monitoring and responsibility of carrying out the monitoring have also been also been included. ***Table 6.1*** presents the Hazard and Consequence Monitoring.

Table 6.1 Proposed Monitoring Program

SN.	Environmental Indicator	Monitoring Parameter	Location	Period & Frequency	Responsibility
ONSHORE ACTIVITIES					
A	**Well pad site development and construction**				
A.1	Location and land required	Land parcels to be taken on lease and related compensations	Onshore well pad sites, access roads and pipeline alignment	Once in project lifecycle	GM Environment
A.2	Ascertain met-oceanic conditions	Met-oceanic conditions –cyclones, sea currents, waves etc.	Onshore well pad sites, access roads and pipeline alignment	Once in project lifecycle	GM Environment
A.3	Approval / Authorization of quarries for sourcing of fill material	Validity of the Approvals for quarries supplying aggregates for site development and road works	Quarry area	Once in project lifecycle	GM Environment
A.4	Topsoil stripping and storage	Area occupied for topsoil storage/ Area planned for topsoil storage	Onshore well pad sites, access roads and pipeline alignment	Once during each site preparation	HSE Manager
A.5	Local drainage pattern	Cross Drainage structures constructed to actual number of cross drainage structures designed	Onshore drill pad sites, access roads and pipeline alignment	Once in project lifecycle	GM Environment
A.6	Fugitive emission of dust during site preparation	Visual observation of dust in air by haziness	Onshore well pad sites, access roads and pipeline alignment	Daily during site preparation	HSE Manager through Contractors operating vehicles
A.7	Emissions from vehicles engaged	Ensure valid PUC Certificates from authorized PUC vendors	Vehicular exhausts	Annually for vehicles engaged	
A.8	Fugitive dust emission during material handling and storage	Visual observation of dust in air by haziness	Near stockpiles and storages	Daily during the entire project life-cycle	HSE Manager through drilling contractor
A.9	Accident reporting	Number of casualties / Number of fatalities	Site & Haul Routes	Entire duration of project lifecycle	HSE Manager
A.10	Quality of surface water from nearby creeks	Essential parameters as per CPCB Use-class	Four locations - natural surface runoff drainage channels	Once, prior to start of well pad development	HSE Manager – through NABL accredited lab
A.11	Groundwater Quality	Essential drinking water parameters as per IS:10500, 2012	Three locations - surrounding receptor points	Once, prior to start of well pad development	
A.12	Ambient Air Quality	PM_{10}, $PM_{2.5}$, NOx, SO_2, CO, HC using	Four locations - surrounding	Once, prior to start of	

SN.	Environmental Indicator	Monitoring Parameter	Location	Period & Frequency	Responsibility
		ambient air samplers	receptor points	well pad development	
A.13	Ambient Noise quality	Equivalent day & night time Noise Levels in $L_{eq\ day}$ & $L_{eq\ night}$ dB(A)	Five locations - surrounding receptor points	Once, prior to start of well pad development	HSE Manager – through NABL accredited lab
A.14	Soil Quality	Parameters pH, NPK ratio, Total Organic Carbon, heavy metals, TPH, organics, etc.	Four locations - onshore well pad sites & adjacent areas	Once, prior to start of well pad development	
B.	**Drilling & Well Testing**				
B.1	Gaseous pollutant emissions from diesel generators	Pollutant concentrations in gaseous emissions and maintenance parameters (air, fuel filters & air-fuel ratio) of DG sets influencing air emissions	Diesel generators deployed	Monthly during drilling & testing	HSE Manager – through NABL accredited lab
B.2	Noise Levels	Equivalent day & night time Noise Levels in $L_{eq\ day}$ & $L_{eq\ night}$ dB(A)	Five locations - surrounding receptor points and at fenceline of the well pad site	Monthly during the entire project life-cycle	HSE Manager – through NABL accredited lab
B.3	Fugitive emission of cement dust during handling and storage	Visual observation of cement dust in air by haziness	Near stockpiles and storages	Daily during the entire project life-cycle	HSE Manager
B.4	Runoff from temporary storage areas	Supervision of functioning of conduits / drains, channels	Onshore well pad sites, access roads and pipeline alignment	Fortnightly during drilling phase	HSE Manager
B.5	Wastewater quantity & quality (washwastewater, formation water etc.)	Volume estimate CPCB General discharge parameters and Oil & Gas Extraction Industry Standards	At ETP discharge point	Weekly during drilling Monthly during drilling	HSE Manager
B.6	Drill cutting storage and disposal	Total volume generated Concentration of hazardous constituents as per Hazardous Waste Management and Handling Rules CPCB Onshore discharge standards for Oil & Gas Extraction Industry	At storage location	Once during drilling period	HSE Manager – NABL accredited lab
B.7	Ambient Air Quality	Measurement of PM_{10}, $PM_{2.5}$, NOx, SO_2, CO, HC using ambient air sampler	Four locations - surrounding receptor points	Twice during drilling and testing	HSE Manager – NABL accredited lab
B.8	Stack Emission Monitoring	Measurement of PM_{10}, $PM_{2.5}$, NOx, SO_2, CO, HC	At DG sets within well pad site	Once during drilling	HSE Manager – NABL accredited lab

SN.	Environmental Indicator	Monitoring Parameter	Location	Period & Frequency	Responsibility
B.9	Ambient noise quality	Equivalent day & night time Noise Levels in $L_{eq\ day}$ & $L_{eq\ night}$ dB(A)	Five locations - surrounding receptor points	Twice during drilling and testing	HSE Manager – through NABL accredited lab
B.10	Workplace Noise Monitoring	Sound Pressure Level in dB(A)	At high noise generating equipment within well pad drilling site	Twice during drilling and testing	HSE Manager – through NABL accredited lab
B.11	Soil quality	pH, NPK ratio, Total Carbon, heavy metals, TPH, organics, etc.	Site, adjacent areas and waste disposal sites	In event of spills over an area of 10 sq.m; once after drilling	HSE Manager – through NABL accredited lab
B.12	Quality of surface water from nearby creeks	Essential parameters as per CPCB Use-class	Four locations - natural surface runoff drainage channels	Monthly during drilling and testing	HSE Manager – through NABL accredited lab
B.13	Groundwater Quality	Analysis of parameters as per IS:10500, 2012	At surrounding receptor points; three locations	Once during drilling & testing	HSE Manager
C	**Post rig demobilization of drilling and testing**				
C.1	Quality of surface water from nearby creeks and canals in proximity to the onshore well sites, access roads and pipeline alignment	Analysis of Parameters as per CPCB Use-class	Four locations - natural drainage channel receiving run-off discharges.	Once after rig demobilization	HSE Manager – through NABL accredited lab
C.2	Ambient Air Quality	Measurement of PM_{10}, $PM_{2.5}$, NOx, SO_2, CO, HC , using ambient air sampler	Four locations - surrounding receptor points.	Once after rig demobilization	HSE Manager
C.3	Soil Quality	pH, NPK ratio, Total Carbon, heavy metals, TPH, organics, etc.	Tthree locations - site & adjacent areas;	Once after site restoration	HSE Manager
D	**Operation of Ravva Terminal**				
D.1	Stack Emission	PM, SO2, NOx, CO.	GTGs: 4x2.5 MDW	Monthly	
D.2	Stack Emission	PM, SO2, NOx, CO, Non-methane Hydro Carbons.	DG sets : 1x1.0 MW, 1 x 0.8 MW) for emergency	Monthly	

SN.	Environmental Indicator	Monitoring Parameter	Location	Period & Frequency	Responsibility
			power generation		
D.3	Ambient Air	PM2.5, PM10, SO2, NO2, CO, C6H6, HC (as CH4), Non-methane HC (NMHC), H_2S, VOCs	4 locations, 24 hrs x consecutive 02 days	Monthly	
D.4	Ambient Air	Additional parameters NH_3, O_3, BaP, Pb, As, Ni	4 locations, 24 hrs x consecutive 02 days	Quarterly	
D.5	Ambient Noise	Equivalent day & night time Noise Levels in $L_{eq\ day}$ & $L_{eq\ night}$ dB(A),	5 locations including (Plant East Gate, Main gate	Monthly	
D.6	ETP	pH, O&G, TSS, BOD, COD, Total Cr, Cu, CN, F, Pb, Hg, Ni, Zn	Untreated and treated effluent	Monthly	
D.7	STP	pH, TSS, BOD, COD	STP Inlet	Monthly	
D.8	STP	pH, TSS, BOD, COD, Residual Chlorine	STP outlet - treated effluent	Monthly	
D.9	Potable water	pH, DO, BOD, Total Coliforms, E-Coli		Monthly	
D.10	Ground water	pH, Conductivity, TDS, Turbidity, Mineral Oil, Total Hardness, Total Alkalinity, Ca, Mg, Mn, B, Ba, Cl, SO4, Sulphides, Fl, NO3, Ammonia, Phenolic Compounds, CN, Cd, As, Cu, Pb, Fe, Total Cr, Se, Zn, Hg, total pesticides, PAH (sum 10), E. Coli, Total Coliform.	4 locations	Quarterly	
D.11	Surface water	pH, DO, BOD, Total Coliforms, Free Ammonia as N, Sodium Adsorption Ratio, Boron, Conductivity	04 locations	Quarterly	
D.12	Work place noise	Sound pressure levels in dB(A)	All high noise generating areas	Quarterly	
D.13	Soil	Bulk Density, Texture, pH, Conductivity, Cl, SO4, Ca, Mg, Na, K, SAR, total N, P, Cd, Total Cr, Cu, Fe, Mn, Pb, Zn, As, Hg, B, Se, Organic Matter, TOC, Benzene, Toluene, Xylene, Ethyle Benzene, TPH, PAH (sum 10)	2 locations within Ravva Terminal + 4 surrounding villages	Six monthly	

SN.	Environmental Indicator	Monitoring Parameter	Location	Period & Frequency	Responsibility
D.14	Land SubsidencePotential risks to assets and socio-economic resources	Review of outcome of ground levels	At areas near well pad sites	Benchmark level monitoring on Six Monthly basis	Well Operations Manager
OFFSHORE ACTIVITIES					
E.	**Offshore Marine Water and Sediments Quality**				
E.1	Marine water	pH, temperature, salinity, suspended solids, DO, NO_3, P, Si, TPH, Cd, Ba, Cu, Cr, Fe, Mn, Ni, Zn, Pb, Hg.	25 locations (along grid formed covering Project activities within PKGM-1 Block) including marine outfall and SPM	Once per season	HSE Manager through NABL accredited lab
E.2	Marine water	Phytoplankton (chlorophyll a), zooplankton (biomass and classification up to groups)	As above	Once per season	
E.3	Marine sediments	Grain size, hydrocarbons (TPH), sulphur, mineral oil, metals like Cd, Ba, Cu, Cr, Fe, Mn, Ni, Pb. Zn, Hg.	As above	Once per season	
E.4	Marine sediments	Benthos (biomass and classification up to groups), diversity index.	AS above	Once per season	
E.5	Fish tissues	Heavy metals in fish tissues viz Cd, Ba, Cu, Cr, Fe, Mn, Ni, Pb, Zn and Hg and total petroleum hydrocarbons (TPH).	Fish catch to be made within 10 km from drilling locations/ platforms on a minimum of 6 varieties of fishes.	Once per season	
E.6	Treated wastewater from deck for offshore discharges during drilling of wells	Laboratory analysis of treated wastewater discharge for pollutant parameters (pH, solids, oil and grease, COD, & BOD)	At well pad sites	4 samples per month	HSE Manager
E.6	Offshore Discharges during drilling of wells	The deck drainage and water treatment systems to ensure that oil in water discharged does not exceed 15 ppm. The bunding and storage arrangements for potentially hazardous chemicals will be audited prior to mobilisation to ensure that secondary containment is provided.	Onboard drilling rig	During and upon completion of drilling of wells	Contractor Logistics Manager HSE Manager

SN.	Environmental Indicator	Monitoring Parameter	Location	Period & Frequency	Responsibility
		Inspection of on-board operation of STP and volume estimate for satisfactory operation of STP	Onboard drilling rig	Daily during the project component execution	HSE Manager
		Audit prior to and during Project activities to ensure discharges are in compliance with the required standards and mitigation measures are well in place and records are being maintained on-board the rig and other support vessels.	Onboard drilling rig	Throughout the Project components execution	Contractor Logistics Manager HSE Manager
E.6	Nature of Drill Cuttings	Volume of drill cuttings generated in m^3 Ascertain characteristics of Drill Cuttings in terms of concentration of contaminants (heavy metals, toxics) Disposal / transfer details (qty, method	At offshore drilling location	Daily during drilling Once during each drill section (of use of WBM and SBM) As and when disposed - records and logs of discharge to be maintained	HSE Manager
E.7	Characteristics of WBM,SBM	Volume of WBM and SBM generated in m3 Characteristics of spent mud in terms of concentration of contaminants (heavy metals, toxics, etc.) Disposal /transfer details (qty, method)	Onboard drilling rig	Daily during drilling & testing Once during each drill section (of use of WBM and SBM) - As and when spent WBM disposed offshore or spent SBM is transferred for disposal at onshore CHWTSDF.	HSE Manager
E.8	Solid and hazardous wastes disposal	Mass of waste generated in kg Disposal details (qty, method)	At offshore drilling location and disposal point	Daily during the project component execution at disposal point	HSE Manager
		Food waste generated is macerated to less than 25 mm size Disposal details (qty, method)	At transfer point at rig site	Daily during the project component execution at transfer point	HSE Manager
		Mass of waste generated in kg Storage & disposal details (qty, method) at transfer point - to be recorded as per manifest system during transfer	Onboard drilling rig and onshore office.	Daily during the project component execution	HSE Manager

SN.	Environmental Indicator	Monitoring Parameter	Location	Period & Frequency	Responsibility
E.11	Potential exposure to radiations leading to health hazards	Inspection of site prior to and post well logging for testing of radiation levels on the tool and the environment	At offshore drilling location	At the beginning and upon completion of drilling.	HSE Manager
	Movement of rig and support vessels-Vessel Collisions	Conduct regular mock drills to ensure emergency preparedness. Conduct regular safety training to operational staff. Adopt monitoring procedures & regular audits to ensure emergency response preparedness.	Route of vessels	Throughout the Project components execution Ongoing as well throughout operations of Ravva Terminal	HSE Manager Director HSE Ravva Well Operations Head
E.12	Any oil spills	Area of spill and Quantity spilled Characterization of spilled substances for contaminants (heavy metals, toxics, etc.) Storage & disposal details (qty, method)	Along the oil spill plume	As and when spills occur	HSE Manager
		Monitoring parameters like pH, Oil and Grease, TPH, PCB, heavy metals	Along the oil spill plume	As and when spill occurs	HSE Manager

7 ADDITIONAL STUDIES

7.1 PUBLIC CONSULTATION

Vedanta Ltd (Cairn Oil & Gas) has been operating in the Ravva Block for last 20 years. It has proactively sought the partnership of the local community from the very inception of its activities in the Ravva JV. Further as per the terms of reference for EIA study as approved by MoEFCC, Public Consultation is required to be organised as per the procedure defined in the EIA Notification, 2006.

Statutory public consultation for the proposed Project conducted by APPCB on 11 October 2018. After completion of the Public Consultation, the environmental concerns expressed during the consultation have been incorporated in the EIA Report.

The public consultation meeting was presided and supervised by Joint Collector & Addl. District Magistrate of East Godavari District. The District Collector, East Godavari District, Kakinada had nominated the Joint Collector & Addl. District Magistrate, East Godavari District as Chairman of the Panel for conducting the Public Hearing. Detailed proceedings of the public consultation are provided under ***Annex 22 of EIA Volume 2.***

7.1.1 *Queries Raised, Views & Suggestions expressed by attendees during Public Consultation*

- **Sri Nagini Nageswar Rao, ZPTC, Katrenikona** expressed his concerns that the promises made in the earlier public hearings by the project authorities such as ONGC, GSPC, Reliance & Vedanta Limited had not been implemented. He questioned the project authorities that whether the project authorities halts the proposed project, if the people oppose the same. He also expressed his concerns that the project authorities had not been implementing the promises made during the public hearing, citing the example that earlier, during the Sri G.M.C. Balayogi period, CSR fund was earmarked initially to S.Yanam Village only, latter allocation of funds extended to mandal level and further to constituency level. He also expressed his concerns that due to exploration of oil & gas in the area, soil subsidence witnessing in the entire coast, thereby causing earthquakes in the area. He also disagreed that no turtles existing in the area and they were disappeared long back. He also expressed his concerns that due to exploration of oil & gas the sea food wealth was considerably decreased in the area. He also opined that monthly allowance shall be provided to the entire fishermen communities and agriculturalists in this area. He also informed that earlier, they staged dharnas infront of Ravva plant for fish death in this area due to pollution and the project authorities managed the higher officials and got a report stating that fish death in this area was not due to pollution from the plant. He also informed that the people of this area are not against establishment of oil companies. If any proposal established, it would be beneficial for development of this area citing the example of development of S.Yanam Village. He demanded for monthly compensation, as they have been loosing their wealth, similarly given by Reliance Industries @ Rs.6700/- per month and also informed that GSPC announced monthly compensation to about 16000 families till the completion of drilling activities, but, they have given compensation for 6 months only instead of 23 months as per agreement. He also informed that the issue of compensation was brought to the notice of the then District Collector, East Godavari District for solving the issue, but not materialized. He also informed that while establishing the project, the authorities informing that there would not be any pollution problems from the proposed project and questioned that why turtles, disappeared in this area. The project authorities drilled two wells in Gatchakayalapuram and Katrenikona, due to which the roads in this area are completely damaged. The Government

sanctioned Rs.8.0 Crores for laying of roads in this area, and apprehended that if the project authorities re-start their activities, again roads would be damaged. He also alleged that due to pollution from the drilling activities, the sea food productivity in this area completely damaged and due this, the youth from the villages are migrating to other areas for their livelihood. He also alleged that earlier, they got about 5Kgs of fish by each fisherman, and now they could not get even ½ kg due to pollution problem. He reiterated that due to pollution from the drilling activities, sea food productivity, agricultural productivity completely damaged in this area and the farmers are converting the fertile agricultural lands into ponds, as no other way. He demanded again for compensation to the lands damaged due to drilling activities, and also suggested that the project authorities shall adopt the villages for development. He also informed that the impact of drilling activity is not confined to this area only, the impact would be more upto 1000 of KMs in the underground and questioned the project authorities that how many tankers of oil they have been producing and re-injecting how many tankers of water into the well. He also alleged that due to drilling activity, the underground would be loosen further, which may lead to earthquakes in this area. While welcoming the project, he further demanded that a committee shall be constituted with members of Revenue, people representatives, village elders for obtaining concrete proposal for fixation of monthly compensation particularly to the fisherman community and agricultural farmers from the project authorities. He also alleged that no employment was given to locals even for security guards by the existing plants and demanded for employment and livelihood for the locals.

- **Sri Isukapatla Ravi Babu, resident of Challapalli,** informed to the public that the daily life of people in India interconnected with the oil & gas fuels, which is very precious. The people have different opinions on exploration of oil & gas in this area. About 24years back the existing Ravva plant established in this area. The GoI started the Ravva plant operations with joint venture, and this may be due to non-availability of technology at that time in India. The existing plant changed from combined petroleum, Cairn Energy and finally into Vedanta Limited at present. The oil production decreased to about 15000 Berrals/ day at present from the installed capacity of 50000 Barrals/day. Gas production is also decreased to 1Lakh m3 from 2 to 3 Lakh m3/day. The project authorities have proposed about 123 Nos. of Exploratory and development wells to explore oil & gas. The people in this area are ready to co-operate but, the activities that are being taken up by the project authorities are not upto satisfactory level. At present, about 10 Lakh Barrles oil storage facilities exiting in this area. Earlier, the village of S.Yanam is also very similar to Chirra Yanam Village with salt marshes and the lands in these villages were affected due to inundation of salt water and the authorities thinking that after establishment of Ravva field the S.Yanam Village is well developed with all facilities, which is not true. About 2% of the profits shall be earmarked for CSR activities and accordingly, the Ravva plant should earmark at-least Rs.10.0 Crores annually. Initially, during the tenure of elders Sri Dangeti Kotayya, he also staged dharnas for CSR funds and CSR fund allocation started with Rs.1.0 Crore annually and gradually increased to Rs.5.0 – Rs.6.0 Crores at present. He expressed his concerns that the plant operations started way back in 24 years, but, no infrastructure facilities provided in S.Yanam including Challapalli village except laying of roads in S.Yanam Village. He also expressed his concerns that the Ravva plant authorities could not even supply the drinking water in the villages till today, inspite of huge amounts of CSR funds allocated. People in this villages facing water scarcity and during the summer it is more intensive. He also expressed his concerns that the surrounding villages of Ravva Plant have been witnessing chemical, water and noise pollution due to operations of Ravva Plant. Whenever, the people in this area raised pollution problems due to operation of the Ravva plant, he informed that the project authorities stating no pollution problems due to their operations, monitoring the irrelevant parameters and the operations are being carried out as per the international standards. He also expressed his concerns that due to operation of existing plant, the people in this area have been witnessing health problems such as hair fall, gastric, cancer and pregnancy problems and requested the Government authorities to enquire the people about the same. 24years back the project authorities promised for 24beded hospital in this area, but, it was materialized in the recent past

only. The people in this area dreamed that they need not go for medical treatment either to Amalapuram or to Kakinada, after establishment of fully equipped hospital. But, the facilities provided at newly constructed hospital are not fully adequate. As per the then agreement, the project authorities should give 36% of permanent employment to the locals, but, at present, the authorities provided permanent employment to 8 Nos. of local people only, out of 105 employees working, and the project authorities stating that the employment decreased due to low production of oil & gas. At present, the project authorities recruited about 333 local people as contract employees and about 200 people recruited non-local people engaged from about 2000 Kms., of Chennai. He questioned the project authorities that why they engaged non-local people despite availability in the local area. He informed that lot of unemployed youth with fully technical qualification available in this area and requested the project authorities not to engage people from other places and recruit the local people in contract employment, as thousands of crores of wealth from this area has been taken out by the project authorities. He also opined that the S.Yanam village was developed due to establishment of Cairn Energy and certain development activities is happening in this area but not upto the mark. At present, the wells and drilling activities are being carried out in offshore, due to discharge of sludge, oil wastes into Sea, fish breeding capacity has been decreasing. The project authorities shall adopt sage culture and shall support the fisherman community providing latest technology. The project authorities shall also provide mechanized boats, nets to the local fisherman community, as these people depends only on fishing activity. The Konaseema area is covered with sea mashes, rivers and Sea and hundreds of fisherman families depending on them, because of oil & gas exploration in this area, the local people loosing their livelihood and asked the project authorities are directly or indirectly reason for that. He further requested the project authorities to re-think about the issues raised by the public as people in this area are always co-operative for such projects. As stated by the project authorities, they are always very co-operative for development of India, exploration, production and usage of Oil & Gas locally and also to decrease the imports of Oil & Gas. He re-iterated that the project authorities shall solve the local problems and shall give employment to the locals. He questioned the project authorities that where the greenbelt was developed and how many acres of greenbelt developed for the past 24years. He suggested that if, requisite land is not available for development of greenbelt, the project authorities may take land from local farmers on lease basis for development of greenbelt. He also informed that the project authorities have not been giving employment to other villagers except S.Yanam, citing that that the people of S.Yanam have not been willing to give employment to other villages. He also informed that while explaining the project detail by the authorities stated that about 50% of the employment has been giving to local people and requested the project authorities about 30% employment may be given to S.Yanm Village and 20% to other villages. He questioned the project authorities that during the job mela conducted in the recent past, whom they have given the employment and requested for employment should be given to locals only, as people of this area are prone to accidents due to the exploration activity citing the example of Mamidikuduru accident. Out of thousand families in the village, about 600families are getting benefitted by way of employment, small contracts and he demanded that the project authorities shall pay the current bills, shall provide daily commodities on monthly basis to the remaining 400 un-benefited poor families as monthly package. He informed that they would support the project duly implementing the local issues pertaining to employment, pollution problems, compensation to the poor families raised in the public hearing.

- **Resident of S.Yanam** demanded for monthly compensation of Rs.5000/- per family. He expressed his concerns that they have been facing health problems due to pollution problems from the plant and also informed that earlier, 200 woman protest for medical compensation and all the 200 women arrested during the pretest. Particularly fisherman community in this area has been loosing their livelihood due to the plant operations and many people migrated for work. He also demanded that after giving monthly compensation of Rs.5000/- per family, employment and medical compensation to each family, only they would allow the proposed project, otherwise, people in this area will protest.

- **Sri Lanke Bhimaraju, resident. of S.Yanam informed** that the people of S.Yanam Village always co-operative for establishment of industries. While carrying operations, the project authorities shall also taking into consideration of loss to the local people. Fish productivity in this area has been gradually decreasing for the past 30 years due to operations of oil & gas exploration industries. Due to decrease in livelihood to fisherman community, many families migrated to other areas as casual labour and requested the environment department to study the issue in detail. Whether it is a misconception or real, the health problems of cancer and gastric increased in this area for the last 20years and requested the environment department to study the issue in detail and reasons may be found out. The project authorities of Vedanta Limited have been carrying out drilling activities in S.Yanam and Chirra Yanam villages and during operations excess gas would flared and the other wastes such as water, oil if releases in to local water sources and back waters, the lands would not be suit for agriculture and particularly the fisherman community would face inconvenience and if it happened, compensation shall be given to the land owners and fisherman community of the area and same should be incorporated in the activities proposed. He also informed that earlier, the project authorities encouraged education benefits to the local fisherman community, same is slow down gradually in the recent past and suggested that the project authorities shall re-start, continue and increase educational benefits to children of fisherman community of this area under the chairmanship of the District Collector. He also informed that earlier, during the oil & gas exploration activity compensation was given in Yanam Village as well as in Gadimoga Village by the industries and in the same way the project authorities shall give compensation to all the affected villages. While welcoming the project, the project authorities shall take all the measures and shall carry their operations without causing any inconvenience to the local people.
- **Sri A.Narasimha Murthy, Resident of Chirrayanam, Ex.Sarpanch** informed that due to activities of GSPC, fish productivity has been decreasing and turtle nesting grounds, which were existing earlier, were also disappeared due to activities of ONGC. He requested the project authorities to adopt their village i.e. Chirrayanam for solving water problem and shall carryout different development activities. While welcoming the project he requested the project authorities to carry their operations without causing any convenience to the local people.
- **Sri M.Annavaram, Resident of Chirrayanam, Ex.Sarpanc**h informed that earlier, the ONGC carried out its operations and promised hospital and CC roads in the village, and completed its operations for 3 – 4 years and not even allocated Rs.1000/- to their village for development. He also informed that no development activities promoted in the village, for which they also staged protest. He also informed that development by the industry confined to the S.Yanam village only, they could not have even transport facilities during the emergency for maternity, and it would take atleast one hour time to reach nearest hospital. He also informed that the roads in this area are completely damaged due to activities of oil & gas exploration industries and minimum three hours time is taking to reach hospital at Amalapuram by auto in the emergency. While welcoming the project, he suggested that the Government authorities shall obtain a concrete proposal from the project authorities pertaining to implementation of CSR activities in the area.
- **Resident of Katrenikona** informed that the ONGC authorities have been carrying its activities in this area since long time. During the drilling activities, the project authorities have been giving very small amount of compensation to the adjacent land owners and there is no mention about the specific amount to be given. After completion of the drilling activity, the un-succeed bore wells are filling with soil of 3 – 4 tractors capacity only, which is in sufficient and the farmer could not carry agricultural activity immediately. He suggested that instead of giving small amount of compensation to the land owners, a fixed amount shall be given equal to the amount lost due to unfavorable condition for agriculture per year. He requested the project authorities that more CSR funds shall be allocated in this area towards education, establishment of play grounds and laboratories, libraries and computers, as they would be help the people. Nobody can stop the activities of oil & gas exploration in this area and these would be explored either by the present management or some other company. He also informed that a special package should be given to each family, besides allocation of more CSR funds for development of infrastructure in this area. He

also suggested that monthly package shall be given to poor families in this area. More CSR funds shall be allocated and advised the project authorities that a residential school shall be established for the merit students of Katrenikona & Uppalaguptam mandals, so that all the engineering people required for ONGC would be produced here only. He also suggested that greenbelt shall be developed in these villages duly giving employment to the local people, so that the people in this area developed socio economically.

- **Sri B.Suri Babu, Resident of Chirrayanam – Gachikayalapuram MPTC** expressed his concerns that due to activities of ONGC, Cairn Energy, GSPC and Reliance Sea fish productivity was decreased. He and on behalf of his village opposed the proposed oil & gas exploration activity. Earlier, they protest against the activities of oil & gas exploration due to which Sea fish productivity decreased and the oil companies promised compensation for two years to each fisherman family, but, compensation was given for only 6 months to few people only. He expressed his concerns that they would allow the processing of public hearing only after obtaining concrete proposal from the project authorities. He also alleged that the Government has not been taken care about the endangering of fisherman community in the area and the Government has not showing the interest like protecting wild life to the fisherman community. He suggested that the project authorities shall provide boats & nets to the local fisherman community. Drinking water infrastructure facilities shall also be provided to their fisherman society. 100 Nos. of additional solar lights shall be provided, as they have facing poor visibility of roads particularly during the cyclones. Hospital facility shall also be provided each at Chirrayanam and Gatchakayalapuram panchayaths and shall provide efficient doctors. Similarly, Reliance Industries, arrangements for corporate education to every 10th passed students of this area shall be provided. Employment opportunities to the un-employed youth shall be provided. He also requested for employment to their youth at ONGC, S.Yanam. An amount of Rs.15,000/- shall be given as additional matching grant in addition to the Government's Rs.15,000/- grant for construction of toilets. Similarly by the Reliance Industries Limited, an amount of Rs.1.0 Lakh financial support shall be given to all the fisherman community brides in this area by the project authorities. Financial assistance for daily commodities shall also be given by the project authorities to fisherman community during the declaration of cyclone emergency by the Government. Preference should be given to locals for employment while drilling wells. He also requested that an amount of Rs.1.0 Lakh shall be given by the project authorities as additional matching grant in addition to the Government's Rs.2.0 Lakh for construction of houses for poor. He also requested that the project authorities shall give compensation of Rs.5,000/- per month each fisherman family during the ban of fish catch from April to May every year by the Government. He also requested that project authorities shall give compensation of Rs.2.0 Lakhs to fisherman family, if loose their life due to any accident. He also requested the project authorities that CSR funds of minimum Rs.1.0 Crore shall be allocated every year to Chirrayanam and Katrenikona Villages, until completion of the proposed project.
- **Sri Jogi Arjuna Rao, Resident of S.Yanam, Ex. MPP, Uppalaguptam** informed that the canals which were damaged by ONGC earlier shall be repaired by the present management. He also informed that the people in the S.Yanam village are very poor and they lost a lot of employment opportunities. He expressed his concerns that the Vedanta Limited has been releasing gas during the night time, due to which they have been facing heart problems. They have also been facing lot of health problems due to the nearby plant. He also informed that they have not even getting sufficient drinking water. The canal bund which was damaged by the ONGC authorities shall also be repaired by the present management. The present management has been carrying its operations for the past 20 – 25 years and about 90% of the people in the S.Yanam village are poor and the management has not taken any concrete proposals for development of the village. Rs.50,000/- shall be given by the project authorities to each poor families for construction of houses. He also requested that employment to the local people in any form shall be given.
- **A Woman, Resident of S.Yanam** expressed her concerns that the project authorities have not been implementing any development activity for the poor in the village. She also informed that they would not allow the proposed project until implementing any developmental activity to them.

- **Smt. Satyavathi, Resident of S.Yanam** while welcoming the project requested the project authorities that developmental activities such as education to their children, and other facilities shall be provided. No employment opportunities given to them till date. She also informed that they do not have even drinking water facilities. Inspite of the promises made by the project authorities, they have not taking up any development activities.
- **Sri R.Tirupathi Rao, Resident of S.Yanam** informed to the public that the people in S.Yanam Village could not even get drinking water till date, though the ONGC operating unit for the past 30years. They could not even breathe fresh air, due to air, water pollution from the plant and every family in the village has been suffering with different type of diseases. The plant has not been taking any steps for control of pollution and the concerned authorities have not taken any action. He also informed that it is the responsibility of industries for development of local area as per re-habilitation and re-settlement act. But, the management has not taken any steps for development of local area, even though it has been operating for the past 30 years, citing the example that the management has not even supplying drinking water to the villages till today. He also demanded for release of white paper on the funds released for S.Yanam Village development year wise for the past 30 years, as people of this village have lot of doubts in this regard. He also alleged that due to drilling of deep wells in this area, the entire agriculture land contaminated with salt water intrusion, thereby people of this area lost their livelihood. He also expressed his concerns that due to release of oily water into Sea by the industry, fish productivity completely decreased in the area, thereby fisherman community lost their livelihood. The company management has not provided employment except giving lower grade employment. He also alleged that the PHC constructed by the project authorities handed over to Government instead of maintaining the same. He also informed that only 14Nos. of teachers appointed and demanded for education facilities to all the villages to be provided by the project authorities from KG to PG. He suggested that the Government authorities and project authorities shall consider the issues raised by the general public and then only start the expansion proposal. Similar type of public hearing presided by the Joint Collector earlier, but, no action taken against the industry on the issues raised by the public.

In addition to oral representation during the public consultation, written representations were also received by the Panel on the dais. The details on the same are presented in the detailed proceedings of the public consultation provided under ***Annex 22 of EIA Volume 2***.

7.1.2 Views & Suggestions expressed by Joint Collector & Addl. District Magistrate, East Godavari District during Public Consultation

- **The Joint Collector & Addl. District Magistrate, East Godavari District** informed that the proposed project is exploration of oil & gas by drilling 123 wells and it would take atleast 1 ½ – 2 years for production of oil & gas. Hence, in the mean time, the project authorities could not generate any employment opportunities and it is not correct to wait such a long time for employment and suggested that the bio data from the impacted villages should be collected and shall provide 3 – 4 months training for placements for eligible un-employed youth in 1st phase. He also suggested that eligible candidates with required experience from the affected villages available, the project authorities shall consider their candidature after successful production of oil & gas after 1 ½ to 2 years time, for which an affidavit would be taken from project authorities along with in principle appointment and bio datas of eligible candidates within 30days. He also informed to the public that an affidavit would be taken on Rs.100/- non-judicial stamp paper from the project authorities, stating the CSR activities that would be taken up in these three villages in the next 3 – 4 months. He also suggested that Gram Sabha in every village shall be conducted once in a year in presence of the Revenue Divisional Officer to monitor the progress on CSR activities committed by the project authorities. He suggested that proper sports infrastructure facilities, libraries, E-Centre with facilities like provision of computers, internet, parks for walkers and children shall be provided by the project authorities within 3 – 4 months as the amount required for these facilities very less and instructed the project authorities to furnish affidavit duly incorporating the above issues. He also

opined that if any well drilled is uneconomical, it is the responsibility of the project authorities for safe closure of well. He enquired about the greenbelt developed by the project authorities and informed that about 110 Acres of Casuarina plantation developed by the industry and instructed the project authorities to inform the area of greenbelt that has to be developed as per norms. He also enquired about the greenbelt development in the village, which could be economically helpful to the villagers. He also instructed the project authorities that a study should be conducted on development of greenbelt, in such a way that the extent of greenbelt required to be developed, to minimize the impact on the surrounding people due to oil & gas exploration activity and progress of implementation of greenbelt development shall be informed. He instructed the RDO to serve a notice under section 133 Cr.PC to industry, if the drinking water is not meeting the standards required. He also suggested to the project authorities that the pipeline network for supply of hygienic drinking water shall be repaired and maintain properly. He also suggested that preference should be given to the locals particularly from the three villages of S.Yanam, Chirrayanam and Katrenikona. He also instructed the project authorities to assess the local infrastructure facilities required duly consulting the villagers. He informed to the public that the project authorities shall earmark 2% of profits under CSR for development of local villages. While concluding the public hearing, the Joint Collector, East Godavari District opined that most of the activities that are being taken up by the project authorities are not permanent and suggested the project authorities that giving the scholarships to merit children from all communities of this area may be more beneficial particularly to the individual, their families and as well as to the nation.

7.1.3 Responses provided by the Project Proponent during Public Consultation

- **Sri Srihari Prasad Reddy, Installation Manager, Vedanta Limited** while giving the reply to the quarries raised by the general public informed that there is no direct provision to give compensation/money to the families/ration cards. As per the company policy, developmental activities would be taken up duly consulting the village elders for improving the livelihood of the people of the villages. They have provision for developmental activities such as skill development, education under CSR activities. About 74% contract employment provided to the Andhra people only, out of which 51% employment from S.Yanam. Out of total 400 employees, only 71 people recruited from outside Andhra Pradesh. In the company employment, representation from Andhra is less, due to inexperience and requisite qualification in oil & gas exploration and also safety is the major concern.
- In this regard the representative of the Environmental Department informed that the company carrying its operations for the past 24 years and all the drilling operations, disposal of wastes everything is incompliance with the regulatory departments and specifically all the conditions stipulated in the Andhra Pradesh Pollution Control Board, Central Pollution Control Board clearances and they have been carried out their operations without causing any pollution problems in the surrounding areas and to the nearby people.
- Sri Srihari Prasad Reddy, Installation Manager, Vedanta Limited further informed that they have already provided employment to 295 locals from S.Yanam Village. He also informed that while carrying the drilling activity in Gatchikalayapuram and Chirrayanam villages, there is possibility of development in that area by way of local employment and CSR activities. He also informed that there are no specific conditions for recruiting security guards from local and non local people and contract would be given to private person for recruiting security guards only. He assured that they would specifically prefer locals while recruiting security guards. He also informed that as per the recommendations of the IB, only Ex. Service Man shall be taken as security guards, as it is a prohibited place. He also informed that there is no need to do the activities by causing water and chemical pollution. The company has been carrying its operations duly complying with all the pollution norms such as APPCB policies, MoEF&CC policies and correct action would be initiated if any pollution caused. He also assured that they would allocate CSR funds for implementation of

sage culture. Compensation was given to all the farmers from whom, lands acquired. Constructed PHC at S.Yanam Village and appointed 14Nos. of teachers to the school. A study was carried out by IIT (BHU) regarding land subsidence due to oil & gas exploration and it was reported that no land subsidence occurring due to oil & gas exploration. The existing schools would be developed under CSR activities. Two new RO plants already procured to replace the existing damaged RO plants in S.Yanam village so as to supply drinking water and also informed that one more RO plant sanctioned for Chirrayanam Village and possibilities of installation of RO plants at Gatchakalayapuram & Katrenikona would be examined. The project authorities would carry requisite repairs to the pipeline network supplying drinking water. They have been planning development of parks for the children. Funds would be allocated under CSR for repair of siphon on canal & drain.

7.1.4 Summary of Key Issues raised during Pubic Consultation and Responses by Project Proponent

A summary of the key issues raised during Pubic Consultation and responses/ clarifications/details provided by the Project Proponent: Vedanta Limited (Cairn Oil & Gas) are provided below.

S.N.	Issues Raised during the Public Consultation	Vedanta Limited's (Cairn Oil & Gas) -Clarifications/ Response/ Details Provided
1.	Provision for the supply of drinking water to the villages	Through CSR initiatives, Cairn (Oil & Gas) would support the District Administration in provision of clean drinking water to villages. Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up to provide clean and safe drinking water to ~ 6,000 people.
2.	Social Infrastructure Development like education, libraries, E-Centre (with provision of computers, internet), parks for walkers and children	Through CSR initiatives, Cairn (Oil & Gas) would support the District Administration in establishment of social infrastructure. Cairn (Oil & Gas) has established mini libraries, public health centres, RO Plants, community health centre, provided playing material/ equipment in nearby schools etc. besides laying of roads and other infrastructure facilities in S Yanam and Challapalli villages.
3.	Greenbelt development in the villages	Greenbelt development in villages would be taken up. Cairn (Oil & Gas) has developed greenbelt in > 35% (83 acre) of Ravva Terminal area. Cairn (Oil & Gas) is planting 3,000 well grown fruit bearing plants in S Yanam village through micro vendors in the community centre and public areas.
4.	Land subsidence concerns due to exploration of oil & gas causing earthquakes in the area	As per the order from Hon'ble HC, MoEF&CC constituted subcommittee assessed and reviewed (in 2009) the potential of Land Subsidence in the KG Basin region and concluded that there were no evidence of land subsidence concern. Land Subsidence study carried out by Cairn (Oil & Gas) through IIT-BHU during 2014-2016. No significant ground subsidence observed due to extraction of oil and gas in the area.
5.	Employment opportunities to the local people	Cairn (Oil & Gas) would continue CSR programs to support local livelihood and skill development. Cairn (Oil & Gas) would also continue to facilitate/ arrange "Job Mela" for the unemployed youth. Approximately, 430 local people out of 500 total employees are working at the Ravva Terminal.

S.N.	Issues Raised during the Public Consultation	Vedanta Limited's (Cairn Oil & Gas) -Clarifications/ Response/ Details Provided
6.	More CSR funds for sports, schools, hospitals, education, etc.	Impactful CSR programs implementation would be continued to support various thematic areas like, health, education, livelihood and skill development. For example, provisions of scholarship to the meritorious students, providing sports kits to schools.
7.	Pollution in the area due to drilling and operation	Cairn (Oil & Gas) would continue to implement environmental pollution prevention and control measures and would adhere to applicable environmental standards and guideline. Cairn (Oil & Gas) would ensure proper plugging and restoration of unsuccessful drill wells as and when required and before handing over the well pad site back to the landowners.
8.	Monthly allowance to the entire fishermen communities and agriculturalist	The proposed activities during site development, drilling and operation phases are not likely to cause any impact to fishing and agriculture activities. Thus, there is no provision to provide direct compensation to fishermen and agricultural communities.
9.	Fish death due to pollution and loss of sea food productivity	Cairn (Oil & Gas) has been carrying out its operations for past 25 years and all operations comply with environmental regulatory requirements. The Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam has carried out marine ecological study annually to monitor any adverse impact caused due to the operation of Cairn (Oil & Gas). The results indicate that no oil pollution or toxicity is found in the marine seawater due to Cairn's operation activity. The study will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC.
10.	Compensation for land-damage due to drilling activities	No onshore drilling activity has been carried out in past 10 years, thus no damage to the land has been caused due to onshore drilling activities.
11.	Public health problems	Cairn (Oil & Gas) been operating Cairn JV Charity Clinic through a tie up with Apollo Hospitals, Kakinada for last 25 years. No such health issues have been reported due to operations in Ravva Block.
12.	Canal repair	Cairn (Oil & Gas) on behalf of Ravva Joint Venture (the Company) is depositing INR 6.00 Crores annually to the State Government of Andhra Pradesh annually for community development works/projects. The district administration will duly consider about repair of the canal bund and may accordingly take up the work.
13	Resettlement and Rehabilitation	The onshore well pad are located in parcels of land, which does not involve any resettlement and rehabilitation.
14.	Maintenance of PHC	The PHC was handed over to the Government as per the requirement of local administration.
15.	Solar lights .	Cairn (Oil & Gas) has already provided 50 nos. of solar lights at S Yanam, Chirrayanam and Gatchakayalapuram

The Ravva JV remains committed to support community development works for the local community. The Ravva JV is currently contributing INR 6.0 Crore per year towards development of local community and reacted initiatives.

INR 5.0 Crore (appx.) is deposited with District Collector to facilitate community development works / projects. With this number of infrastructure projects / works have been executed in S. Yanam village and surrounding villages which include:

- Setting up of Potable water system (storage pond, filtration unit, over-head tanks, piping network covering houses)
- Construction of concrete roads, bridges
- Construction of hospital building (PHC), ambulance
- Installation of 50 solar lights etc.
- Provision of mini truck for the collection & disposal of waste as part of "Swatch Bharat" initiative

Recently, a "job mela" was arranged for unemployed youth in Amalapuram and more than 2,500 unemployed youth participated in this event.

INR 1.0 Cr (appx.) is being spent by Ravva JV towards supporting additional teachers in village schools as per the requirement of villagers (engaged through contractors), pension for widows and physically disabled persons (payment made to RDO), bus passes for students from local villages (through RTC), maintenance of RO plants & potable water plant. Also Ravva JV supports women empowerment programs, skill development program for unemployed youth etc.

As part of the aforesaid contribution, the Ravva JV will support the following CSR initiatives:

- Providing sports kits for all schools is already in progress. Creating Basket Ball, Volley Ball and Cricket Pitch along with required sports kits at all three villages by next six months of time (subjected to suitable land availability). (Already sanctioned play material for all S.Yanam schools and Anganwadis. 4 more schools in Katrenikona Mandal.
- Establishment of libraries with weekly & monthly magazines in all three villages in next six months. A total no 200 Mini Libraries supported to the Government Primary schools. Out of 200 Libraries 50 Libraries Distributed to Uppalaguptam Mandal and Katrenikona Mandal schools
- Providing sports kits for all schools is already in progress. Creating Basket Ball, Volley Ball and Cricket Pitch along with required sports kits at all three villages by next six months of time (subjected to suitable land availability). (Already sanctioned play material for all S.Yanam schools and Anganwadis. 4 more schools in Katrenikona Mandal.
- Establishment of libraries with weekly & monthly magazines in all three villages in next six months. A total no 200 Mini Libraries supported to the Government Primary schools. Out of 200 Libraries 50 Libraries Distributed to Uppalaguptam Mandai and Katrenikona Mandal schools
- Develop IT training Centers in each of three villages with computers for organizing training for the youth in basic use of the computers and internet by next 3 months.
- Develop parks with gravel walking tracks of 150-200 m length, Grass, sprinkler system Subjected to land availability this will be completed within 9 Months of time.
- Develop parks with gravel walking tracks of 150-200 m length, Grass, sprinkler system. Subjected to land availability this will be completed within 9 Months of time. Development of green belt in the villages with green cover by planting 5,000 saplings in next 12 months.(Already contract awarded to local vendor for 2100 well grown fruit bearing plants and Tree Guards.
- Proper plugging of unsuccessful drill holes and restoration of unsuccessful well sites, as and when required and before the handing over of the site back to land owners.
- Supporting the District administration in provision of clean drinking water to the villages. Two RO Plants replaced in S.Yanam and one new RO plant sanctioned for Chirrayanam village
- Provide scholarships to the meritorious students of affected villages (Scheme for criteria, scholarship amount and quantity will be formalized with coordination with DA), by next six months.
- Carry out an assessment of infrastructure development projects to be undertaken in the effected villages. Survey of S. Yanam village has already carried out through Smart Village Foundation of AP and survey of other two villages will be carried out by next six months.

- Provision of 50 Nos of solar lights for S.Yanam, Chirrayanam and Gachakayalapora villages.

The Ravva JV has already provided official commitment on afore mentioned CSR activities to the District Authorities vide letter no. RV/18/IM/DC/154 (dated 23rd October 2018) to the Joint Collector and Addl. District Magistrate of East Godavari District (refer to ***Annex 22 of EIA Volume 2***).

Note: Detailed Action Plan with budget on issues raised during Public Hearing are included in Table 9.3 in the EMP Section

7.2 ADDITIONAL STUDIES - RISK ASSESSMENT

7.2.1 Risk Assessment for Onshore Activity

This section on Quantitative Risk Assessment (QRA) aims to provide a systematic analysis of the major risks that may arise from **onshore** 10 exploratory and 23 development wells drilling and laying of oil and gas pipeline in Ravva Block. The QRA process outlines rational evaluations of the identified risks based on their significance and provides the outline for appropriate preventive and risk mitigation measures. Results of the QRA provides valuable inputs into the overall project planning and the decision making process for effectively addressing the identified risks. This will ensure that the project risks stay below As Low as Reasonably Practicable (ALARP) levels at all times during project implementation. In addition, the QRA will also help in assessing risks arising from potential emergency situations like a blow out and develop a structured Emergency Response Plan (ERP) to restrict damage to personnel, infrastructure and the environment.

The risk study for the onshore drilling and testing activities has considered all aspects of operation of the drilling rig and other associated activities during the exploratory/development phase. Loss of well control / blow-out and process/pipeline leaks constitute the major potential hazards that may be associated with the proposed onshore development and production of oil and natural gas at the identified well locations within the Ravva Block.

The following section describes objectives, methodology of the risk assessment study and then presents the assessment for each of the potential risk separately. This includes identification of major hazards, hazard screening and ranking, frequency and consequence analysis for major hazards. The hazards have subsequently been quantitatively evaluated through a criteria based risk evaluation matrix. Risk mitigation measures to reduce significant risks to acceptable levels have also been recommended as a part of the risk assessment study.

Objective of the QRA Study

The overall objective of this QRA with respect to the proposed project involves identification and evaluation of major risks, prioritizing risks identified based on their hazard consequences and formulating suitable risk reduction/mitigation measures in line with the ALARP principle. Hence in order to ensure effective management of any emergency situations (with potential individual and societal risks) that may arise during the development drilling activities, following specific objectives need to be achieved.

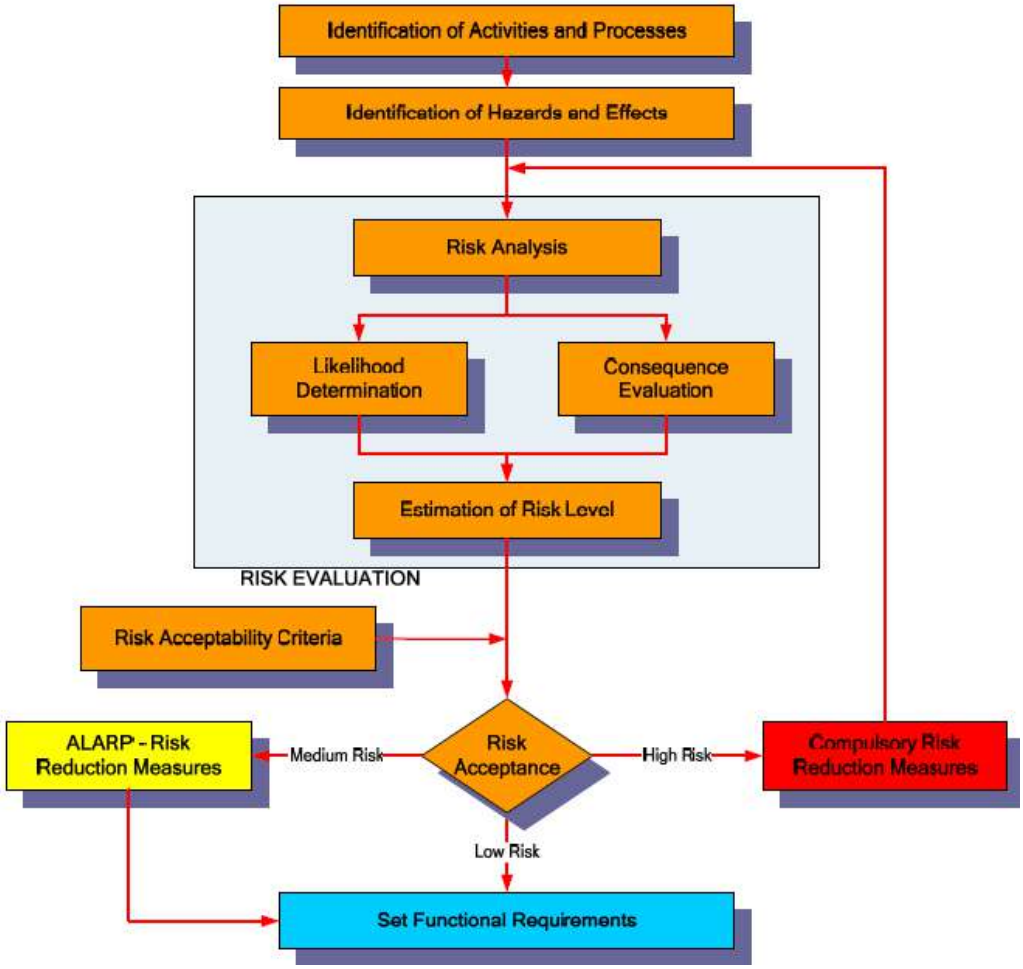
- Identify potential risk scenarios that may arise out of proposed development well drilling, operations of GCS, trunk and assorted oil and gas pipelines and associated equipment's, mud chemicals storage and handling etc.
- Analyse the possible likelihood and frequency of such risk scenarios by reviewing historical accident related data for onshore oil and gas industries.
- Predict the consequences of such potential risk scenarios and if consequences are high, establish the same by through application of quantitative simulations.
- Recommend feasible preventive and risk mitigation measures as well as provide inputs for drawing up of Emergency Management Plan (EMP) for the Project.

Risk Assessment Methodology

The risk assessment process is primarily based on likelihood of occurrence of the risks identified and their possible hazard consequences particularly being evaluated through hypothetical accident scenarios. With respect to the proposed Project, major risks viz. blow outs, pipeline and process leaks, non-process fires etc. have been assessed and evaluated through a risk matrix generated to combine the risk severity and likelihood factor. Risk associated with the well exploration and development activities have been determined semi-quantitatively as the product of likelihood/probability and severity/consequence by using order of magnitude data (risk ranking = severity/consequence factor x likelihood/probability factor). Significance of such project related risks was then established through their classification as high, medium, low, very low depending upon risk ranking.

The risk matrix is a widely accepted as standardized method of quantitative risk assessment and is preferred over purely quantitative methods, given that its inherent limitations to define a risk event is certain. Application of this tool has resulted in the prioritization of the potential risks events for the drilling activity thus providing the basis for drawing up risk mitigation measures and leading to formulation of plans for risk and emergency management. The overall approach is summarized in the ***Figure 7.1***.

Figure 7.1 Risk Assessment Methodology



Hazard Identification

Hazard identification for the purposes of this QRA comprised of a review of the Project and associated activity related information provided by Vedanta Ltd (Cairn Oil & Gas). In addition, guidance provided by knowledge platforms/portals of the upstream oil & gas industry including OGP, ITOPF, EGIG and DNV, Norwegian Petroleum Directorate etc. are used to identify potential hazards that can arise out of proposed Project activities. Taking into account the applicability of different risk aspects in context of the development drilling operations to be undertaken in the identified well locations, there are three major categories of hazards that can be associated with proposed Project which has been dealt with in detail. This includes:

- Blowouts leading to uncontrolled well flow, jet fires, pool fires;
- Non-process fires / explosions, the release of a dangerous substance or any other event resulting from a work activity which could result in death or serious injury to people within the site;
- Leaks from GCS, interconnecting pipeline network/trunk pipeline leading to jet fire; and
- Any event which may result in major damage to the structure of the rig

Well control incident covers a range of events which have the potential of leading to blow-outs but are generally controlled by necessary technological interventions. Hence, such incidents are considered of minor consequences and as a result not well documented. Other possible

hazard scenarios like mud chemical spills, falls, etc. has also not been considered for detailed assessment as preliminary evaluation has indicated that the overall risk that may arise out of them would be low. In addition, it is understood that, causative factors and mitigation measures for such events can be adequately taken care of through exiting safety management procedures and practices of Vedanta Ltd (Cairn Oil & Gas).

It must also be noted here that many hazards identified are sometimes interrelated with one hazard often having the ability to trigger off another hazard through a domino effect. For example, a large oil spill in most instances is caused by another hazardous incident like a blowout or process leak. This aspect has been considered while drawing up hazard mitigation measures and such linkages (between hazards) has also been given due importance for managing hazards and associated risks in a composite manner through Vedanta Ltd (Cairn Oil & Gas)'s Health, Safety & Environmental Management System (HSEMS) and through the Emergency Management Plan, if a contingency situation so arises.

Frequency Analysis

Frequency analysis involves estimating the likelihood of each of the failure cases identified during the hazard identification stage. The analysis of frequencies of occurrences for the key hazards that has been listed out is important to assess the likelihood of such hazards to actually unfold during the lifecycle of the project. The frequency analysis approach for the proposed Project is based primarily on historical accident frequency data, event tree analysis and judgmental evaluation. Major oil and gas industry information sources viz. statistical data, historical records and global industry experience were considered during the frequency analysis of the major identified risks[1].

For QRA for the proposed Project, various accident statistics and published oil industry databases have been consulted for arriving at probable frequencies of identified hazards. However, taking into account the absence of representative historical data/statistics with respect to onshore operations[2], relevant offshore accident databases have been considered in the frequency analysis of identified hazards. The same has been recommended in the "*Risk Assessment Data Directory" published by the International Association of Oil & Gas Producers (OGP). Key databases/reports referred as part of the QRA study includes Worldwide Offshore Accident Databank (WOAD), Outer Continental Shelf (OCS) Reports, Norwegian Petroleum Directorate Directives, Offshore Reliability Data (OREDA) Handbook, HSE Offshore Incident Database, SINTEF Offshore Blowout Database etc*.

Based on the range of probabilities arrived at for different potential hazards that may be encountered during the proposed well development activities, following criteria for likelihood rankings have been drawn up as presented in the ***Table 7.1***.

[1]It is to be noted that the frequency of occurrences are usually obtained by a combination of component probabilities derived on basis of reliability data and /or statistical analysis of historical data.

[2]Although Alberta Energy & Utilities Board (EUB) maintains a database for onshore incidents for the period 1975-1990 the same has not been considered in the context of the present study as the Alberta wells are believed to be sour with precaution being taken accordingly to minimize the likelihood of release

Table 7.1 Frequency Categories and Criteria

Likelihood Ranking	Criteria Ranking (cases/year)	Frequency Class
5	>1.0	Frequent
4	$>10^{-1}$ to <1.0	Probable
3	$>10^{-3}$ to $<10^{-1}$	Occasional/Rare
2	$>10^{-5}$ to $<10^{-3}$	Not Likely
1	$>10^{-6}$ to $<10^{-5}$	Improbable

Consequence Analysis

In parallel to frequency analysis, hazard prediction / consequence analysis exercise assesses resulting effects in instances when accidents occur and their likely impact on project personnel, infrastructure and environment. In relation to the proposed Project, estimation of consequences for each possible event has been based either on accident experience, consequence modelling or professional judgment, as appropriate.

Given the high risk perception associated with blow outs in context of onshore drilling operation, a detailed analysis of consequences has been undertaken for blow outs taking into account physical factors and technological interventions. Consequences of such accidental events on the physical, biological and socio-economic environment have been studied to evaluate the potential of the identified risks/hazards. In all, the consequence analysis takes into account the following aspects:

- Nature of impact on environment and community;
- Occupational health and safety;
- Asset and property damage;
- Corporate image
- Timeline for restoration of environmental and property damage
- Restoration cost for environmental and property damage.

The following criterion for consequence rankings (***Table 7.2***) is drawn up in context of the possible consequences of risk events that may occur during proposed well development activities:

Table 7.2 Severity Categories and Criteria

Consequence	Ranking	Criteria Definition
Catastrophic	5	▪ Multiple fatalities/Permanent total disability to more than 50 persons ▪ Severe violations of national limits for environmental emission ▪ More than 5 years for natural recovery ▪ Net negative financial impact of >10 crores ▪ Long term impact on ecologically sensitive areas ▪ International media coverage ▪ National stakeholder concern and media coverage
Major	4	▪ Single fatality/permanent total disability to one or more persons ▪ Major violations of national limits for environmental emissions ▪ 2-5 years for natural recovery ▪ Net negative financial impact of 5 -10 crores ▪ Significant impact on endangered and threatened floral and faunal species ▪ Loss of corporate image and reputation
Moderate	3	▪ Short term hospitalization & rehabilitation leading to recovery ▪ Short term violations of national limits for environmental emissions ▪ 1-2 years for natural recovery ▪ Net negative financial impact of 1-5 crores ▪ Short term impact on protected natural habitats ▪ State wide media coverage
Minor	2	▪ Medical treatment injuries ▪ 1 year for natural recovery ▪ Net negative financial impact of 0.5 - 1 crore ▪ Temporary environmental impacts which can be mitigated ▪ Local stakeholder concern and public attention
Insignificant	1	▪ First Aid treatment with no Lost Time Incidents (LTIs) ▪ Natural recovery < 1year ▪ Net negative financial impact of <0.5 crores. ▪ No significant impact on environmental components ▪ No media coverage

Risk Evaluation

Based on ranking of likelihood and frequencies, each identified hazard has been evaluated based on the likelihood of occurrence and the magnitude of consequences. Significance of risks is expressed as the product of likelihood and consequence of the risk event, expressed as follows:

Significance = Likelihood X Consequence

The ***Table 7.3*** below illustrates all possible product results for five likelihood and consequence categories while the
Table 7.4 assigns risk significance criteria in four regions that identify the limit of risk acceptability. Depending on the position of intersection of a column with a row in the risk matrix, hazard prone activities have been classified as low, medium and high thereby qualifying a set of risk reduction / mitigation strategies.

Table 7.3 Risk Matrix

Consequence ↑			Likelihood →				
			Frequent	Probable	Remote	Not Likely	Improbable
			5	4	3	2	1
	Catastrophic	5	25	20	15	10	5
	Major	4	20	16	12	8	4
	Moderate	3	15	12	9	6	3
	Minor	2	10	8	6	4	2
	Insignificant	1	5	4	3	2	1

Table 7.4 Risk Criteria and Action Requirements

Risk Significance	Criteria Definition & Action Requirements
High (16 - 25)	**"Risk requires attention"** – Project HSE Management need to ensure that necessary mitigation are adopted to ensure that possible risk remains within acceptable limits
Medium (10 – 15)	**"Risk is tolerable"** – Project HSE Management needs to adopt necessary measures to prevent any change/modification of existing risk controls and ensure implementation of all practicable controls.
Low (5 – 9)	**"Risk is acceptable" –** Project related risks are managed by well-established controls and routine processes/procedures. Implementation of additional controls can be considered.
Very Low (1 – 4)	**"Risk is acceptable" –** All risks are managed by well-established controls and routine processes/procedures. Additional risk controls need not to be considered

Risk Assessment of Identified Project Hazards

As already discussed in the previous section, three major categories risk have identified in relation to proposed development drilling activities. A comprehensive risk assessment study has been undertaken to assess and evaluate significance of identified risks in terms of severity of consequences and likelihood of occurrence.

Risk assessment study details have been summarized in the subsequent sections below:
A) Blow Outs / Loss of Well Control

Blow out is an uncontrolled release of well fluid (primarily hydrocarbons viz. oil and/or gas and may also include drilling mud, completion fluid, water etc.) from an exploratory or development well. Blow outs are the result of failure to control a kick and regain pressure control and are typically caused by equipment failure or human error. The possible blow out cause events occurring in isolation or in combination have been listed below:

- Formation fluid entry into well bore;
- Loss of containment due to malfunction (viz. wire lining);
- Well head damage (e.g. by fires, storms, dropped object etc.); and
- Rig forced off station (e.g. by anchor failure) damaging Blow Out Preventer (BOP) or wellhead.

The most common cause of blow out can be associated with the sudden/unexpected entry/release of formation fluid into well bore that may arise as a result of the following events as discussed in the ***Box 7.1*** below:

Box 7.1 Primary Causes of Blow Outs

Shallow gas
In shallow formations there may be pockets of shallow gas. In these instances there is often insufficient mud density in the well and no BOP is in place. If the hole strikes shallow gas the gas may be released on the drilling rig very rapidly. Typical geological features which suggest the presence of shallow gas can then be detected. Historically, striking of shallow gas has been one of the most frequent causes of blowouts in drilling.

Swabbing
As the drill pipe is pulled upwards during trips out of the hole or upward movement of the drill string, the pressure in the hole beneath the drill bit is reduced, creating a suction effect. Sufficient drilling mud must be pumped down-hole to compensate for this effect or well fluids may enter the bore. Swabbing is also a frequent cause of drilling blowouts.

High formation pressure
Drilling into an unexpected zone of high pressure may allow formation fluids to enter the well before mud weight can be increased to prevent it.

Insufficient mud weight
The primary method of well control is the use of drilling mud; in correct operation, the hydrostatic pressure exerted by the mud prevents well fluids from entering the well bore. A high mud weight provides safety against well fluids in-flows. However, a high mud weight reduces drilling speed, therefore, mud weight is calculated to establish weight most suitable to safely control anticipated formation pressures and allows optimum rates of penetration. If the required mud weight is incorrectly calculated then well fluid may be able to enter the bore.

Lost Circulation
Drilling mud circulation can be lost if mud enters a permeable formation instead of returning to the rig. This reduces the hydrostatic pressures exerted by the mud throughout the well bore, and may allow well fluids from another formation to enter the bore.

Gas cut mud
Drilling fluids are denser than well fluids; this density is required to provide the hydrostatic pressure which prevents well fluids from entering the bore. If well fluids mix with the mud then its density will be reduced. As mud is circulated back to surface, hydrostatic pressure exerted by the mud column is reduced. Once gas reaches surface it is released into the atmosphere.

Source: A Guide to Quantitative Risk Assessment for Offshore Installations; John Spouge – DNV Technical Publication 99/100a

For better understanding, causes of blow outs have been systematically defined in terms of loss of pressure control (failure of primary barrier), uncontrolled flow of fluid or failure of secondary barrier (BOP). The blow out incidents resulting from primary and secondary failures for proposed operations as obtained through comprehensive root cause analysis of the Gulf Coast (Texas, OCS and US Gulf of Mexico) Blow Outs[1] during 1960-1996 have been presented in the ***Table 7.5***.

Table 7.5 Blow Out Cause Distribution for Failures during Drilling Operations

Sl. No.	Causal Factors	Blow Out Incidents (Nos.)
A.	**Primary Barrier**	
1	Swabbing	77
2	Drilling Break	52
3	Formation breakdown	38

[1] "Trends extracted from 1200 Gulf Coast blowouts during 1960-1996" – Pal Skalle and A.L Podio

Sl. No.	Causal Factors	Blow Out Incidents (Nos.)
4	Trapped/expanding gas	09
5	Gas cut mud	26
6	Low mud weight	17
7	Wellhead failure	05
8	Cement setting	05
B.	**Secondary Barrier**	
1	Failure to close BOP	07
2	Failure of BOP after closure	13
3	BOP not in place	10
4	Fracture at casing shoe	03
5	Failure to stab string valve	09
6	Casing leakage	06

Thus, underlying blowout causes as discussed in the above table can be primarily attributed to swabbing as the primary barrier failure which is indicative of insufficient attention given to trip margin and controlling pipe movement speed. Also, it is evident from the above table that lack of proper maintenance, operational failures and absence of BOPs as secondary barrier contributed to majority of blowout incidents (approx.. 30 nos.) is recorded.

Blowout Frequency Analysis

Blow out frequency estimates is obtained from a combination of incident experience and associated exposure in a given area over a given period. For the purpose of calculation of blow out frequency analysis in context of the present study involving developmental drilling, blow out frequencies per well drilled have been considered.

The blowout frequencies presented in this report are extracted from the latest revision of the Scandpower[1] report and are presented in ***Table 7.6***. The blowout probability is determined from blowouts in the North Sea. (i.e. British, Dutch and Norwegian sectors) given comparable data for onshore operations are not readily available.

Table 7.6 Blow Out Frequencies Recommended per Drilled Well

Drilling Operation	Well Category	Frequency, gas well	Frequency, oil well
Exploration	Normal	1.12E-04	1.23E-04
Wild Cat	Normal	9.70E-05	1.17E-04
Appraisal	Normal	1.07E-04	1.30E-04
Development	Normal	2.16E-05	2.62E-05

Based on the aforesaid frequency and information provided by Vedanta Ltd (Cairn Oil & Gas) the blow out frequency for the proposed project has been computed as follows:

No of onshore wells to be drilled per year = 5 exploratory & 5 developmental (A)

Blow out frequency for exploratory drilling (oil) = 1.12×10^{-4} per well drilled (B)

Blow out frequency for exploratory drilling (gas) = 1.23×10^{-4} per well drilled (C)

[1] "Blowout and Well Release Frequencies" - Based on SINTEF Offshore Blowout Database 2010, Report, Scandpower Risk Management. Report no. 19.101.001-3009/2011/R3, 05.04.2011.

Blow out frequency for development drilling (oil) = 2.62 x 10^{-5} per well drilled (D)

Blow out frequency for development drilling (gas) = 2.16 x 10^{-5} per well drilled (E)

Frequency of blow out occurrence for exploration (oil) = (A x B) = 5 x 1.12 x 10^{-4}
= 5.60 X 10^{-4} per well drilled

Frequency of blow out occurrence for exploration (gas) = (A x C) = 5 x 1.23 x 10^{-4}
= 6.15 X 10^{-4} per well drilled
Frequency of blow out occurrence for development (oil) = (A X D) = 5 x 2.62 x 10^{-5}
= 1.31 X 10^{-4} per well drilled

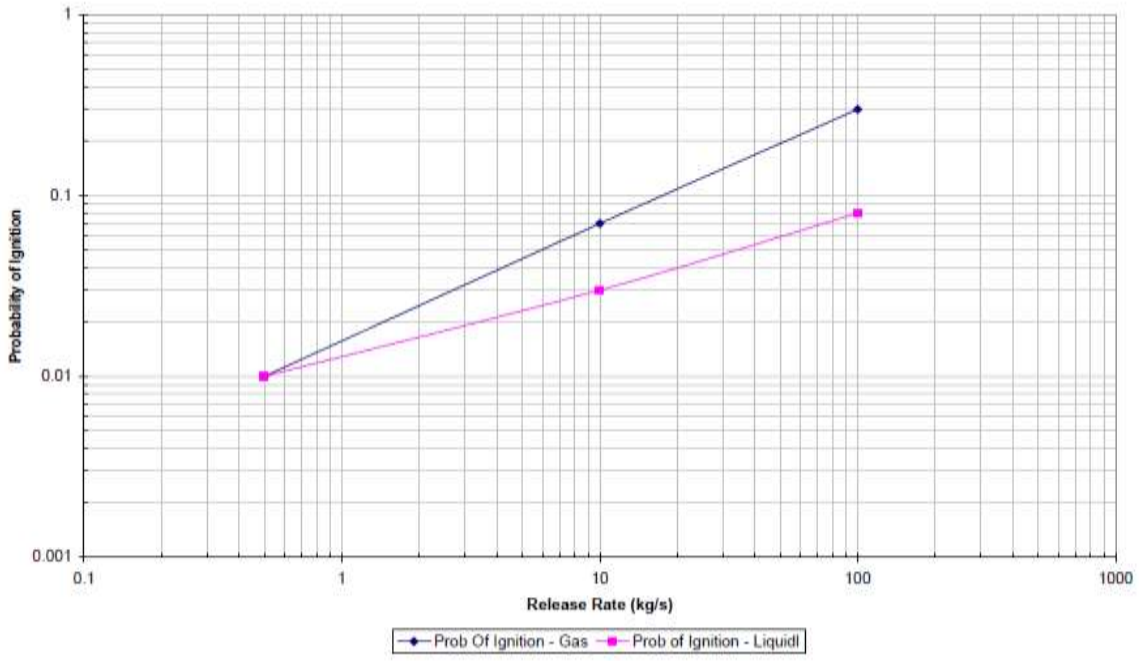
Frequency of blow out occurrence for development (gas) = (A X E) = 5 x 2.16 x 10^{-5}
= 1.08 X 10^{-4} per well drilled

Thus, the blow out frequency for the proposed project for both exploratory and development oil and gas wells have been identified to be as **"Not Likely**"

Blowout Ignition Probability

Review of SINTEF database indicates that a rounded ignition probability of 0.3 has been widely used for the purpose of quantitative risk analysis arising from blow outs. As per this database generally ignition occurred within first 5 minutes in approximately 40% of the blowouts leading to either pool and/or jet fire. Blow out leading to flammable gas release has a greater probability of ignition compared to liquid releases[1] (***Figure 7.2***).

Figure 7.2 ***Ignition Probability Vs Release Rate***



[1]Fire and Explosion – Fire Risk Analysis by Daejun Change, Division of Ocean System and Engineering

An alternative to the blowout ignition probabilities given by the UKOOA look-up correlations can be obtained from Scandpowers's interpretation of the blowout data provided by SINTEF 2. The most significant category is that for deep blowouts which indicates an early ignition probability of 0.09. For the purpose of the QRA study this can be taken as occurring immediately on release and calculation provided below:

No of onshore wells to be drilled per year = 5 (A) exploratory & 5 developmental
Blow out frequency for exploratory drilling (oil) = 1.12×10^{-4} per well drilled (B)

Blow out frequency for exploratory drilling (gas) = 1.23×10^{-4} per well drilled (C)

Blow out frequency for development drilling (oil) = 2.62×10^{-5} per well drilled (D)

Blow out frequency for development drilling (gas) = 2.16×10^{-5} per well drilled (E)

Blow out ignition probability = 0.09 (F)

Probability of Blow out ignition for exploration (oil) = (A x B x F) = $5 \times 1.12 \times 10^{-4} \times 0.09$
$= 0.50 \times 10^{-4} = \sim 0.005\%$

Probability of Blow out ignition for exploration (gas) = (A x C x F) = $5 \times 1.23 \times 10^{-4} \times 0.09$
$= 0.55 \times 10^{-4} = \sim 0.005\%$
Probability of Blow out ignition for development (oil) = (A x D x F) = $5 \times 2.62 \times 10^{-5} \times 0.09$
$= 1.17 \times 10^{-5} = \sim 0.001\%$

Probability of Blow out ignition for development (gas) = (A x E x F) = $5 \times 2.16 \times 10^{-5} \times 0.09$
$= 0.97 \times 10^{-5} = \sim 0.0009\%$

Hence, based on the aforesaid calculation the probability of ignition of blow out releases of hydrocarbons for the proposed development project for both oil and gas is found to range within ~0.0009% and 0.005% and therefore can be considered to be as negligible.

Blowout Consequence Analysis

Blow out from a hydrocarbon development wells may lead to the following possible risk consequences:

a. Jet fires resulting from ignited gas blow outs; and
b. Oil slicks resulting from un-ignited oil pools.

Pool fire

A pool fire is a turbulent diffusion fire burning above a pool of vaporizing hydrocarbon fuel where the fuel vapor has negligible initial momentum. The probability of occurrence of pool fires for oil and gas exploration is high due to continuous handling of heavy hydrocarbons. The evaporation of hydrocarbons from a pool forms a cloud of vapor above the pool surface which, on ignition, leads to generation of pool fire.

For the purpose of consequence modeling for pool fires resulting from blow outs, following hypothetical scenarios in terms of hydrocarbon (particularly crude oil) release rates (***Table 7.7***) have been considered based on DNV Technica's FLARE program.

Table 7.7 Pool Fire Modelling Scenario

Scenario	*Release Rate (kg/s)*	*Release Type*
Scenario - I	1	Small
Scenario - II	10	Medium
Scenario – III (Worst Case)	50	Large

The release rates as specified for the aforesaid scenarios have been utilized in the computing the pool fire diameter utilizing the following equation and input parameters:

$D = \sqrt{4Q/\pi b}$

Where D = pool diameter (m)

Q = release rate (kg/s)

b = burning rate (kg/m^2s)

The mass burning rate for crude oil has been considered to be 0.05 kg/m^2s. Based on above equation, the pool fire diameter and the steady study burning areas computed for various release types have been presented in the ***Table 7.8*** below.

Table 7.8 Pool Fire Diameter & Steady State Burning Scenario

Scenario	*Release Rate (kg/s)*	*Release Type*	*Pool fire diameter (m)*	*Steady State Burning Area (m^2)*
Scenario - I	1	Small	5.05	6.37
Scenario - II	10	Medium	15.96	63.69
Scenario - III	50	Large	35.69	318.47

The impact zone for long duration fires is conveniently described by thermal radiation contours and its effects on the people who are exposed to such radiation levels for one minute (60sec). The thermal radiation threshold values (measured in kilowatts per square meter) defined for crude oil pool fire consequence modeling is provided in ***Table 7.9*** below:

Table 7.9 Thermal Radiation Intensity Threshold Values Impact Criterion

Threshold Radiation Intensity	*Threat Zone*	*Impact Criterion*
5.0 kW/m^2	**Green**	▪ Escape actions within one minute. ▪ Cause second degree burns within 60 sec.
12.5 kW/m^2	**Blue**	▪ Escape actions lasting for few seconds. ▪ Cause second degree burns within 40 sec.
37.5 kW/m^2	**Red**	▪ Results in immediate fatality. ▪ Pain threshold is instantaneous leading to second degree burns within 8 sec.

For estimating the distance to a pool fire heat radiation level that could cause second degree burns and fatality for a maximum exposure of 60 sec the following EPA equation and input parameters are utilized.

$$X = H_c \sqrt{\frac{0.0001\,A}{5000\,\Pi\,(H_v + C_p\,(T_B - T_A))}}$$

Where:

X = distance to the heat radiation level (m)
HC = heat of combustion of the flammable liquid (joules/kg)
HV = heat of vaporization of the flammable liquid (joules/kg)
A = pool area (m^2)
CP = liquid heat capacity (joules/kg-^oK)
TB = boiling temperature of the liquid (^oK)
TA = ambient temperature (^oK)

For crude oil **HC = 42,600,000 joules/kg; HV = 957,144 joules/kg; CP = 1,892 joules/kg-°K; TB = 633 °K** and **TA = 300 °K.** The following input parameter along with pool area (m^2) computed for blow out risk scenarios provided the distance to the threshold heat radiation levels for the threat zones and have been presented in ***Table 7.10.***

Table 7.10 Distance to Thermal Radiation Threshold Levels

Release Type	*Pool fire diameter (m)*	*Pool fire area (m^2)*	*Distance to 5.0 kW/m^2 (m)*	*Distance to 12.5 kW/m^2 (m)*	*Distance to 37.5 kW/m^2 (m)*
Small	5.05	6.37	6.81	4.31	2.49
Medium	15.96	63.69	21.54	13.62	7.86
Large	35.69	318.47	48.16	30.46	17.59

The worst hazard for release and ignition of crude oil at a rate of **50kg/s** for a thermal radiation intensity of **37.5 kW/m^2** is likely to be experienced to a maximum distance of **17.59m** from the source with potential lethal effects experienced within 8 sec.

Risk Ranking – Blowout Pool Fire (Worst Case Scenario)

Likelihood ranking	**3**	**Consequence ranking**	**4**
Risk Ranking & Significance = 12 i.e. "Medium" i.e. Risk is Tolerable and can be managed through adoption of necessary controls.			

Ignition of Flammable Gas Release leading to Jet Fire

Jet fires are burning jet of gas or sprays of atomized liquids resulting from gas and condensate release from high pressure equipment and blow outs. Jet fires may also result in the release of high pressure liquid containing dissolved gas due to gas flashing off and turning the liquid into a spray of small droplets. In context of the present study, formation of jet fires can be attributed by the high pressure release and ignition of natural gas if encountered during exploration of block hydrocarbon reserves.

Natural gas as recovered from underground deposits primarily contains methane (CH_4) as a flammable component, but it also contains heavier gaseous hydrocarbons such as ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}). Other gases such as CO_2, nitrogen and hydrogen sulfide (H_2S) are also often present. Methane is typically 90 percent, ethane 5-15 percent, propane and butane, up to 5 percent. Thus, considering higher percentage of methane in natural gas, the thermo-chemical properties of the same has been utilized in the jet fire blow out consequence modelling. The following risk scenarios (***Table 7.11***) have been considered for nature gas release consequence modelling:

Table 7.11 Natural Gas Release Modelling Scenario

Scenario	Release Rate (kg/s)	Release Type
Scenario - I	1	Small
Scenario - II	5	Medium
Scenario – III (Worst Case)	10	Large

The modelling of nature gas releases has been carried out using ALOHA. A Flammable Level of Concern approach has been utilized for assessing safety risk associated with the release of flammable gases (here methane) from well blow outs. In ALOHA, a flammable Level of Concern (LOC) is a threshold concentration of fuel in the air above which a flammability hazard may exist. While modelling the release of a flammable gas that may catch fire—but which is not currently burning—ALOHA can predict the flammable area of the vapour cloud so that flammability hazard can be established.

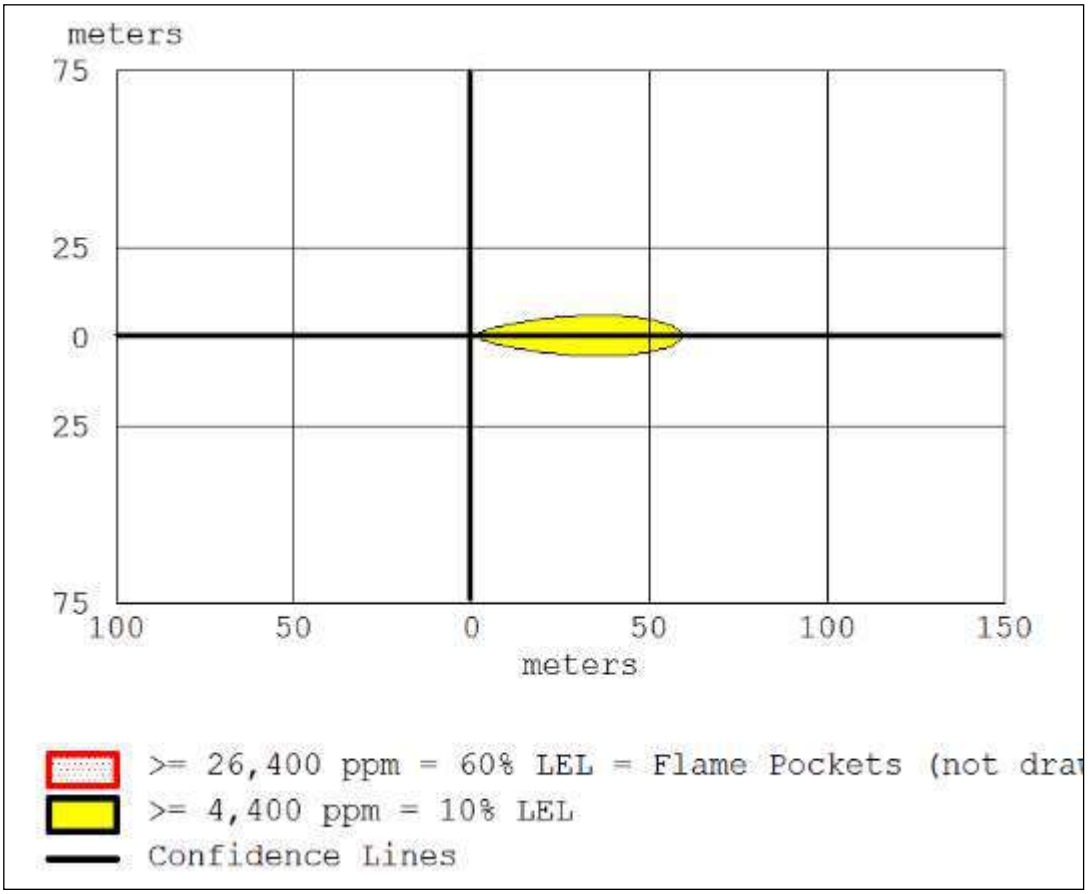
The flammable area is the part of a flammable vapor cloud where the concentration is in the flammable range, between the Lower and Upper Explosive Limits (LEL and UEL). These limits are percentages that represent the concentration of the fuel (that is, the chemical vapor) in the air. If the chemical vapor comes into contact with an ignition source (such as a spark), it will burn only if its fuel-air concentration is between the LEL and the UEL—because that portion of the cloud is already pre-mixed to the right mixture of fuel and air for burning to occur. If the fuel-air concentration is below the LEL, there is not enough fuel in the air to sustain a fire or an explosion—it is too lean. If the fuel-air concentration is above the UEL, there is not enough oxygen to sustain a fire or an explosion because there is too much fuel—it is too rich.

When a flammable vapor cloud is dispersing, the concentration of fuel in the air is not uniform; there will be areas where the concentration is higher than the average and areas where the concentration is lower than the average. This is called concentration patchiness. Because of concentration patchiness, there will be areas (called pockets) where the chemical is in the flammable range even though the average concentration has fallen below the LEL. Because of this, ALOHA's default flammable LOCs are each a fraction of the LEL, rather than the LEL itself. ALOHA uses 60% of the LEL as the default LOC for the red threat zone, because some experiments have shown that flame pockets can occur in places where the average concentration is above that level. Another common threat level used by responders is 10% of the LEL, which is ALOHA's default LOC for the yellow threat zone. The flammable LOC threat zones for methane release are as follows:

Red : 26,400 ppm = 60% LEL = Flame Pockets
Yellow: 4,400 ppm = 10% LEL

Well site risk contour maps for worst case scenario prepared based on ALOHA modeling of natural gas releases for flammable vapour cloud has been presented in **Figure 7.3 - Figure 7.5** below.

Figure 7.3 Scenario I: Risk Contour Map



THREAT ZONE:

Threat Modelled: Flammable Area of Vapor Cloud

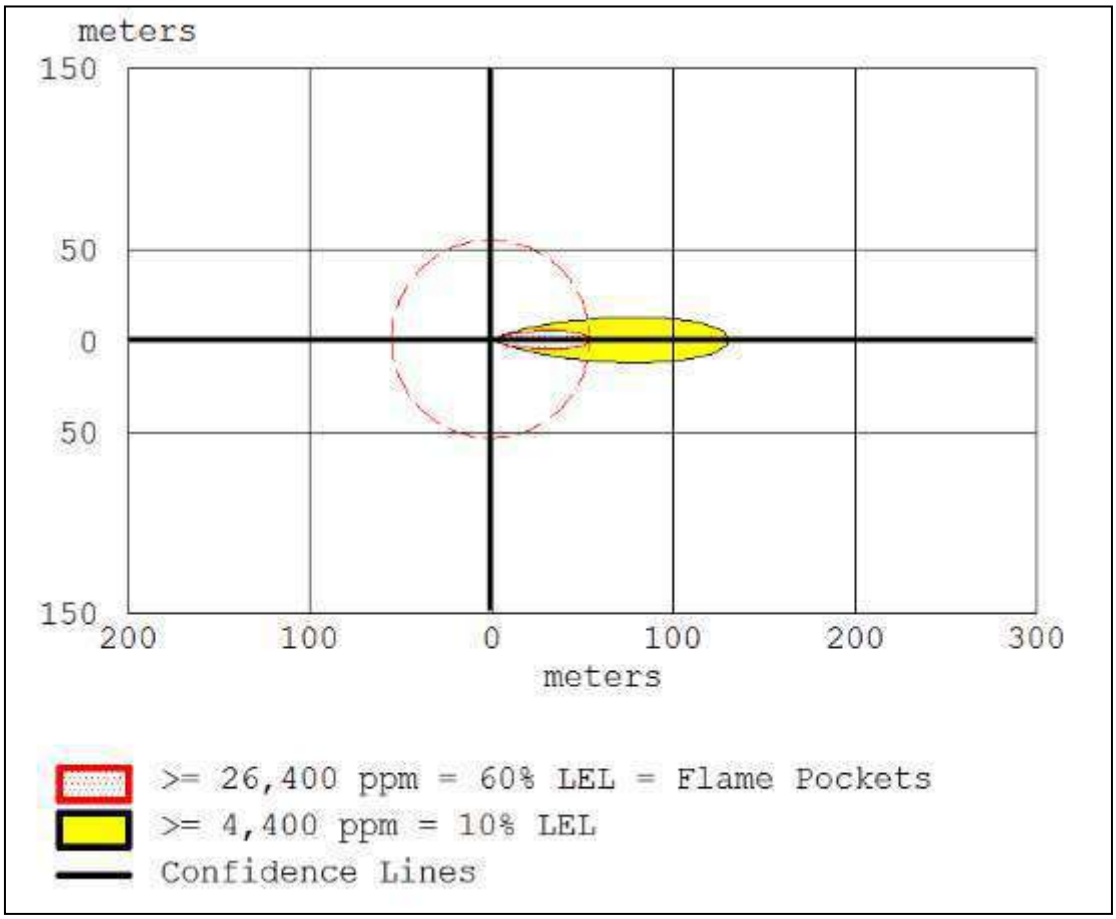
Model Run: Gaussian

Red : 25 meters --- (26,400 ppm = 60% LEL = Flame Pockets)

Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.

Yellow: 60 meters --- (4,400 ppm = 10% LEL)

Figure 7.4 Scenario II: Risk Contour Map



THREAT ZONE:

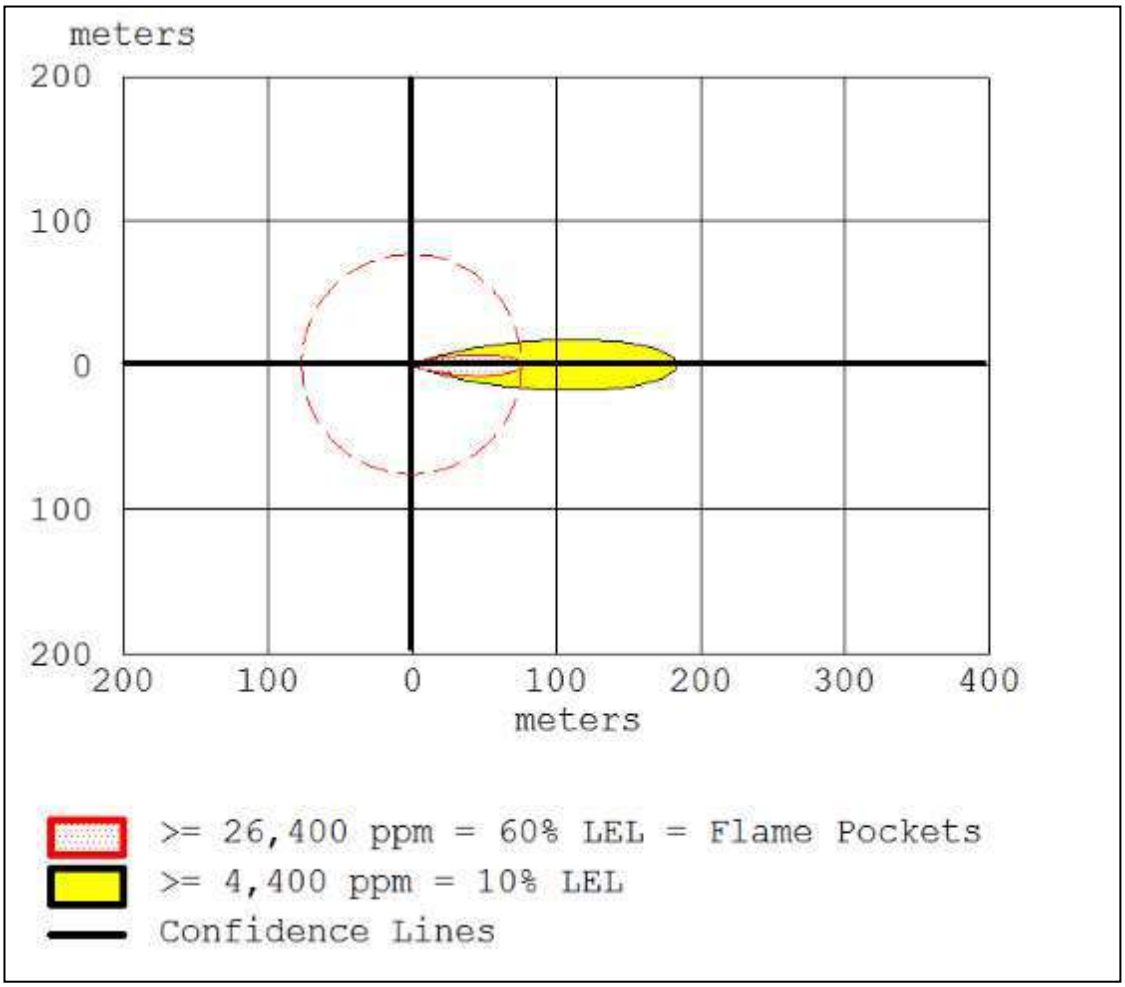
Threat Modeled: Flammable Area of Vapor Cloud

Model Run: Gaussian

Red : 55 meters --- (26,400 ppm = 60% LEL = Flame Pockets)

Yellow: 131 meters --- (4,400 ppm = 10% LEL)

Figure 7.5 Scenario III: Risk Contour Map



THREAT ZONE:

Threat Modeled: Flammable Area of Vapor Cloud

Model Run: Gaussian

Red : 77 meters --- (26,400 ppm = 60% LEL = Flame Pockets)

Yellow: 183 meters --- (4,400 ppm = 10% LEL)

The zone of flammable vapour cloud calculated for hypothetical natural gas release under risk scenarios discussed in the earlier sections have been presented in the ***Table 7.12*** below.

Table 7.12 Zone of Flammable Vapour Cloud-Natural Gas Release Scenarion

Release Type	Release Rate (kg/s)	Red -60% LEL (m)	Yellow -10% LEL (m)
Small	1	25	65
Medium	5	55	131
Large	10	77	183

Hence for a worst case scenario (10kg/s) the flammable vapor cloud zone/flame pockets' resulting from accidental release of natural gas will be covering a radial zone of 77m from source with the flammable gas concentration within this zone being 26,400 ppm.

Based on the flammable vapour cloud concentration modelled for the worst case scenario (10 kg/s) an effort was made to establish the overpressure (blast force zone) that may result from delayed ignition of vapour cloud generated from any such accidental release. For overpressure risk modelling using ALOHA a delayed ignition time of 5 minutes was considered of the vapour cloud mass. However the threat modelled revealed that Level of Concern (LOC) was never exceeded that may possibly lead to damage to property or life within the blast radius. The results have been provided in ***Figure 7.6*** below.

Figure 7.6 Scenario III (Worst Case) – Overpressure Risk Modeling

```
Threat Modeled: Overpressure (blast force) from vapor cloud explosion
Time of Ignition: 5 minutes after release begins
Type of Ignition: ignited by spark or flame
Level of Congestion: uncongested
Model Run: Gaussian
Explosive mass at time of ignition: 188 kilograms
Red    : LOC was never exceeded --- (8.0 psi = destruction of buildings)
Orange: LOC was never exceeded --- (3.5 psi = serious injury likely)
Yellow: LOC was never exceeded --- (1.0 psi = shatters glass)
```

The risk significance for the potential blow out scenario resulting from exploratory and development drilling has been presented below. For calculating the risk significance, the likelihood ranking is considered to be "2" as the frequency analysis for blow outs incidents is computed at "~ 10^{-4}" whereas the consequence ranking has been identified to be as "4" given the worst case scenario modelling (blast overpressure) indicates that the LOC was never exceeded leading to multiple fatalities (For criteria ranking please refer to ***Table 7.1*** and ***Table 7.2***).

Risk Ranking – Blowout Natural Gas Release (Worst Case Scenario)

Likelihood ranking	**2**	**Consequence ranking**	**4**
Risk Ranking & Significance = 8 i.e. "Low" i.e. Risk is Acceptable and can be managed through use of existing controls and evaluation of additional controls.			

B) Hydrocarbons Leaks Due to Loss of Containment While Drilling & Testing

The releases of hydrocarbons that may be isolated from reservoir fluids include gas releases in the mud return area during drilling. The consequences of gas releases are described in this section. ALOHA model has been used to model the releases from failure of the test separator.

Frequency Analysis

Review of the hydrocarbon release database (HCRD) of 2003 for **One North Sea Platform** indicates the process gas leak frequencies for large releases (>10 kg/s) to be about **6.0×10^{-3} per year**. The same frequency has been considered for potential release from leaks due to loss of containment while drilling.

Gas Releases during Drilling

a) Flash Fire

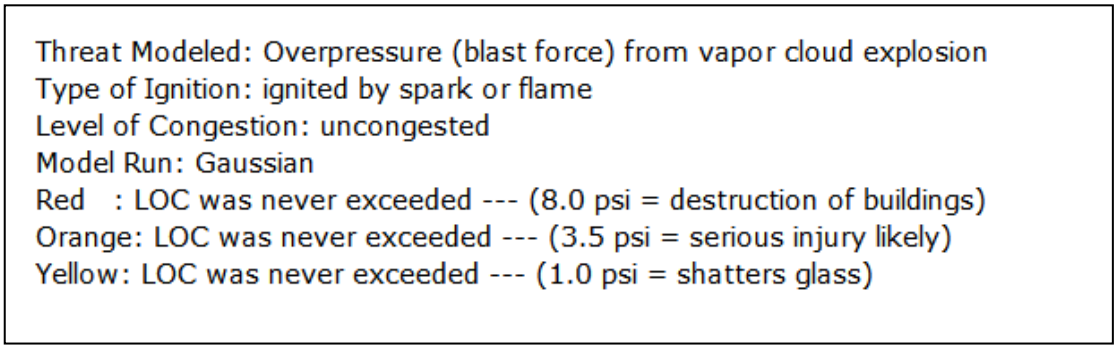
If gas is entrained in the mud then it could be released from the mud pits or shakers. The amount of gas returned is unlikely to be so great that a jet fire could occur, but the gas could build up into a flammable vapour cloud in the mud pit area. If the cloud then ignites it will result in a flash fire or vapour cloud explosion. Again, there is also the potential for a toxic cloud to be present if the release is during a period when sour crude is a possibility. The mud return typically contains around 50% water this means it cannot be ignited in liquid form so there is no danger of pool fires. Liquid mud fires are therefore not considered further.

The mud - gas separator can be other source that contains both flammable liquid and gas.

A well test separator rupture could result in release of gas when a gas cloud will form, initially located around the release point. If the release is ignited immediately then a fireball will be formed. If this cloud is not immediately ignited, then a vapour cloud will form, which will disperse with the wind and diluted as a result of air entrainment. The principal hazard arising from a cloud of dispersing flammable material is its subsequent (delayed) ignition, resulting in a flash fire. Large-scale experiments on the dispersion and ignition of flammable gas clouds show that ignition is unlikely when the average concentration is below the lower flammability limit (LFL).

As in the case for blow outs,) an effort was made to establish the overpressure (blast force zone) that may result from delayed ignition of vapour cloud generated from any such accidental release. For overpressure risk modelling using ALOHA a delayed ignition time of 5 minutes was considered of the vapour cloud mass. However the threat modelled revealed that Level of Concern (LOC) was never exceeded that may possibly lead to damage to property or life within the blast radius. The results have been provided in ***Figure 7.7*** below.

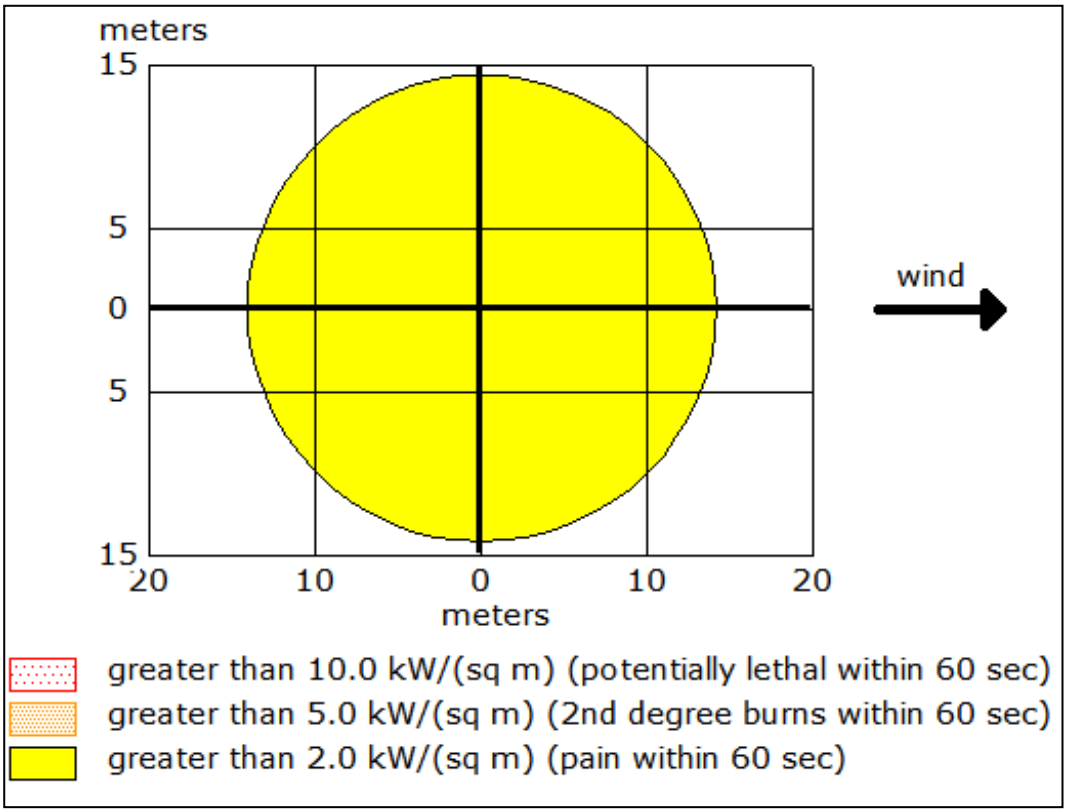
Figure 7.7 Overpressure Risk Modeling – Well Releases during drilling



b) Jet Fire

The term jet fire is used to describe the flame produced due to the ignition of a continuous pressurised leakage from the pipe work. Combustion in a jet fire occurs in the form of a strong turbulent diffusion flame that is strongly influenced by the initial momentum of the release. Flame temperatures for typical jet flames vary from 1600°C for laminar diffusion flames to 2000°C for turbulent diffusion flames. The principal hazards from a jet fire are thermal radiation and the potential for significant knock-on effects, such as equipment failure due to impingement of the jet fire. The thermal radiations distances due to Jet Flame are shown in ***Figure 7.8*** and ***Figure 7.9*** below**.**

Figure 7.8 Thermal Radiation Distances of Jet Flame due to Leak of 25 mm size



THREAT ZONE:

Threat Modeled: Thermal radiation from jet fire

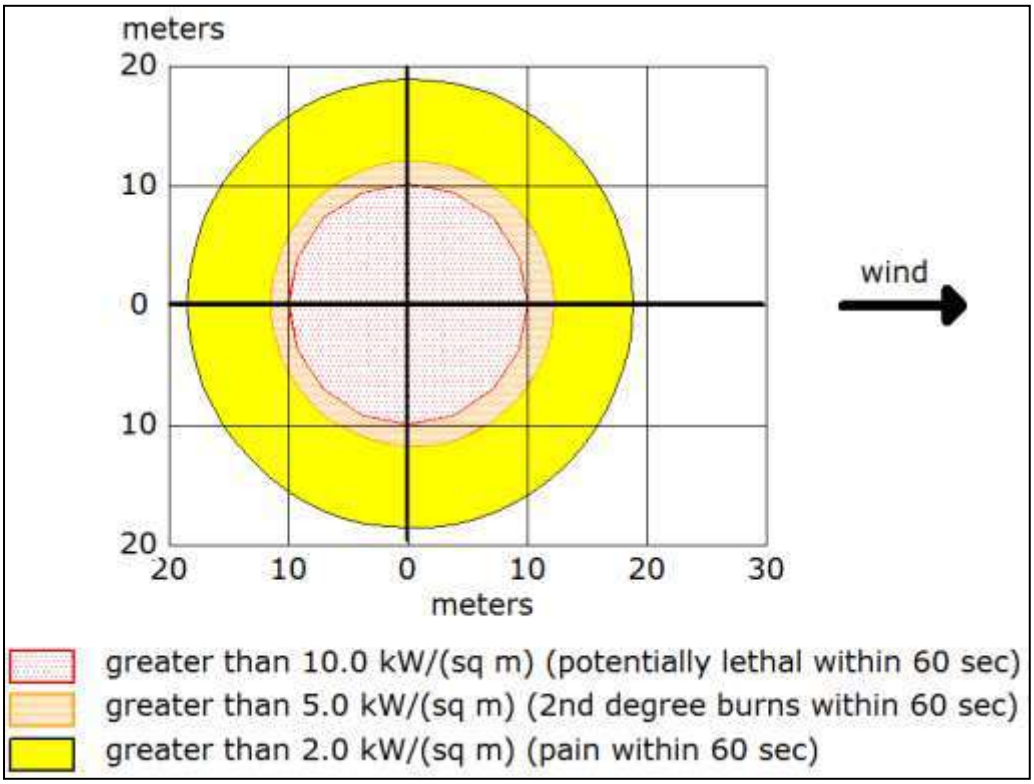
Model Run: Gaussian

Red: < 10 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: < 10 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 14 meters --- (2.0 kW/(sq m) = pain within 60 sec)

Figure 7.9 Thermal Radiation Distances of Jet Flame due to Leak of 50 mm size



THREAT ZONE:

Threat Modeled: Thermal radiation from jet fire

Model Run: Gaussian

Red : 10 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 12 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 19 meters --- (2.0 kW/(sq m) = pain within 60 sec)

The zone of thermal radiation calculated for hypothetical release and ignition of natural gas during well testing have been presented in the ***Table 7.13*** below.

Table 7.13 Thermal Radiation Zone for Natural Gas Release Scenario during Well Testing

Release Type	Red (kW/sqm)	Orange (kW/sqm)	Yellow (kW/sqm)
Leak of 25 mm size	<10 m	<10 m	14 m
Leak of 50 mm size	10 m	12 m	19 m

Hence for a worst case scenario (50 mm leak) the ignition of natural gas release will be resulting in generation of thermal radiation which will be lethal within a maximum radius of 10m within 1 minute of its occurrence. The risk significance for the potential well release scenario resulting from exploratory drilling has been presented below. For calculating the risk significance, the likelihood ranking is considered to be "2" as the frequency analysis for blow outs incidents is computed at "~ 10^{-4}" whereas the consequence ranking has been

identified to be as "4" given the worst case scenario modelling (blast overpressure)/jet fire indicates that the LOC was never exceeded leading to multiple fatalities (for criteria ranking please refer to ***Table 7.1*** and ***Table 7.2***).

Risk Ranking – Jet Fire/Blast Overpressure from Well Releases (Worst Case Scenario)

Likelihood ranking	**2**	**Consequence ranking**	**4**
Risk Ranking & Significance = 8 i.e. "Low" i.e. Risk is Acceptable and can be managed through use of existing controls and evaluation of additional controls.			

C) Interconnecting Hydrocarbon Pipeline Network

As discussed in the project description section, the following hydrocarbon pipelines is likely to be laid as part of the proposed project viz.

- 8" sub surface crude oil (well fluid) pipelines connecting onshore well pads to Ravva Terminal; and
- 6" sub surface gas lift pipeline of connecting onshore well pads to Ravva Terminal.

Some of the key hazard likely to be associated with same has been presented below

- Jet fires associated with pipework failures;
- Vapour cloud explosions; and
- Flash fires.

Each of these hazards has been described below.

Jet Fire

Jet fires result from ignited releases of pressurized flammable gas or superheated/ pressurized liquid. The momentum of the release carries the material forward in a long plume entraining air to give a flammable mixture. Jet fires only occur where the natural gas is being handled under pressure or when handled in gas phase and the releases are unobstructed.

Flash Fire

Vapour clouds can be formed from the release of vapour of pressurized flammable material as well as from non-flashing liquid releases where vapour clouds can be formed from the evaporation of liquid pools or leakage/rupture of pressurized pipelines transporting flammable gas.

Where ignition of a release does not occur immediately, a vapour cloud is formed and moves away from the point of origin under the action of the wind. This drifting cloud may undergo delayed ignition if an ignition source is reached, resulting in a flash fire if the cloud ignites in an unconfined area or vapour cloud explosion (VCE) if within confined area.

Vapour Cloud Explosion

If the generation of heat in a fire involving a vapour-air mixture is accompanied by generation of pressure then the resulting effect is a vapour cloud explosion (VCE). The amount of overpressure produced in a VCE is determined by the reactivity of the gas, the strength of the ignition source, the degree of confinement of the vapour cloud, the number of obstacles in and around the cloud and the location of the point of ignition with respect to the escape path of

the expanding gases. However, in the case of the interconnecting gas pipeline network *jet fire* has been identified as the most probable hazard.

Pipeline Frequency Analysis – Gas Pipelines

An effort has also been made to understand the primary failure frequencies of pressurised gas/oil to be transported through the interconnecting pipeline network. Based on the European Gas Pipeline Incident Data Group (EGIG) database the evolution of the primary failure frequencies over the entire period and for the last five years has been provided in ***Table 7.14*** below.

Table 7.14 Primary Gas Pipeline Failure Frequency

Period	No. of Incidents	Total System Exposure (km.yr)	**Primary Failure Frequency** (1000 km.yr)
1970-2007	1173	$3.15.10^6$	0.372
1970-2010	1249	$3.55.10^6$	0.351
1970-2013	1309	$3.98.10^6$	0.329
1974-2013	1179	$3.84.10^6$	0.307
1984-2013	805	$3.24.10^6$	0.249
1994-2013	426	$2.40.10^6$	0.177
2004-2013	209	$1.33.10^6$	0.157
2009-2013	110	$0.70.10^6$	0.158

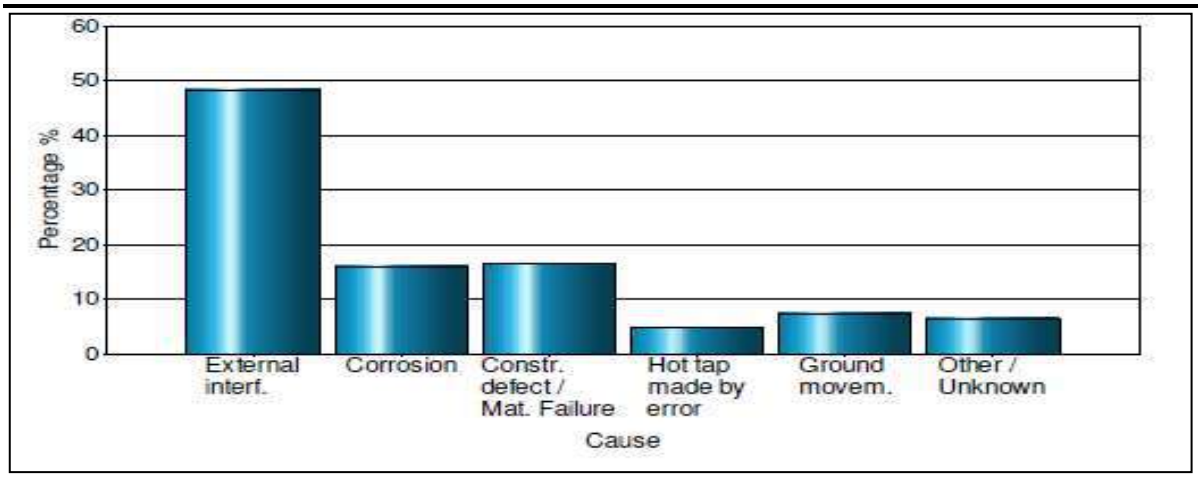
Source: 9th EGIG Report

As referred in the above table the overall failure frequency (0.33) of the entire period (1970-2013) is slightly lower than the failure frequency of 0.35 reported in the 8th EGIG report (1970-2010). The failure frequency of the last 5 years was found to be 0.16 per 1000km.year, depicting an improved performance over the recent years.

Incident Causes

Gas pipeline failure incidents can be attributed to the following major causes viz. external interference, construction defects, corrosion (internal & external), ground movement and hot tap. The distribution of incidents with cause has been presented in the ***Figure 7.10*** below.

Figure 7.10 Gas Pipeline Failure – Distribution of Incident & Causes



Source: 8th EGIG Report

The interpretation of the aforesaid figure indicated external interference as the major cause of pipeline failure contributing to about 48.4% of the total failure incidents followed by construction defects (16.7%) and corrosion related problems (16.1%). Ground movement resulting from seismic disturbance, landslides, flood etc. contributed to only 7.4% of pipeline failure incident causes.

Review of the 9th EGIG report indicates that primary failure frequency varies with pipeline diameter, and the same has been presented in ***Table 7.15*** below.

Table 7.15 Primary Failure Frequency based on Diameter Class (1970-2013)

Nominal Diameter (inch)	Primary Failure Frequency (per km.yr)		
	Pinhole/Crack	**Hole**	**Rupture**
diameter < 5"	4.45×10^{-4}	2.68×10^{-4}	1.33×10^{-4}
5" ≤ diameter < 11"	2.80×10^{-4}	1.97×10^{-4}	6.40×10^{-5}
11" ≤ diameter < 17"	1.27×10^{-4}	0.98×10^{-4}	4.10×10^{-5}
17" ≤ diameter < 23"	1.02×10^{-4}	5.00×10^{-5}	3.40×10^{-5}
23" ≤ diameter < 29"	8.50×10^{-5}	2.70×10^{-5}	1.20×10^{-5}
29" ≤ diameter < 35"	2.30×10^{-5}	5.00×10^{-6}	1.40×10^{-5}
35" ≤ diameter < 41"	2.30×10^{-5}	8.00×10^{-6}	3.00×10^{-6}
41" ≤ diameter < 47"	7.00×10^{-6}	-	-
diameter ≥ 47"	6.00×10^{-6}	6.00×10^{-6}	6.00×10^{-6}

Source: 9th EGIG Report

The pipeline failure frequency viz. leaks or rupture for the natural gas pipeline has been computed based on the aforesaid table. Considering the gas pipeline to be laid is likely to have a diameter of 6 inches, the probability of pinhole is estimated to be **2.80×10^{-4} per km year,** while full bore rupture is considered to be **6.40×10^{-5} per km year. (Refer *Table 7.16* below).**

Table 7.16 Interconnecting Gas Pipeline - Failure Frequency

S N	Pipeline Failure Case	EGIG Failure Frequency (per km. year)	Pipeline Dia. (inch)	Avg. Pipeline Length (km)	Project Pipeline Failure Frequency (per year)	Frequency
1	Pipeline Rupture	6.40×10^{-5}	6	15	9.60×10^{-4}	Not Likely
2	Pipeline Leak	2.80×10^{-4}	6	15	4.20×10^{-3}	Occasional/Rare

Thus the probability of pipeline leak and rupture with respect to the interconnecting hydrocarbon pipeline network is identified to be both "*Not Likely*" and "*Occasional/Rare*".

Oil Pipeline Failure Frequency

Concawe (2015) has developed estimates for leak frequencies from onshore crude oil pipelines. Over the past 20 years the typical leak frequency from larger oil pipelines (>16") has been of the order 0.2 per 1000 km pipeline and year, among these 19% are defined as rupture, giving the largest spill rate, often of the order the transport rate of the pipeline after an initially higher transient leak rate. 17% of the holes were defined as "split", with an opening of 75-1000mm x 10% of diameter, which could also give release rates similar to the pipeline flow rate. This would correspond to a total release frequency of 2×10^{-4}/y and rupture plus split frequency of

7x10^{-5}/y per km pipeline. Almost half of the releases were categorized as caused by 3rd party, a small, but a strongly increasing fraction last couple of years was found to be intentional, primarily due to theft.

Review of the CONCAWE[1] accident database for the period 1970-2010, reveals the liquid pipeline failure frequency in Europe to be around 1.01 X10^{-6}; hence for the 8" inch sub surface crude oil (well fluid) pipelines (~15km length) from onshore well pads to Ravva Terminal the frequency is computed to be around 1.51 X10^{-5} i.e. "*Not Likely*".

Gas Pipeline Failure – Ignition Probability

The ignition probability of natural gas pipeline failure (rupture & leaks) with respect to the proposed expansion project is derived based on the following equations as provided in the IGEM/TD/2 standard

$P_{ign} = 0.0555 + 0.0137pd2$; for $0 \leq pd^2 \leq 57$
(For pipeline ruptures)
$P_{ign} = 0.81$; for $pd^2 > 57$

$P_{ign} = 0.0555 + 0.0137(0.5pd2)$; for $0 \leq 0.5pd^2 \leq 57$
(For pipeline leaks)
$P_{ign} = 0.81$; for $0.5pd^2 > 57$

Where:

P_{ign} = Probability of ignition
p = Pipeline operating pressure (bar)
d = Pipeline diameter (m)

The ignition and jet fire probability of natural gas release from a leak/rupture of interconnected pipeline network is calculated based on the above equations and presented in **Table 7.17** below.

Table 7.17 Interconnecting Pipeline – Ignition & Jet Fire Probability

S. N	Pipeline Failure Case	Pipeline Dia (inch)	Project Pipeline Failure Frequency (per year)	Ignition Probability	Jet Fire Probability
1	Pipeline Rupture	6	9.60 x 10^{-4}	0.06	5.76 x 10^{-5}
2	Pipeline Leak	6	4.20 x 10^{-3}	0.058	2.43 x 10^{-4}

Hence from the above table it can be concluded that ignition probability of natural gas that may be released from the interconnecting pipeline due to any accidental event is considered to be "***Not likely***".

Oil Pipeline Failure – Ignition Probability

OGP (2010) gives an estimated ignition probability for large crude oil releases of 0.70% in rural areas; hence considering the same the ignition probability of oil spills/leakages from 8" sub surface pipeline (~15km length) is computed to be around **1.05 x 10^{-5}.**

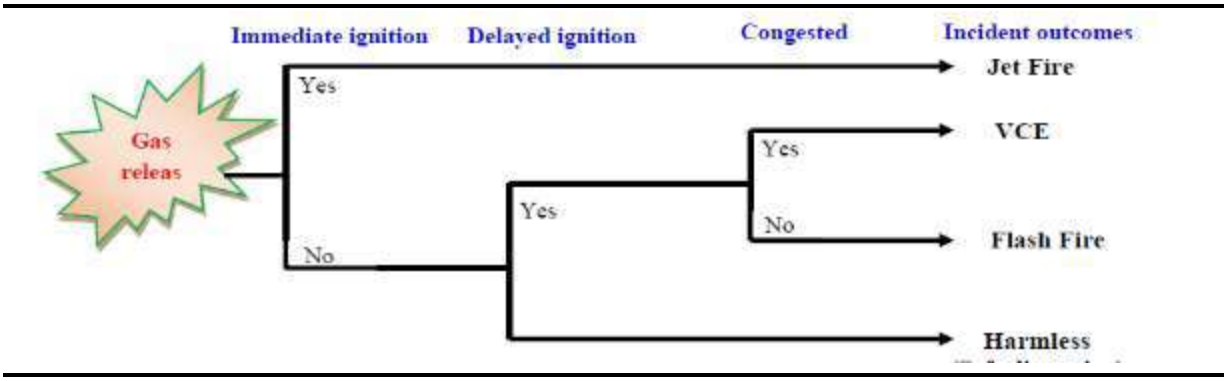
[1] Davis, P. M., Dubois, J., Gambardella, F., Sanchez-Garcia, E., Uhlig F., (2011). "Performance of European cross-country oil pipelines - Statistical summary of reported pillages in 2010 and since 1971". Report no. 8/11, CONCAWE,

Consequence Analysis – Pipelines

Pipelines generally contains large inventories of oil or gas under high pressure; although accidental releases from them are remote they have the potential of catastrophic or major consequences if related risks are not adequately analysed or controlled. The consequences of possible pipeline failure is generally predicted based on the hypothetical failure scenario considered and defining parameters such as meteorological conditions (stability class), leak hole & rupture size and orientation, pipeline pressure & temperature, physicochemical properties of chemicals released etc.

In case of pipe rupture containing highly flammable natural gas, an immediate ignition will cause a jet fire. Flash fires can result from the release of natural gas through the formation of a vapour cloud with delayed ignition and a fire burning through the cloud. A fire can then flash back to the source of the leak and result in a jet fire. Flash fires have the potential for offsite impact as the vapour clouds can travel considerable distances downwind of the source. Explosions can occur when a flammable gas cloud in a confined area is ignited; however where vapour cloud concentration of released material is lower than Lower Flammability Limit (LFL), consequently the occurrence of a VCE is highly unlikely. VCE, if occurs may result in overpressure effects that become more significant as the degree of confinement increases (Refer ***Figure 7.11***).Therefore, in the present study, only the risks of jet fires for the below scenarios have been modelled and calculated.

Figure 7.11 Natural Gas Release – Potential Consequences



[Source: "Safety risk modelling and major accidents analysisof hydrogen and natural gas releases: A comprehensive risk analysis framework" - Iraj Mohammadfam, Esmaeil Zarei]

Based on the above discussion and frequency analysis as discussed in the earlier section, the following hypothetical risk scenarios (Refer ***Table 7.18***) have been considered for consequence analysis of the interconnecting pipelines.

Table 7.18 Interconnecting Pipeline Risk Modelling Scenarios

Scenario	Source	Pipeline dia (inch)	Accident Scenario	Design Pressure (bar)	Temperature	Potential Risk
1	Pipeline	6	Leak of 25mm dia	17.23	24°C	Jet Fire
2	Pipeline	6	Leak of 50mm dia	17.23	24°C	Jet Fire
3	Pipeline	6	Complete rupture	17.23	24°C	Jet Fire
4	Pipeline	8	Leak of 25mm dia	17.23	24°C	Pool Fire
5	Pipeline	8	Leak of 50mm dia	17.23	24°C	Pool Fire
6	Pipeline	8	Complete rupture	17.23	24°C	Pool Fire

The pipeline failure risk scenarios have been modeled using ALOHA and interpreted in terms of Thermal Radiation Level of Concern (LOC) encompassing the following threshold values (measured in kilowatts per square meter) for natural gas (comprising of ~95% methane[1]) and crude oil (represented by n-decane) to create the default threat zones:

- *Red: 10 kW/ (sq. m) -- potentially lethal within 60 sec;*
- *Orange: 5 kW/ (sq. m) -- second-degree burns within 60 sec; and*
- *Yellow: 2 kW/ (sq. m) -- pain within 60 sec.*

For vapour cloud explosion, the following threshold level of concern has been interpreted in terms of blast overpressure as specified below:

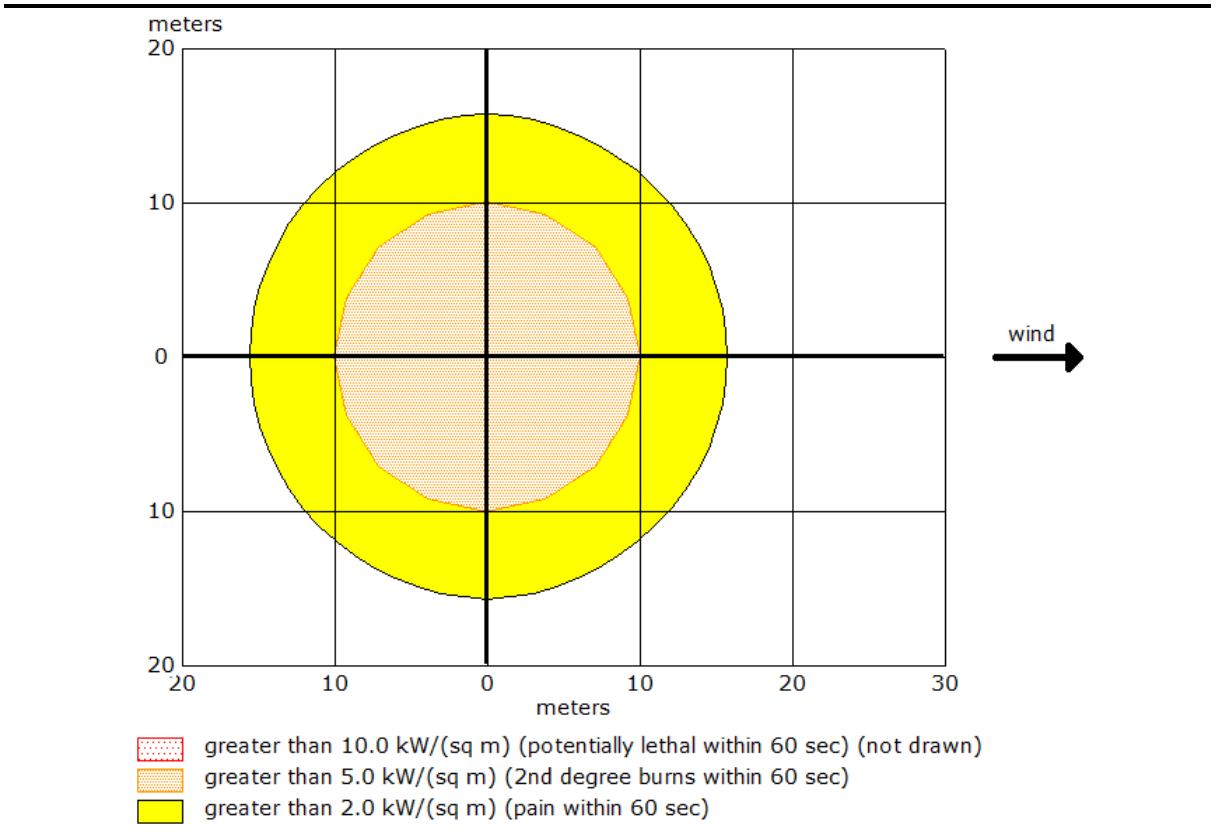
- *Red: 8.0 psi – destruction of buildings;*
- *Orange: 3.5 psi – serious injury likely; and*
- *Yellow: 1.0 psi – shatters glass*

The risk scenarios modelled for pipeline failure has been presented below:

Scenario 1: Gas Pipeline Leak (25mm dia)

The jet fire threat zone plot for release and ignition of natural gas from pipeline leak (25mm) is represented in ***Figure 7.12*** below.

Figure 7.12 Threat Zone Plot – Gas Pipeline Leak (25mm dia)



Source: ALOHA

[1] https://www.naesb.org//pdf2/wgq_bps100605w2.pdf

http://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=18&ved=0ahUKEwjF7MiDttPRAhVCMI8KHd7aD6cQFghrMBE&url=http%3A%2F%2Fwww.springer.com%2Fcda%2Fcontent%2Fdocument%2Fcda_downloaddocument%2F9781848828711-c1.pdf%3FSGWID%3D0-0-45-862344-p173918930&usg=AFQjCNEaJklfYKl3fRUdi6xiRYeW-FJb2A

THREAT ZONE:

Threat Modeled: Thermal radiation from jet fire

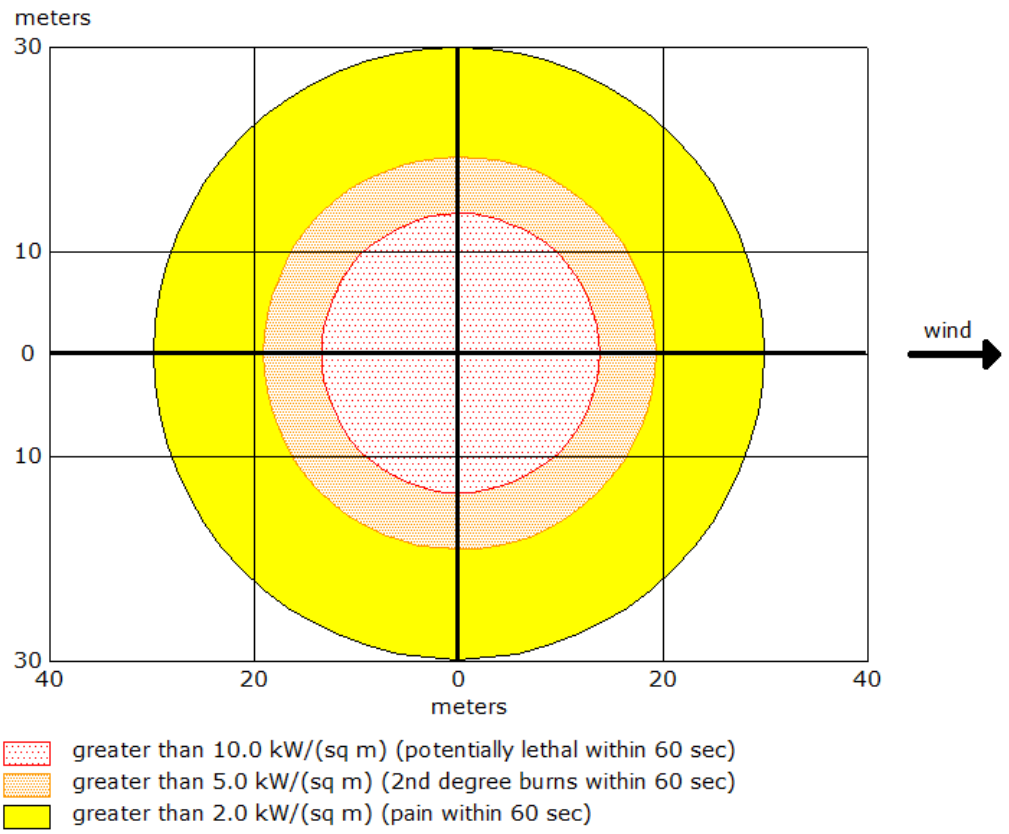
- *Red : <10 meters --- (10.0 kW/ (sq. m) = potentially lethal within 60 sec)*
- *Orange: 10 meters --- (5.0 kW/ (sq. m) = 2nd degree burns within 60 sec)*
- *Yellow: 16 meters --- (2.0 kW/ (sq. m) = pain within 60 sec)*

The worst hazard for release and ignition of natural gas from the gas pipeline leak (25mm dia) will be experienced to a maximum radial distance of <10m from the source with potential lethal effects within 1 minute.

Scenario 2: Gas Pipeline Leak (50mm dia)

The jet fire threat zone plot for release and ignition of natural gas from pipeline leak (50mm) is represented in ***Figure 7.13*** below.

Figure 7.13 Threat Zone Plot – Gas Pipeline Leak (50mm dia)



Source: ALOHA

THREAT ZONE:

Threat Modeled: Thermal radiation from jet fire

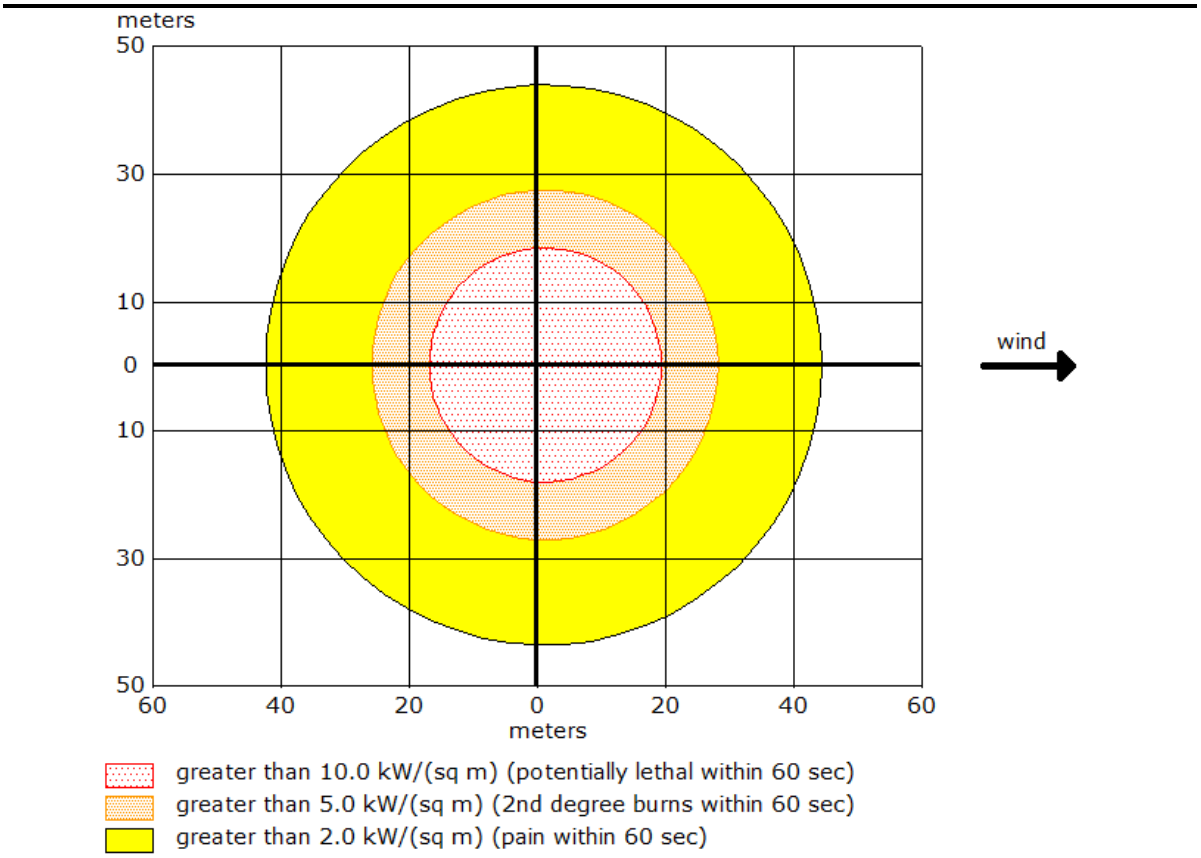
- *Red : 14 meters --- (10.0 kW/ (sq. m) = potentially lethal within 60 sec)*
- *Orange: 19 meters --- (5.0 kW/ (sq. m) = 2nd degree burns within 60 sec)*
- *Yellow: 30 meters --- (2.0 kW/ (sq. m) = pain within 60 sec)*

The worst hazard for release and ignition of natural gas from the gas pipeline leak (50mm dia) will be experienced to a maximum radial distance of 14m from the source with potential lethal effects within 1 minute.

Scenario 3: Gas Pipeline Rupture

The jet fire threat zone plot for release and ignition of natural gas from gas pipeline rupture is represented in ***Figure 7.14*** below.

Figure 7.14 Threat Zone Plot – Gas pipeline rupture



Source: ALOHA

THREAT ZONE:

Threat Modeled: Thermal radiation from jet fire

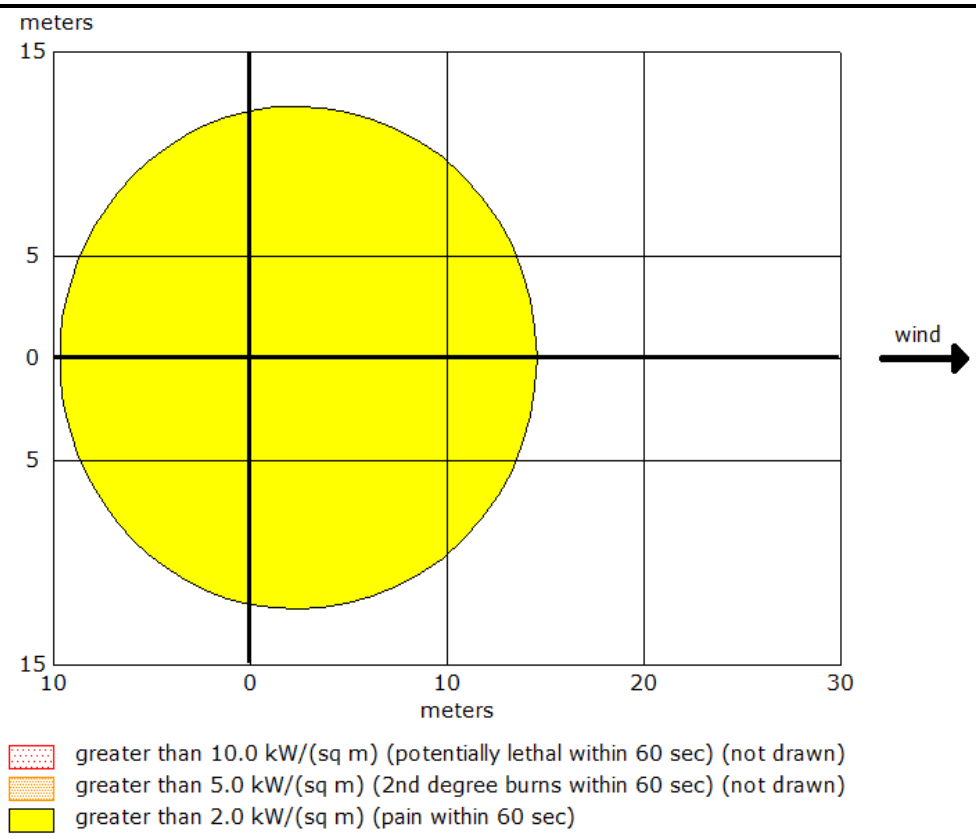
- *Red : 20 meters --- (10.0 kW/ (sq. m) = potentially lethal within 60 sec)*
- *Orange: 28 meters --- (5.0 kW/ (sq. m) = 2nd degree burns within 60 sec)*
- *Yellow: 45 meters --- (2.0 kW/ (sq. m) = pain within 60 sec)*

The worst hazard for release and ignition of natural gas from pipeline rupture will be experienced to a maximum radial distance of 20m from the source with potential lethal effects within 1 minute.

Scenario 4: Oil Pipeline Leak (25mm dia)

The pool fire threat zone plot for release and ignition of oil from pipeline leak (25mm dia) is represented in **Figure 7.15** *below.*

Figure 7.15 Threat Zone Plot –Oil Pipeline Leak (25mm dia)



Source: ALOHA

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire

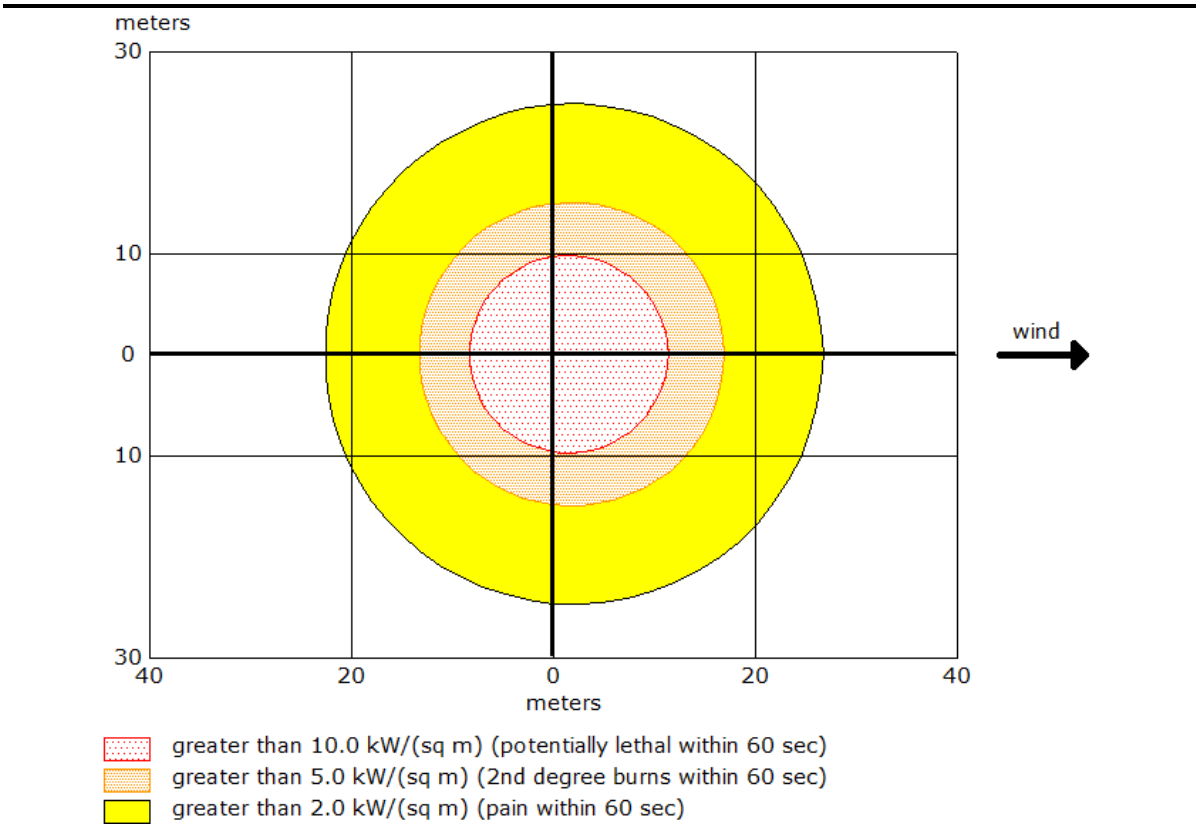
- *Red : <10 meters --- (10.0 kW/ (sq. m) = potentially lethal within 60 sec)*
- *Orange: <10 meters --- (5.0 kW/ (sq. m) = 2nd degree burns within 60 sec)*
- *Yellow: 15 meters --- (2.0 kW/ (sq. m) = pain within 60 sec)*

The worst hazard for release and ignition of oil from pipeline leak (25mm dia) will be experienced to a maximum radial distance of <10m from the source with potential lethal effects within 1 minute.

Scenario 5: Oil Pipeline Leak (50mm dia)

The pool fire threat zone plot for release and ignition of oil from pipeline leak (50mm dia) is represented in ***Figure 7.16*** below.

Figure 7.16 Threat Zone Plot – Oil Pipeline Leak (50mm dia)



Source: ALOHA

THREAT ZONE:
Threat Modeled: Thermal radiation from pool fire

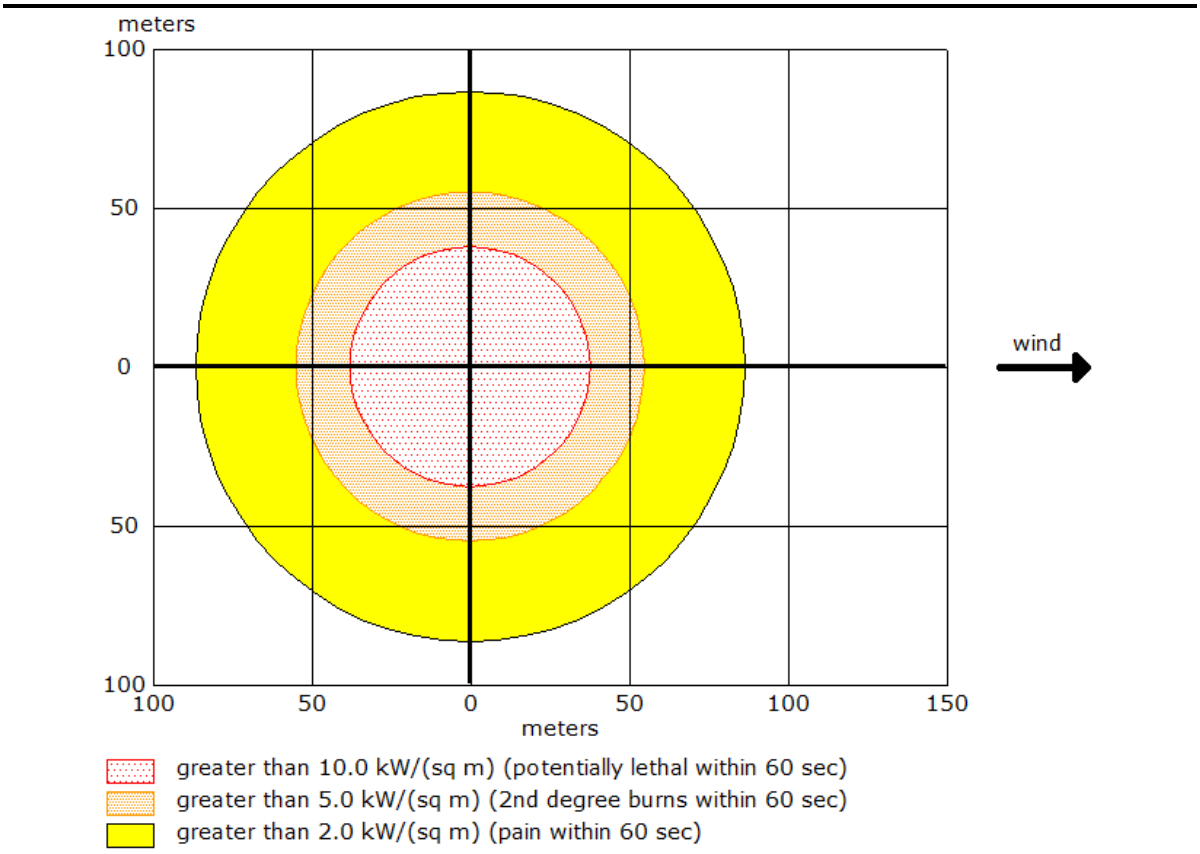
- *Red : 12 meters --- (10.0 kW/ (sq. m) = potentially lethal within 60 sec)*
- *Orange: 17 meters --- (5.0 kW/ (sq. m) = 2nd degree burns within 60 sec)*
- *Yellow: 27 meters --- (2.0 kW/ (sq. m) = pain within 60 sec)*

The worst hazard for release and ignition of oil from pipeline leak (50mm dia) will be experienced to a maximum radial distance of 12m from the source with potential lethal effects within 1 minute.

Scenario 6: Oil Pipeline Rupture

The pool fire threat zone plot for release and ignition of oil from pipeline rupture is represented in ***Figure 7.17*** below.

Figure 7.17 Threat Zone Plot –Oil Pipeline Rupture



Source: ALOHA

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire

- *Red : 38 meters --- (10.0 kW/ (sq. m) = potentially lethal within 60 sec)*
- *Orange: 55 meters --- (5.0 kW/ (sq. m) = 2nd degree burns within 60 sec)*
- *Yellow: 86 meters --- (2.0 kW/ (sq. m) = pain within 60 sec)*

The worst hazard for release and ignition of oil from pipeline rupture will be experienced to a maximum radial distance of 38m from the source with potential lethal effects within 1 minute.

For VCE modelled for catastrophic failure of interconnecting pipeline the LOC level was never exceeded

THREAT ZONE:

Threat Modeled: Overpressure (blast force) from vapor cloud explosion

Type of Ignition: ignited by spark or flame

Level of Congestion: uncongested

Model Run: Heavy Gas

- *Red : LOC was never exceeded --- (8.0 psi = destruction of buildings)*
- *Orange: LOC was never exceeded --- (3.5 psi = serious injury likely)*
- *Yellow: LOC was never exceeded --- (1.0 psi = shatters glass)*

For calculating the risk significance of oil and gas pipeline, the likelihood ranking is considered to be "3" as the probability of pipeline rupture is computed to be ~10^{-4} per year; whereas the consequence ranking has been identified to be as "3" as given for a worst case scenario (rupture) lethal effects is likely to be limited within a radial zone of ~38m.

Further as discussed in the earlier section, adequate number of leak and fire detection system of appropriate design will be provided for the interconnecting pipeline network including GCS to prevent for any major risk at an early stage of the incident.

Risk Ranking – Pipeline Rupture (Worst Case Scenario)

Likelihood ranking	**3**	**Consequence ranking**	**3**
Risk Ranking & Significance = 9 i.e. "Low" i.e. Risk is Acceptable and can be managed through use of existing controls and evaluation of additional controls.			

D) Transportation of Crude by Road Tankers

As discussed in the project description section, the proposed project involves generation of 1500 barrels of oil per day from each well which will be transported to Ravva onshore terminal by approximately 12 Oil Tankers (considering tanker size of 20 KL and 1 barrel = 0.1589873 KL). Hence considering simultaneous operations of both wells, a movement of 24 crude oil bearing tankers is anticipated in a day to the Ravva Terminal.

The crude is pumped from the well site storage area through aboveground pipework to the site road tanker loading gantry. Road tanker loading occurs during the day and at night. The details of the road tanker loading facilities has been provided in the ***Table 7.19*** below.

Table 7.19 Road Tanker Loading Facility Details

S. N.	Characteristics	Values
1	Tanker Sizes	20 m^3
2	Compartment Size	5 m^3
3	Connections per Tanker	2
4	Hose Size	100mm
6	Average flowrate in pipeline to Gantry	0.1 m^3/s

Road Tanker Failure Hazards

As compared to other modes of transport, tanker trucks operate in close proximity to the general public and share the same infrastructure (i.e., highways, roads, neighbourhoods). Trucks can also operate in densely populated areas. This increases the risk of accidents, including collisions and accidents at crossings. Collisions may involve multiple vehicles and can occur at high speeds, which may increase the risk of fire and explosion.

The potential hazards associated with the failure of road tanker loading and transport has been presented in the ***Table 7.20*** below with the pool fire identified to be the most common hazard.

Table 7.20 Road Tanker Failure - Potential Hazards

S. N.	Failure Scenario	Potential Hazards
1	Road tanker loading hose leak/rupture	Flash Fire; Pool Fire
2	Road tanker collision/toppling	Flash Fire; Pool Fire

Road Tanker Failure Frequency

To determine the probability of a pool fire occurring, the failure rate needs to be modified by the probability of the material finding an ignition source. The probability of a pool fire occurring in the event of a release is therefore equal to the product of the failure rate and the probability of ignition. The frequency of the release scenarios identified in the above section is represented in ***Table 7.21*** & ***Table 7.22.***

Table 7.21 Failure Frequencies for Road Tanker Loading Hoses

Sl. No.	Failure Type	Failure Frequency
1	Full Bore Rupture	4.0×10^{-6} per operation
2	15mm Hole	0.4×10^{-6} per operation
3	5mm Hole	6.0×10^{-6} per operation

Table 7.22 Frequencies for Road Tanker Incidents

S.N	Failure Type	Failure Frequency (per km)	Max. Distance to terminal (km)	Calculated Frequency
1	Catastrophic failure	1.0×10^{-5}	15	1.5×10^{-4}
2	Large connection failure	5.0×10^{-7}	15	7.5×10^{-6}

Thus the probability of road tanker failures with respect to the proposed project is identified to be "*Improbable"* with respect to road tanker loading hose failure and "*Not Likely*" for road tanker collision/toppling.

Road Tanker Failure Consequence Analysis

For offloading scenarios, generally release rates for this assessment have been taken equal to the initial release rates. Where the flow through a hose is driven by a pump, the maximum flow rate arising from a leak was set to 150% of the normal flow rate to allow for pump over-speed. The following representative scenarios (Refer ***Table 7.23***) for the tankers loading and transport have been considered:

Table 7.23 Road Tanker Failure Scenarios

S. N.	Failure Type	Characteristics	
A	**Hose Failure[1]**	**Hose Dia (mm)**	**Hose Length (m)**
1	5mm Hole	100	50
2	15mm Hole	100	50
3	Full Bore Rupture	100	50

[1] Failure Rate and Event Data for use within Land Use Planning Risk Assessments – FR 1.2.3 – Hoses and Couplings

S. N.	Failure Type	Characteristics	
B	Road Tanker Failure[1]	Tank Capacity (KL)	Tank Dia (m)
1	Catastrophic failure	20	1.5
2	50mm dia tank leak	20	1.5
3	100mm dia tank leak	20	1.5

The aforesaid failure risk scenarios have been modeled using ALOHA and interpreted in terms of Thermal Radiation Level of Concern (LOC) encompassing the following threshold values (measured in kilowatts per square meter) for natural gas (comprising of ~95% methane[2]) and crude oil (represented by n-decane) to create the default threat zones:

- *Red: 10 kW/ (sq. m) -- potentially lethal within 60 sec;*
- *Orange: 5 kW/ (sq. m) -- second-degree burns within 60 sec; and*
- *Yellow: 2 kW/ (sq. m) -- pain within 60 sec.*

For vapour cloud explosion, the following threshold level of concern has been interpreted in terms of blast overpressure as specified below:

- *Red: 8.0 psi – destruction of buildings;*
- *Orange: 3.5 psi – serious injury likely; and*
- *Yellow: 1.0 psi – shatters glass*

The risk scenarios modelled for tanker failure as outlined in the ***Table 7.23*** has been presented below.

Scenario A.1: Road Tanker Loading Hose Leak (5mm dia)

THREAT ZONE:
Threat Modeled: Thermal radiation from pool fire

- *Red : less than 10 meters - (10.0 kW/(sq m) = potentially lethal within 60 sec)*
- *Orange: less than 10 meters -- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)*
- *Yellow: less than 10 meters - (2.0 kW/(sq m) = pain within 60 sec)*

The worst hazard for release and ignition of crude oil from tanker loading hose leak (5mm dia) will be experienced to a maximum radial distance of <10m from the source with potential lethal effects within 1 minute.

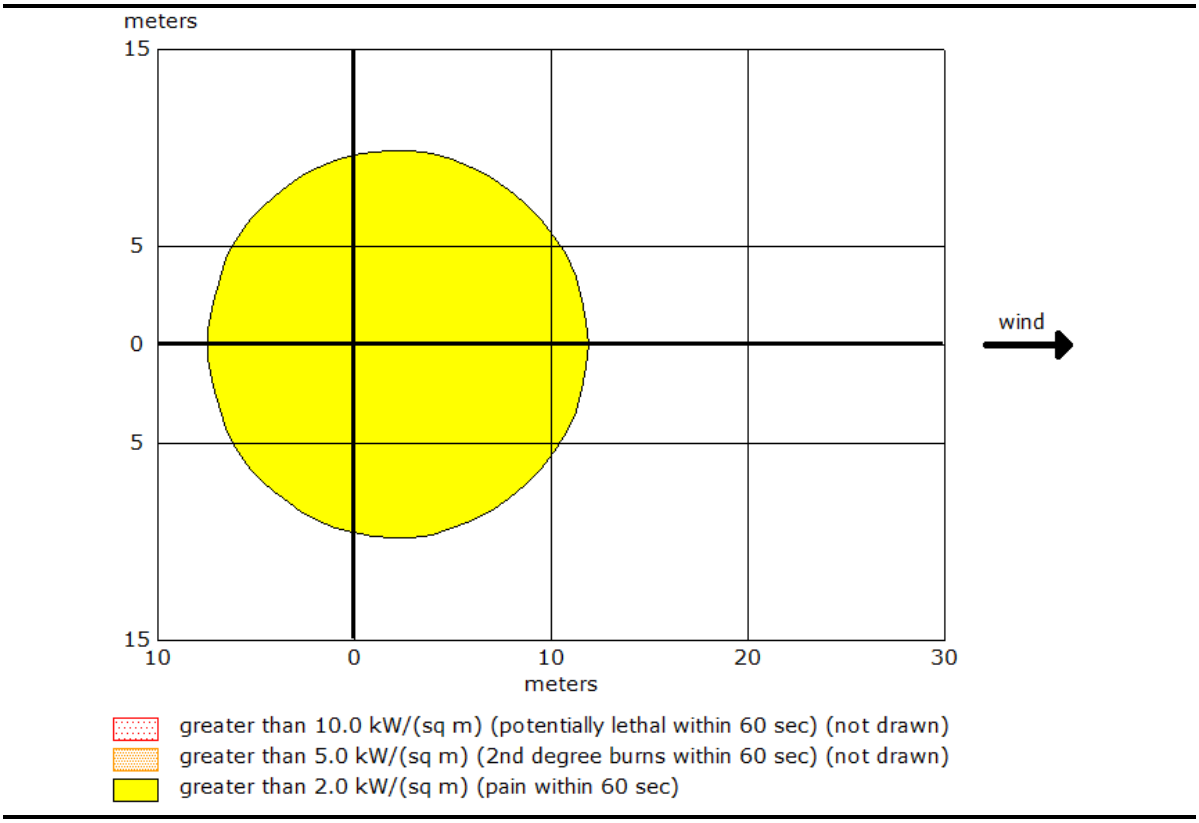
Scenario A.2: Road Tanker Loading Hose Leak (15mm dia)

The pool fire threat zone plot for release and ignition of crude oil from tanker loading hose leak (20mm) is represented in ***Figure 7.18*** below.

[1] Publication Series on Dangerous Substances - Guidelines for quantitative risk assessment, 'Purple Book', CPR18E, Chapter 3.2.9 Transport units in an establishment, Page 3.12
[2] https://www.naesb.org//pdf2/wgq_bps100605w2.pdf

http://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=18&ved=0ahUKEwjF7MiDttPRAhVCMI8KHd7aD6cQFghrMBE&url=http%3A%2F%2Fwww.springer.com%2Fcda%2Fcontent%2Fdocument%2Fcda_downloaddocument%2F9781848828711-c1.pdf%3FSGWID%3D0-0-45-862344-p173918930&usg=AFQjCNEaJklfYKl3fRUdi6xiRYeW-FJb2A

Figure 7.18 Threat Zone Plot – Road Tanker Loading Hose Leak (20mm dia)



Source: ALOHA

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire

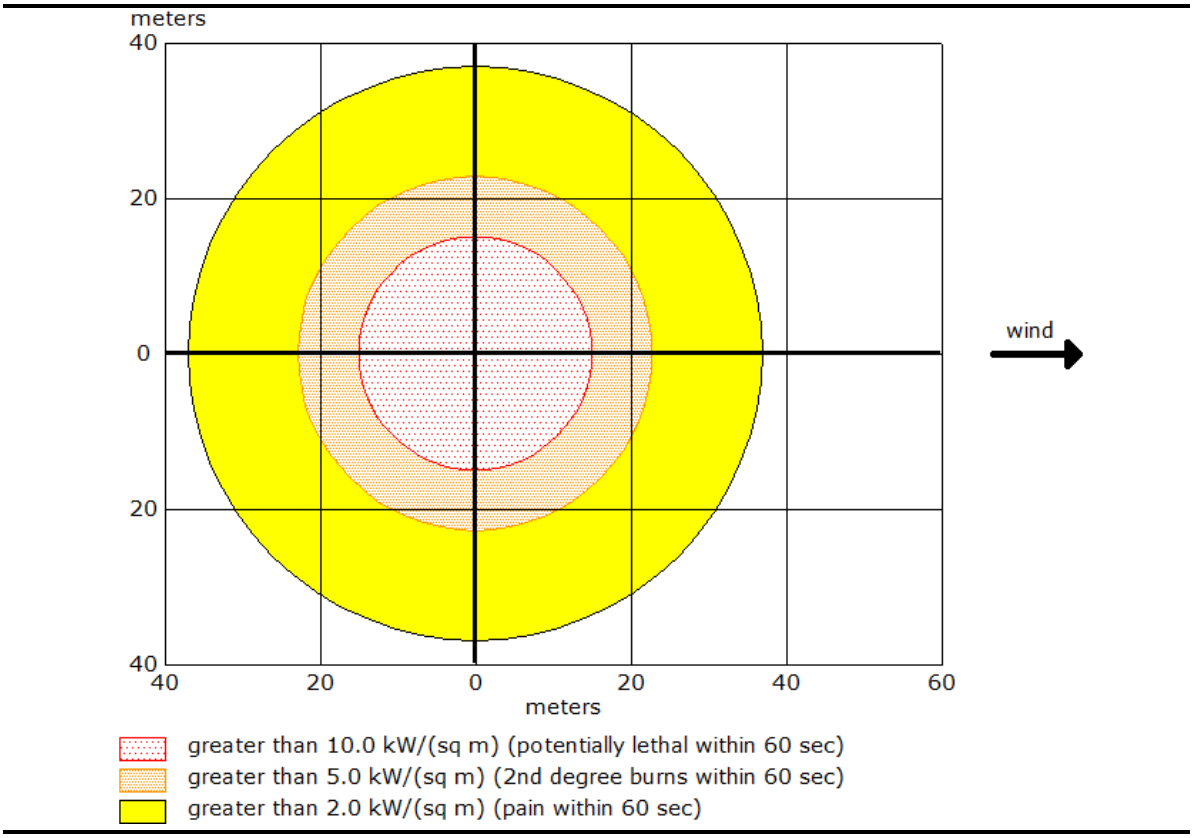
- *Red : <10 meters --- (10.0 kW/ (sq. m) = potentially lethal within 60 sec)*
- *Orange: <10 meters --- (5.0 kW/ (sq. m) = 2nd degree burns within 60 sec)*
- *Yellow: 12 meters --- (2.0 kW/ (sq. m) = pain within 60 sec)*

The worst hazard for release and ignition of crude oil from tanker loading hose leak (5mm dia) will be experienced to a maximum radial distance of <10m from the source with potential lethal effects within 1 minute.

Scenario A.3: Road Tanker Loading Hose Rupture

The pool fire threat zone plot for release and ignition of crude oil from tanker loading hose rupture is represented in ***Figure 7.19*** below.

Figure 7.19 Threat Zone Plot – Road Tanker Loading Hose Rupture



Source: ALOHA

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire

- *Red : 15 meters --- (10.0 kW/ (sq. m) = potentially lethal within 60 sec)*
- *Orange: 23 meters --- (5.0 kW/ (sq. m) = 2nd degree burns within 60 sec)*
- *Yellow: 37 meters --- (2.0 kW/ (sq. m) = pain within 60 sec)*

The worst hazard for release and ignition of crude oil from tanker loading hose rupture will be experienced to a maximum radial distance of 15m from the source with potential lethal effects within 1 minute.

The risk significance for the potential worst case scenario resulting from road tanker loading hose rupture has been presented below. For calculating the risk significance, the likelihood ranking is considered to be "1" as the frequency analysis for rupture is computed at "*4 X 10-6*" whereas the consequence ranking has been identified to be as "3" as the potential lethal zone is likely to be limited within a distance of 15m. (For criteria ranking please refer to ***Table 7.1*** and ***Table 7.2***).

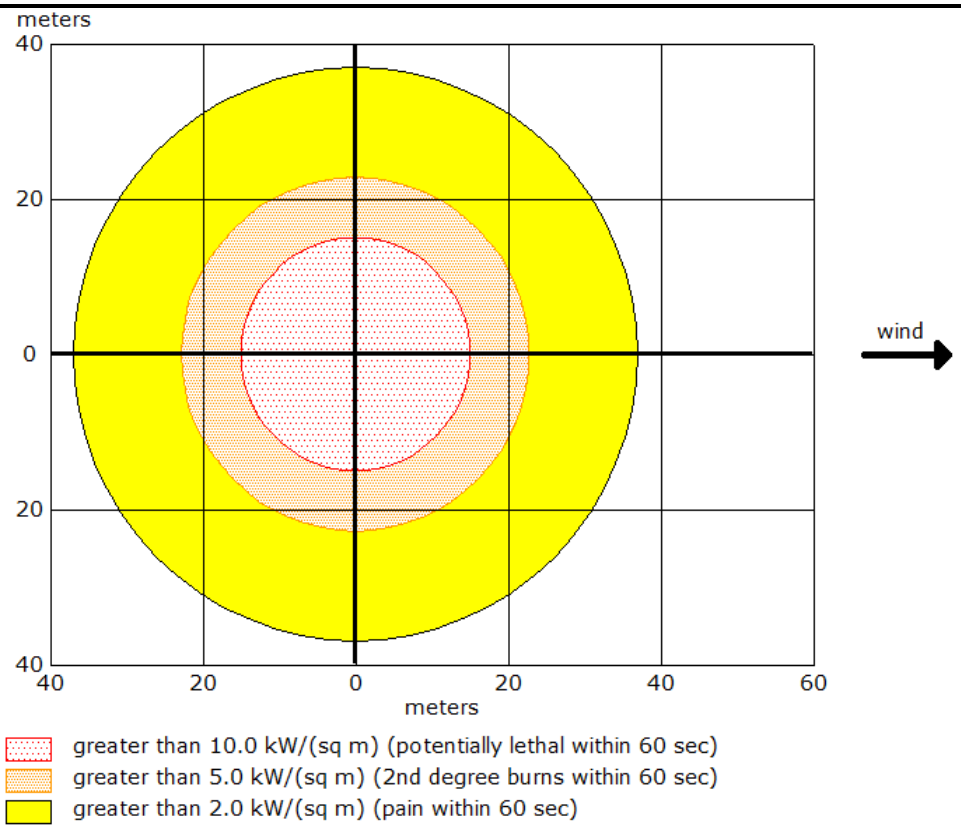
Risk Ranking – Road Tanker Hose Rupture (Worst Case Scenario)

Likelihood ranking	**1**	**Consequence ranking**	**3**
Risk Ranking & Significance = 3 i.e. "Very Low" i.e. Risk is Acceptable and can be managed through use of existing controls.			

Scenario B.1: Road Tanker Leak (50mm dia)

The pool fire threat zone plot for release and ignition of crude oil from road tanker leak (50mm dia) is represented in ***Figure 7.20*** below.

Figure 7.20 Threat Zone Plot – Road Tanker Leak (50mm dia)



Source: ALOHA

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire

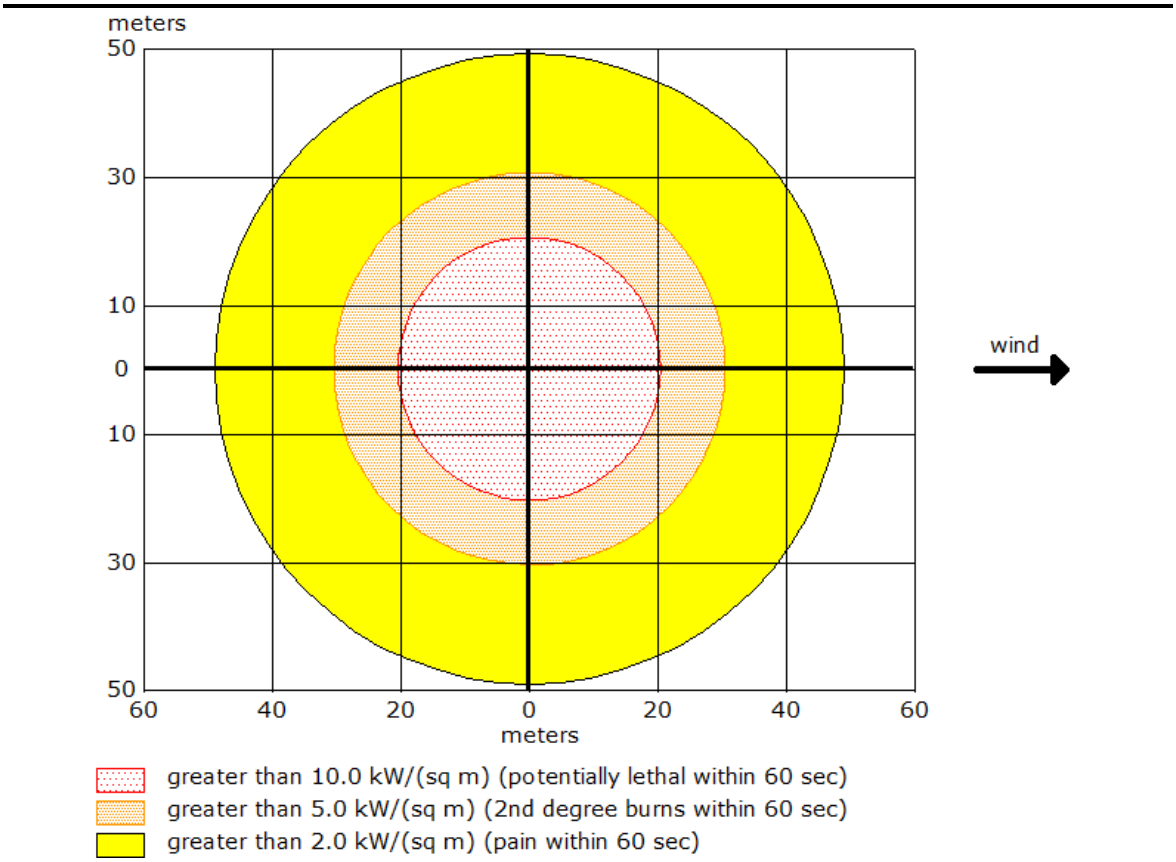
- *Red : 12 meters --- (10.0 kW/ (sq. m) = potentially lethal within 60 sec)*
- *Orange: 17 meters --- (5.0 kW/ (sq. m) = 2nd degree burns within 60 sec)*
- *Yellow: 27 meters --- (2.0 kW/ (sq. m) = pain within 60 sec)*

The worst hazard for release and ignition of crude oil from road tanker leak (50mm dia) will be experienced to a maximum radial distance of 12m from the source with potential lethal effects within 1 minute.

Scenario B.2: Road Tanker Leak (100mm dia)

The pool fire threat zone plot for release and ignition of crude oil from road tanker leak (100mm dia) is represented in ***Figure 7.21*** below.

Figure 7.21 Threat Zone Plot – Road Tanker Leak (100mm dia)



Source: ALOHA

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire

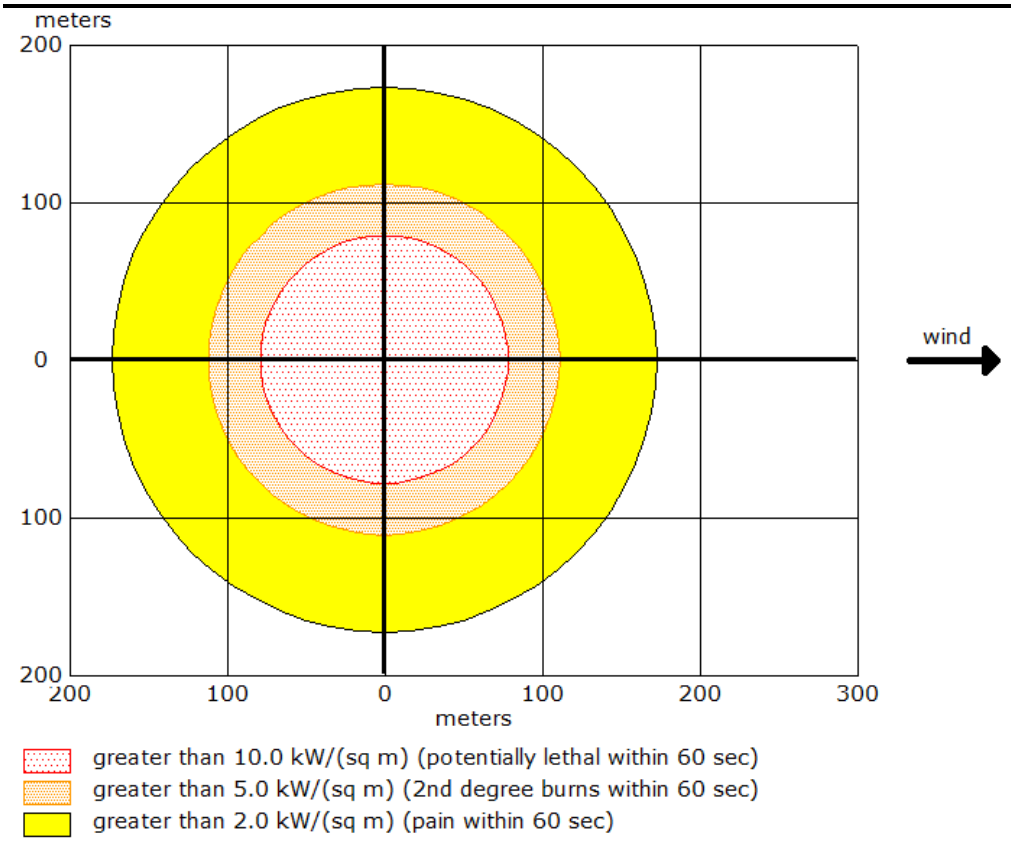
- *Red : 20 meters --- (10.0 kW/ (sq. m) = potentially lethal within 60 sec)*
- *Orange: 30 meters --- (5.0 kW/ (sq. m) = 2nd degree burns within 60 sec)*
- *Yellow: 49 meters --- (2.0 kW/ (sq. m) = pain within 60 sec)*

The worst hazard for release and ignition of crude oil from road tanker leak (100mm dia) will be experienced to a maximum radial distance of 20m from the source with potential lethal effects within 1 minute.

Scenario B.3: Road Tanker Catastrophic Failure

The pool fire threat zone plot for release and ignition of crude oil from catastrophic failure of road tanker is represented in ***Figure 7.22*** below.

Figure 7.22 Threat Zone Plot – Road Tanker Catastrophic Failure



Source: ALOHA

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire

- *Red : 79 meters --- (10.0 kW/ (sq. m) = potentially lethal within 60 sec)*
- *Orange: 112 meters --- (5.0 kW/ (sq. m) = 2nd degree burns within 60 sec)*
- *Yellow: 173 meters --- (2.0 kW/ (sq. m) = pain within 60 sec)*

The worst hazard for release and ignition of crude oil from road tanker catastrophic failure will be experienced to a maximum radial distance of 79m from the source with potential lethal effects within 1 minute.

The risk significance for the potential worst case scenario resulting from road tanker accident/incident has been presented below. For calculating the risk significance, the likelihood ranking is considered to be "2" as the frequency analysis for rupture is computed at "*1.5 X 10^{-5}*" whereas the consequence ranking has been identified to be as "*5*" as the potential fatal zone is likely to span over a radial distance of 78m. (For criteria ranking please refer to ***Table 7.1*** and ***Table 7.2***).

Risk Ranking – Road Tanker Catastrophic Failure (Worst Case Scenario)

Likelihood ranking	**2**	**Consequence ranking**	**5**
Risk Ranking & Significance = 10 i.e. "Medium" i.e. Risk is Tolerable and can be managed through adoption of necessary controls.			

E) Hazardous Material Releases or Mishaps

Release of following materials are not considered as major accidents and therefore are not quantified in terms of frequency, consequence and the resulting risk.

- Diesel fuel;
- Lubricants;
- Mud Chemicals;
- Explosives.

Exposure to such hazards would be **occupational** rather than **major** hazards.

F) External Hazards

External hazards which may impair the safety of the rig include the following:

- Severe weather conditions;
- Earthquake or ground movement; and
- Security breaches.

Extreme weather conditions are primarily lightening, cyclones and high winds and heavy rains. They may result in injury (through slips trips of personnel) or equipment damage. Cyclones and high winds may damage the rig structure. There are potential hazards to workers from direct impact of the structure i.e. falling equipment and any subsequent hydrocarbon releases caused by equipment damage. However, no fatalities are expected from such conditions i.e. the risk to workers is low, providing:

- Reliable weather forecasts are available;
- Work or rig move is suspended if conditions become too severe;
- Design and operational limits of the rig structure are known and not exceeded.

The risk of external hazards causing blowouts has been considered in the frequency estimation of oil and gas blowouts in the earlier sections.

Individual Risk

Individual risk is the probability at which an individual may be expected to sustain a given level of harm from the realization of specified hazards. In simple terms it is a measure to assess the overall risk of the area concerned thus to protect each individual against hazards involving hazardous chemicals, irrespective of the size of the accident that may occur. Graphically it represents as iso-risk contour which connects all of the geographical locations around a hazardous activity with the same probability of fatality.

In order to generate different level of iso-risk curves for the area concerned, it is required to estimate the respective contribution of each reference scenario. Accordingly, individual risk of each scenario was estimated by combining the frequency of the initiating event, the conditional probability of that scenario sequence and the Probit value of the effect footprints. In particular following expression was used to estimate the Individual Risk (IR) at a given geographical location for each reference scenario:

$$IR(x, y, i) = fi.PFi \ldots\ldots\ldots \text{(Eq. iv)}$$

where:

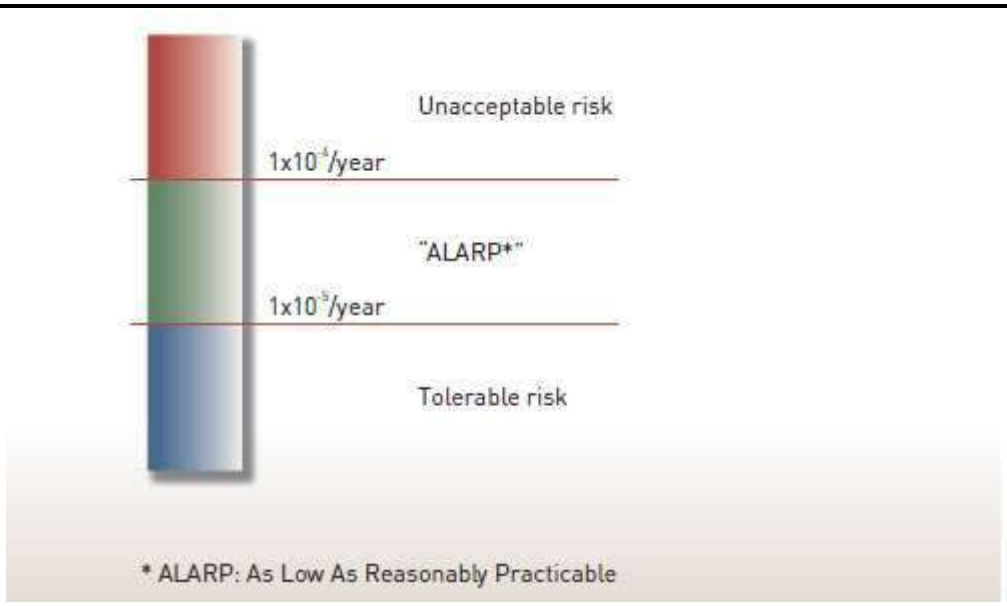
- fi is the frequency of the accident scenario i (year-1);

calculated as multiplicative factor of the frequency of the initiating event and the probability that the sequence of events leading to the accident scenario i will occur: fi = fincident i . Psequence i

- PFi is the probability of fatality that the accident scenario i will result at location (i.e. Probit).

The individual risk so obtained is then compared with the Tolerance Criteria of Individual Risk as provided in the ***Figure 7.23*** below.

Figure 7.23 Tolerance Criteria for Individual Risks



Hence for the proposed project the individual risk has been considered for both blow outs and gas releases and ignition during well drilling and from oil & gas pipeline failure. Based on the above equation the individual risk as calculated including the tolerance criteria has been presented in the ***Table 7.24*** below.

Table 7.24 Individual Risk – Blow Out & Loss of Containment

Accident Scenarion-Frequency	Fatality Probability	Individual Risk	Individual Risk Criterion
A. Blow Outs			
0.50×10^{-4}	0.01	5.00×10^{-5}	Tolerable
0.55×10^{-4}	0.01	5.50×10^{-5}	Tolerable
1.17×10^{-5}	0.01	1.17×10^{-7}	Tolerable
0.97×10^{-5}	0.01	9.70×10^{-6}	Tolerable
B. Oil/Gas Pipeline Failure			
2.43×10^{-4}	0.01	2.43×10^{-6}	Tolerable
1.05×10^{-5}	0.01	1.05×10^{-7}	Tolerable

The individual risk criterion for blow outs and well releases leading to 1% fatality probability has been identified to be within ALARP limits. However still necessary control measures in the form of design interventions, use of well control equipment's etc. will be adopted by Vedanta Ltd (Cairn Oil & Gas) to minimise the risk further.

7.2.2 *Risk Assessment for Offshore Activity*

Objectives and Scope

This study is conducted as a representative case for one RF Platform, which is an offshore platform located almost in the central area of the PKGM-1 Block. Other existing platforms are assumed to be similar to the RF Platform and hence the risk associated with them is expected to be similar in line with the risks associated with the RF Platform.

The scope of the risk assessment Study included evaluation of the risks to personnel working on the RF Platform during normal operations. As stated earlier other existing platforms are assumed to be similar to the RF Platform and hence the risk associated with them is expected to be similar lines.The analysis carried out was limited to estimation of personnel risks associated with travel to/from and their presence on the Platform.

Assumptions

The risk analysis has been based on combination of data. Some of the data are derived from the operational data of the already existing RF & other existing Platforms. In some cases where specific data has not been available or is not practicable to obtain, industry-wide data has been used; primarily from the North Sea (examples of this include transport, system leak / fire frequencies, etc.) in the absence of data for the Indian continental shelf. Where this has been the case, the data has been assessed for its applicability and, if necessary, modification factors were applied using engineering judgement and ERM's experience of the offshore risk analysis. The remainder of this section has been structured as follows:

- Facilities Description
- Methodology of the QRA Study
- Hazards identified in this study
- The study inputs
- Consequence analysis
- Results of the QRA Study
- Conclusions
- *Annex 2* EIA Volume 2 presents Ship Collisions Risk Assessment
- *Annex 3* EIA Volume 2 presents Transport & Occupational Risks
- *Annex 4* EIA Volume 2 presents Dropped Object Hazards and Risk Assessment

Facility Description

a) Topside Process Facilities

A wellhead platform typically consist of the following process facilities as a minimum:

- Well flow arm;
- Production header & Test header (Gas & Oil);
- Multi-Phase Flow Meter (Gas & Oil);
- Instrument/Utility gas system;
- Pneumatic based well shutdown panel inclusive of safety shutdown system;
- Safety & relief system;
- Fire & gas detection system;
- Chemical injection system;

- Crude/ condensate transfer system;
- Vent and drain system;
- Lift gas system;
- Launchers / Receivers; and
- Fresh Water System.

b) Oil/Gas Production Manifold, Test Header, Lift Gas Manifold

The production manifold (Oil) is designed for hook-up of wells (both existing and proposed). The production manifold has a production header for gathering of well fluid and a test header for testing individual wells. The production and test header are inter-connected for processing of well fluid and testing of individual wells, respectively.

The production manifold (Gas) is designed for hook-up of wells (both existing and proposed). The production manifold has a production header for gathering of well fluid and a test header for testing individual wells. The production and test header is inter-connected for processing of well fluid and testing of individual wells, respectively. The lift gas manifold is designed for hook-up of wells (both existing and proposed). The individual lift gas flow arms can also be hooked-up with vent header for manual depressurizing whenever required.

c) Well Testing Facilities

Well testing facility consist of – Multi Phase Flow Meter (MPFM) along with associated instrumentation, for measurement of oil, water and gas flow rate, for the flow arm string capacity additionally 25% surge factor on well fluid flow and 15% swell factor on oil flow. MPFM functions for wells testing purposes.

d) Instrument/Utility Gas System

The instrument/utility gas system is designed for 180 Nm^3/hour of instrument/utility gas requirement as minimum. The instrument/utility gas is generated by following three various sources:
1. Lift gas;
2. Non-associated gas from gas manifold; and
3. Associated gas from Oil manifold.

Among the above, lift gas source is the primary source for instrument/ utility gas system. Instrument/utility gas system consists of lift gas heater (will be in line when lift gas is a primary source for instrument/utility gas system), pressure reduction, instrument gas drum along with associated piping, instrumentation and safety items.

d1) Inlet Gas Condition

Lift Gas
- Pressure, psig : 1737
- Temperature, ^oC : 19

Associated Gas (Oil manifold)
- Pressure, psig : 217-287

- Temperature °C : 90

Associated Gas (Gas manifold)
- Pressure, psig : 624-839
- Temperature °C : 90

The instrument/utility gas system consists of the following equipment:

e) Lift Gas Heater

Lift gas heater is designed to preheat the lift gas from 19 ^{o}C to 60 ^{o}C by well fluid as heating source. Lift gas heater will be in line when lift gas is a primary source for instrument/utility gas system.

Shell side
- Fluid : Well fluid from Oil Manifold
- Operative pressure : 217 psig (min), 287 psig (max)
- Operative temperature : 90 °C (inlet)

Tube side
- Fluid : Lift gas
- Operative pressure : 1737 psig
- Operative temperature : 19 °C (inlet), 60 °C (outlet)

f) Instrument Gas Drum

Platform instrument/utility gas requirement is supplied by instrument gas drum at the platform. Typical details are as follows:
- Number : One
- Capacity : 0.44 m^3 (508 mm ID X 1981mm S/S)
- Pressure, kg/cm^2g : 10.68/ 7.7 / 14.06 (Max/ Min. / Design)
- Temperature, ^{o}C : 16

Instrument Gas Drum is provided with automatic drain system through Level Control Valve to automatically remove the liquid, generated if any.

g) Drain system

Platform drain system shall consist of:
- Open deck drain to collect storm water and subsequent routing to Overboard;
- Open hydrocarbon drain to collect platform hydrocarbon maintenance drains and skid drains. Open hydrocarbon drains shall be routed to closed drain drum for onward transfer; and
- Closed hydrocarbon drain to collect all continuous and intermittent operational drains.

The closed drain system consists of a closed drain drum with associated piping and instrumentations. Closed drain drum evacuation is done with the help of closed drain transfer pump. Discharge line of the closed drain Transfer Pump is routed to departing well fluid pipeline.

h) Closed Drain Drum

- Purpose : To collect liquid from Closed Drain Header (CDH) and open Hydrocarbon Drain (OHD) Header.
- Hold-Up : 1.5m³ - with 80% full
- Liquid Disposal : To departing well fluid pipeline
- Mode of Operation : Evacuation to be carried out using closed drain Transfer pump

i) Closed Drain Transfer Pump

- Purpose :To transfer liquid from Closed Drain drum to Oil Departing line.
- Type : Positive displacement pump
- Capacity : 200 LPH @ 400 psig
- Liquid Disposal : To departing well fluid pipeline
- Mode of Operation : Gas driven

j) Chemical injection system

j1) Oil Corrosion Inhibitor System

- Service : OCI injection to each flow arm.
- Mode of injection : Gas driven pump (1Standby + 1Duty).
- Pump capacity : 1.5LPH @ 400 psig
- Dosage rate : 60 ppm (wt) of maximum well fluid flow rate.
- Storage : OCI Storage Tank (One no.)
- Storage capacity : 1 m³ (15 days @ 60 ppm (wt.) of max flow at each)

j2) Gas Corrosion Inhibitor System

- Service : GCI injection to each flow arm
- Mode of injection : Gas driven pump (1Standby + 1Duty).
- Pump capacity : 3.5LPH @ 900 psig
- Dosage rate : 60 ppm (wt.) of maximum well fluid flow rate.
- Storage : GCI Storage Vessel (One no.)
- Storage capacity : 1.5 m³ (15 days @ 60 ppm (wt.) of max flow at each)

j3) Oil Scale Inhibitor System

- Service : OSI injection to each flow arm
- Mode of injection : Gas driven pump (1Standby + 1Duty).
- Pump capacity :1.5LPH @ 400 psig
- Dosage rate : 60 ppm (wt.) of maximum well fluid flow rate
- Storage : OSI Storage Vessel (One no.)
- Storage capacity :1 m³ (15 days@60 ppm (wt.) of maximum flow at each)

All 3 Chemical Storage Tanks shall be given as combined Single Tank with 3 compartments.

k) Launchers/ Receivers

Following launchers / receivers is typically provided on the well platform:

Oil Pipeline Pig Launcher (8" X 12")

- Pipeline size : 8"
- Service : Well fluid to other platform

Gas Pig Launcher (8" X 12")

- Pipeline size : 8"
- Service : NANG to other platform

Lift Gas Pig Receiver (4" X 8")

- Pipeline size : 4"
- Service : Lift gas from other platform

l) Safety and Relief system

Platform Safety Relief System including ESD & FSD is designed as per API-RP-14C. All vents and relief valves is discharged to safety and relief system comprising of Vent knock out drum, flame arrestors, vent boom etc. Further, the vent boom is located at a safe distance and at a safe location from the platform in prevailing downwind direction. The vent connections from wellhead flow arms, production manifold, receivers/ launchers, crude condensate vessel etc. are hooked-up with vent header.

Vent Knock Out Drum

- Purpose : To collect liquid from Vent Header during Emergency/ Continuous relief before being discharge ito atmosphere through vent boom.
- Capacity : 1.02 m^3 (762mm I.D X 1981mm T/T)
- Liquid Disposal : To closed drain drum
- Relief disposal : To atm through flame arrestors and vent boom

The vent boom is so located that any H_2S and HC gas concentration on the platform remains within acceptable limits for personnel safety, under worst operating and environmental conditions.

m) Fire and Gas Detection and Suppression System

Fire and gas detection facilities is provided to ensure safe operation of the platform. The system can be clubbed in Pneumatic based well shut down panel with provision of local and remote monitoring. Pneumatic based system is designed to ensure system integrity and to reduce maintenance.

This includes:-

- Fusible plug loop with necessary ESD and FSD system
- Portable CO_2 and DCP fire extinguisher

n) Fresh Water Systems

Fresh water system is provided to supply the potable water to the Platform.

- Number : One
- Capacity, m^3 : 1 (1m x 1m x 1m)
- Pressure, kg/cm^2g : Atm
- Temperature, ^oC : 15-40

o) Platform Crane

Platform Crane shall be provided to handle the materials at platform.

- Number : One
- Capacity : 5 MT Dynamic Load @ 10 m Radius

The holdup capacity of the Diesel Day Tank is provided for 24 Hrs continuous running of platform crane.

p) Diesel Electric Generator

Diesel Electric Generator is provided to fulfill the emergency power requirements.

- Number : One
- Capacity : 35 kW MT Dynamic Load @ 10 m Radius

The holdup capacity of the Diesel Day Tank is provided for 24 hours continuous running of Diesel Electric Generator.

q) Platform Demography

Wellhead Crew for Satellite Platforms: The case is modeled reflecting the normal operation and manning philosophy i.e. 3 people visiting the platform 2 days per week and work there during the day for an average 8 hours.

r) Helicopter Operations

The flying time from Ravva onshore terminal to RF and other wellhead platform is expected to be 10 minutes. On an average one landing en-route has been considered.

The helicopters used to transport personnel to and from the Ravva platforms are expected to be Bell, and the normal passenger level is considered as 7 passengers and 2 pilots. The average flight time to a Ravva field platform is 10 minutes. It is considered that on an average day the wellhead team will visit two platforms.

Methodology

a) Study Inputs

The main stages of QRA study are as follows:

Facilities Definition - This stage involves setting the boundary limits of the study and defining the facilities layouts, its process equipment, hydrocarbon inventories, safety systems and manning levels such that they can be entered into the risk model;

Hazard Identification - Categories of accidents that have the potential to cause fatalities such as hydrocarbon releases, vessel collisions, structural events and transport accidents were identified;

Development of Accident Scenarios – The accident scenarios for the hydrocarbon events and potential scenarios that could lead to loss of containment. Additional scenarios that could lead to fatalities associated with the non-hydrocarbon hazards were also assessed;

Frequency Analysis and Consequence Modeling - The initial frequency analysis and consequence modeling of the hydrocarbon release scenarios were conducted. The results were then used as inputs to the risk model;

Risk Integration - The ultimate frequencies and consequences of the various outcomes of the numerous accident scenarios associated with the platform were integrated at this stage to determine the risk results, i.e. Individual Risk Per Annum (IRPA) and Potential Loss of Life (PLL). Note that risk integration of the offshore Platform with the LQ at S.Yanam to determine the overall risk results for comparison with the acceptance criteria is excluded in this study;

Risk Reduction Measures (RRM) - Based on the QRA findings, additional RRM if required will be proposed for further reducing the risk, as an approach in fulfilling As Low as Reasonably Practicable (ALARP) principle in the design of the facilities.

b) Personnel Risk Measures

b1) Overview

The following personnel risk parameters were considered in the QRA Study:

- Location Specific Individual Risk (LSIR);
- Individual Risk Per Annum (IRPA); and
- Potential Loss of Life (PLL) per year.

b2) Fatality Phrases

In general, fatalities resulting from the various accident scenarios may be categorized as follows:

- Immediate fatalities which occur in the local area as an immediate result of the hazardous event;
- Escape fatalities of personnel who have survived the immediate effects of the accident but who are not able to reach a means of evacuation; and
- Evacuation fatalities which occur during emergency evacuation of personnel from the platform

b3) Location Specific Individual Risk (LSIR)

Location Specific Individual Risk (LSIR) indicates the risk at a particular location. It is the fatality risk for a hypothetical individual who remains at that particular location 24 hours per day for 365 days per year. It should be noted that the LSIR is independent of the manning

level. No criterion is set for acceptability of LSIR, but rather it is used to compare risk levels in different areas of the facility.

b4) Individual Risk Per Annum (IRPA)

Individual risk is the combined risk to a single person, as a result of exposure to all identified hazards. Individual risk is normally calculated as the frequency of fatality per year. Individual risk is the risk to which an individual worker is exposed taking into account their movement around the facilities and the time spent offshore.

b5) Potential Loss of Life (PLL)

The Potential Loss of Life (PLL) is defined as the average annual number of fatalities expected amongst personnel arising from their work on the platform (and their travel to and from the platform).

The risk analysis process estimates the frequency (F) and fatality level (N) associated with each outcome from each initiating event. Therefore for each outcome, there is an F-N pair, where F is a frequency of occurrence per year and N is the predicted number of fatalities. The PLL can thus be calculated as follows:

$$PLL = F1N1 + F2N2 + F3N3 = \Sigma FnNn$$

The number of fatalities is then the product of the number of personnel in a given area and the probability of fatality given their presence in that area at the time of the initiating event.

c) Risk Acceptance Criteria

Due to the unavailability of the Company's Individual Risk Criteria, the generic UK Health and Safety Executive criteria of an average individual risk on offshore installations was proposed to be adopted for this Project:

- Maximum tolerable for installations in general - **1×10^{-3} per year**; and
- Broadly acceptable for any installation - **1×10^{-6} per year**.

Within the two limits, acceptance criterion is based on ALARP.

Hazard Identification

a) Overview

The following hazards were assessed in this study:

- Topside Hydrocarbon Releases;
- Riser and Pipeline Releases;
- Blowouts;
- Vessel Collisions;
- Transportation Accidents;
- Occupational Accidents;
- Structural Events; and
- Dropped Objects.

b) Topside Hydrocarbon releases

The accidental releases of flammable hydrocarbon on the Platform were assessed to have potential to lead to personnel fatalities. Detailed Consequence Analysis for topside process events is presented in subsequent sections.

The probability of an explosion is highly dependent on the gas cloud location and the level of platform congestion. In the case that significant quantities of flammable gas cover areas of congestion on the platform, then significant explosion consequences could be generated on ignition. In the platform, no explosions are expected due to the minimum facility installation where there are relatively low obstructions, hence the potential for explosion events which could generate significant overpressures on the platform was considered unlikely. Further quantification of risk was therefore not carried out.

c) Riskers and Pipeline Releases

Risks experienced by personnel due to failures of the riser/ pipeline sections were assessed in this QRA Study. The consequences for the pipeline and the associated riser are detailed in subsequent sections.

d) Blowouts

A blowout is defined as an uncontrolled release of well fluids from the wellhead. The blowout risk associated with the production phase from oil wells and gas wells during normal operations was assessed.

e) Vessel Collisions

The risks experienced by personnel due to collisions from in-field vessels were assessed. The facilities are located adjacent to the merchant shipping lanes and shipping routes. The platform is also visited by supply vessels. Details of the personnel risk calculations due to collision from in-field vessels are provided in ***Appendix 7.1 Ship Collision Risk Assessment*.**

f) Transport Accidents

Personnel working on the Platforms are transferred from and to the platform via helicopter. The helicopter journey is approximately 10 minutes. The transportation risk associated with personnel travelling by helicopter to the Platforms was assessed and detailed in the ***Annex 3 of* EIA Volume 2*:***

g) Occupational Accidents

Occupational accidents are defined as those that do not have the potential to cause fatalities outside the immediate area of the incident. In the majority of such accidents no more than a single fatality is expected to occur. These accidents include a wide variety of events such as falls, falling overboard, mechanical impacts, etc. The occupational accident risks were quantified and the details are presented in ***Annex 3 of EIA Volume 2*.**

h) Structural Events

The main cause of structural failures is extreme weather conditions. As the visit to the wellhead platform is restricted during severe weather conditions, the risk to personnel from structural failures is considered to be negligible and therefore not assessed further.

A review of the structural design criteria document (PRJ-RI-473100) that covered proposal for new platform and modification works in existing pltforms indicated factors of safety considered as design criteria as stated in ***Table 7.25.***

Table 7.25 Factors of Safety Considered for the Structure Design Criteria

SN	Design Condition	Factor of Safety
A	Foundation	
2	Pile penetration - extreme storm	1.5
3	Pile penetration - operating storm	2.0
4	On-bottom stability - still water *	2.0
5	On-bottom stability - still water with wave *	1.5
B	Tubular member hydrostatic collapse	
1	Extreme storm	1.5
2	Operation storm	2.0
3	Earthquake	1.2
4	Installation - jacket lowering to seabed	2.0
5	Installation - jacket laying on-bottom (accidental complete submergence)	1.5
6	Buoyancy tanks	2.0

Source: Design Doc: PRJ-RI-473100, Vedanta Ltd (Cairn Oil & Gas); Note * =Factor of safety against sliding, overturning, and bearing capacity.

i) Dropped Objects

There is a potential dropping of load on the topsides leading to equipment damage. The dropped object risks were quantified and the details are presented in ***Annex 4: Dropped object Hazards & Risk Assessment.***

Study Inputs

a) Hydrocarbon Fluid Properties

The fluid properties for different streams are summarised in ***Table 7.26.***

Table 7.26 Fluid properties for different streams

S.N.	Equipment/ Sections	Pressure (psig)	Temperature(◦C)
1	Oil Well Fluid	287	90
2	Gas Well Fluid	839	90
3	Oil Production Manifold / Test Manifold	287	90
4	Gas Production Manifold / Test Manifold	839	90
5	Oil Pipeline Pig Launcher	287	90
6	Gas Pipeline Pig Launcher	839	90
7	Lift Gas Manifold	1565	19
8	Lift Gas Heater Outlet	1565	60
9	Utility / Instrument Gas Supply	137	16
10	Instrument Gas Drum	137	16
11	CCD Pump Discharge	290	16

b) Isolatable Sections & Inventories

Isolation between sections is achieved by the ESD valves or non-return valves successfully operating on emergency shutdown.

The size of the inventories in terms of mass of hydrocarbon has been taken from an analysis of volumes in each inventory. ***Table 7.27*** presents a summary of the different isolatable sections, and section inventories.

Table 7.27 Isolatable Sections & Inventories

S. N.	Equipment / Section Name	Type	Mass Density Gas Phase (kg/m3)	Inventory of Gas Phase (kg)	Mass Density Liquid Phase (kg/m3)	Inventory of Liquid Phase (kg)
1	Christmas Tree Upstream of Choke Valve – Oil Well	L200m-D100mm Pipeline	40	53	788	198
2	Oil Production Manifold up to Oil Pipeline Pig Launcher SDV	L20m-D150mm Pipeline	40	54	788	203
		L40m - D200mm Pipeline				
3	Oil Test Manifold	L50m - D150mm Pipeline	40	30	788	112
4	Oil Export Pipeline to RB - Downstream of Launcher	L2.1Km - D200mm Pipeline	50.44	1742	788	24777
5	Christmas Tree Upstream of Choke Valve – Gas Well	L200m - D100mm Pipeline	47.47	144	788	91
6	Gas Production Manifold up to Gas Pipeline Pig launcher SDV	L20m - D150mm Pipeline	47.47	74	788	47
		L40m - D200mm Pipeline				
7	Gas Test Manifold	L50m - D150mm Pipeline	47.47	40	788	26
8	Utility / Instrument Gas Drum	L2m - D500mm Vessel	8.6	4	788	0
		L10m - D50mm Pipeline				
9	Closed Drain Drum	L2.1m - D975mm Vessel	8.6	13	788	62
10	Closed Drain Transfer Pump	L20m - D50mm Pipeline	40	0	788	31
11	Gas Export Pipeline to RG - Downstream of Launcher	L3.9Km - D200mm Pipeline	44.61	5317	788	2626
12	Lift Gas Pipeline from RB to Lift Gas Receiver SDV	L2.2Km - D100mm Pipeline	117.35	2028	788	0
13	Lift Gas Manifold from Pig Receiver SDV to well SDV & up to inlet of Lift Gas Heater	L30m - D100mm Pipeline	117.35	39	788	0
		L50m - D50mm Pipeline				
14	Lift gas heater outlet up to Instrument gas drum inlet PCV	L30m - D100mm Pipeline	8.6	2	788	0

c) Meteorological – Weather Data

This is used to define the wind speed distribution for use in smoke modelling. The wind rose used in the analysis is shown in ***Table 7.28.***

Table 7.28 Meteorological data

Wind	Wind Blowing Toward Direction								
Speed	**N**	**NE**	**E**	**SE**	**S**	**SW**	**W**	**NW**	**TOTAL**
1.0 m/s	0.05	0.07	0.05	0.04	0.04	0.09	0.18	0.12	0.64
3.0 m/s	0	0	0.02	0.02	0.01	0.02	0.01	0	0.08
5.0 m/s	0	0.03	0.04	0.01	0	0.07	0.09	0.01	0.25
9.0 m/s	0	0.01	0	0	0	0.01	0.01	0	0.03
Total									1

d) Population Distribution & Helicopter Operation

d1) Population Distribution

Wellhead Crew for wellhead Platforms (RA to RF): The case is modelled reflecting the normal operation and manning philosophy i.e. 3 people visiting a platform 2 days per week and work there during the day for an average 8 hours.

d2) Population Distribution

Table 7.29 Manning Distribution & Helicopter Operation at the Platform

Platform	Average number of crew visit to wellhead	Average Number of visit to wellhead per week	Average intermediate landings	Average Travel time from Ravva Terminal to the platform	Average duration of stay on wellhead per visit
	Nos	**Nos**	**Nos.**	**Minutes**	**Hours**
RF	3	2	0	10	8

The flying time from Ravva onshore terminal to a wellhead platform (RA to RF) is expected to be in the region of 10 minutes. On an average one landing en-route has been considered.

The helicopters used to transport personnel to and from the Ravva platforms are expected to be Bell, and the normal passenger level is considered as 7 passengers and 2 pilots. The average flight time to a Ravva field platform is 10 minutes. It is considered that on an average day the wellhead team will visit two platforms.

e) Allocation of Failure Frequencies

e1) Process Release Frequencies

Process release frequencies are taken from Hydrocarbon Release (HCR) database. The sample failure frequencies are indicated in ***Table 7.30***.

Table 7.30 Process Release Frequencies- Extract from HCR Database

Equipment	Minor Leak		Medium Leak		Major Leak	FB Rupture	Total
	5mm	12.5mm	25 mm	50 mm	100 mm	>100 mm	
Process Pipe < 3"	1.90E-04	2.13E-05	8.26E-06	8.66E-07	1.73E-06		2.2 E-4
Process Pipe 3"-11"	5.10E-05	8.37E-06	1.83E-06	1.05E-06	5.20E-07	3.92E-06	6.7 E-5
Process pipe >11"	4.97E-05	1.01E-05	9.22E-07			5.52E-06	6.6 E-5
Flanges < 3"	2.83E-05	2.73E-06	2.10E-06	4.18E-07	2.11E-07	2.11E-07	3.4 E-5
Flanges 3"-11"	4.83E-05	2.36E-06	1.69E-06	3.38E-07	3.38E-07	2.36E-06	5.5 E-5
Flanges >11"	7.83E-05	2.24E-06		2.24E-06		6.71E-06	8.9 E-5
ESD Valves < 3" ESD	1.47E-04	2.94E-05			2.94E-05		2.1 E-4
Valves 3'-11" ESD	4.28E-04	2.14E-05					4.5 E-4
Valves >11" Control	7.99E-04						8.0 E-4
Valves < 3" Control	1.40E-03	6.98E-05	6.98E-05	2.32E-05			1.6 E-3
Valves 3'-11" Control	8.92E-04	2.55E-05	7.65E-05			5.10E-05	1.0 E-3
Valves >11" Relief	1.60E-03						1.6 E-3
Valves < 3" Relief	6.38E-04	1.51E-04					7.9 E-4
Valves 3'-11" Relief	8.71E-04	1.31E-04	4.36E-05			4.36E-05	1.1 E-3
Valves >11" Manual							
Valves < 3" Manual	1.56E-04			1.56E-05			1.7 E-4
Valves 3'-11" Manual	3.29E-05		1.64E-05	1.64E-05		3.29E-05	9.9 E-5
Valves >11"	5.85E-04		2.34E-04				8.2 E-4
Small Bore Fittings	4.22E-03	5.89E-04	3.86E-05	1.56E-05	7.81E-06	7.81E-06	4.9 E-3
Heat Exchanger HC in Shell	4.15E-03	4.88E-04	2.44E-04				4.9 E-3
Heat Exchanger HC in Tube	2.81E-03	5.36E-04				1.34E-04	3.5 E-3
Centrifugal Compressor	1.01E-02	2.12E-03	2.65E-04				1.2 E-2
Reciprocating Compressor	7.69E-02	8.01E-03	1.60E-03	1.60E-03			8.8 E-2
Centrifugal Pump Single Seal	8.49E-03	9.90E-04	1.41E-04				9.6 E-3
Centrifugal Pump Double Seal	6.86E-03	6.67E-04					7.5 E-3
Storage Tank	2.42E-03	2.42E-03	7.76E-04	2.91E-04		2.91E-04	6.2 E-3
Separator - Vertical	1.10E-03						1.1 E-3
Separator - Horizontal	8.83E-04	8.83E-04	1.47E-04	2.94E-04	1.47E-04		2.4 E-3
KOD - Vertical	1.08E-03	1.08E-03		7.17E-04			2.9 E-3
KOD - Horizontal	4.38E-03	4.56E-03		4.38E-03	2.19E-03		1.5 E-2
Scrubber - Vertical	8.40E-04	4.20E-04					1.3 E-3
Scrubber - Horizontal							
Metering - Oil	2.85E-02	5.34E-03	5.92E-04	5.92E-04	1.19E-03	5.92E-04	3.7 E-2
Metering - Gas	2.54E-02	2.80E-03	3.51E-04				2.9 E-2
Metering - Condensate	2.89E-02	3.77E-03					3.3 E-2
Xmas Tree P<=5000psi	3.23E-03	3.80E-04	4.77E-05			9.50E-05	3.8 E-3

f) Risers & Pipelines Leak frequencies:

OGP March 2010 database provides frequencies for risers and pipelines releases. Risers are considered to comprise three sections:

- Above water (often taken to be the topside section below riser ESDV/NRV as applicable);
- Splash Zone (exposed to aggressive corrosion conditions and ship collisions); and

- Below water (to the flange connection with the pipeline or a spool piece)

The frequencies given are based on analysis for pipelines conveying hydrocarbons. There is an implicit assumption that the pipelines are built to a recognised international standard such as ANSI/ASME B31.4/8 or for subsea pipelines DNV-OS-F101. An extract from OGP - 2010 is provided in the ***Table 7.31, Table 7.32 & Table 7.33.***

Table 7.31 Riser & Pipeline Frequencies

Pipeline	Category	Failure Frequency	Unit
Subsea pipeline: in open sea	Well stream pipeline and other	5.0×10^{-4}	per km-yr^{-1}
	Small pipelines containing unprocessed fluid		
	Processed oil or gas, pipeline diameter ≤ 24 inch	5.1×10^{-5}	per km- yr^{-1}
	Processed oil or gas, pipeline diameter > 24 inch	1.4×10^{-5}	per km- yr^{-1}
Subsea pipeline: external loads causing damage in safety zone	Diameter ≤ 16 inch	7.9×10^{-4}	per year
	Diameter > 16 inch	1.9×10^{-4}	per year
Flexible pipelines: subsea	All	2.3×10^{-3}	per km- yr^{-1}
Risers	Steel - diameter ≤ 16 inch	9.1×10^{-4}	per year
	Steel – diameter > 16 inch	1.2×10^{-4}	per year
	Flexible	6.0×10^{-3}	per year
Oil pipelines onshore	Diameter < 8 inch	1.0×10^{-3}	per km- yr^{-1}
	8 inch ≤ diameter ≤ 14 inch	8.0×10^{-4}	per km- yr^{-1}
	16 inch ≤ diameter ≤ 22 inch	1.2×10^{-4}	per km- yr^{-1}
	24 inch ≤ diameter ≤ 28 inch	2.5×10^{-4}	per km- yr^{-1}
	Diameter > 28 inch	2.5×10^{-4}	per km- yr^{-1}
Gas pipelines onshore	Wall thickness ≤ 5 mm	4.0×10^{-4}	per km- yr^{-1}
	5 mm < wall thickness ≤ 10 mm	1.7×10^{-4}	per km- yr^{-1}
	10 mm < wall thickness ≤ 15 mm	8.1×10^{-5}	per km- yr^{-1}
	Wall thickness > 15 mm	4.1×10^{-5}	per km- yr^{-1}

Table 7.32 Hole Size distribution for Risers & Pipelines

Hole size	Subsea pipeline	Onshore Pipeline		Riser
		Gas	Oil	
Small (< 20 mm)	74%	50%	23%	60%
Medium (20 to 80 mm)	16%	18%	33%	15%
Large (> 80 mm)	2%	18%	15%	-
Full rupture	8%	14%	29%	25%

Table 7.33 Release Location Distribution for Risers

Riser Location	Distribution
Above water	20%
Splash zone	50%
Subsea	30%

The calculated Riser frequencies for different hole-sizes are as per ***Table 7.34.***

Table 7.34 Riser Failure Frequency

Leak Size	Above Water		Splash Zone	
	<=16″ Diameter	**>16″ Diameter**	**<=16″ Diameter**	**>16″ Diameter**
5 mm Leak	1.09E-04	1.44E-05	2.73E-04	3.60E-05
25mm Leak	2.73E-05	3.60E-06	6.83E-05	9.00E-06
100mm Leak	4.55E-05	6.00E-06	1.14E-04	1.50E-05

Blowouts Frequencies

Blowout frequencies are used from OGP Risk assessment Data Directory Report No. 434-2, March 2010. It provides data in two categories. One is for North Sea and in other offshore areas where the equipment is of 'North sea standard'. The second category is for well operations in other areas of world where 'North sea standard' is not used.

North Sea standard operations in OGP database refers to operation performed with BOP installed including shear ram and two barrier principle followed. It is assumed that well operations in Vedanta Ltd (Cairn Oil & Gas) will follow this standard and hence Blow out frequencies indicated for 'North sea standard' are used in present study.

Following definitions are taken from OGP report:

Blowout: An incident where formation fluid flows out of the well or between formation layers after all the predefined technical well barriers or the activation of the same has failed.

Well release: An incident here hydrocarbon flow from the well at some point where flow was not intended and the flow was stopped by use of the barrier system that was available on the well at the time of incident.

Base frequency for blowout and well releases are selected as producing wells (excluding external causes) are as under.

For Oil Wells:

- Well Blowout frequency : 2.60E-06
- Well Release frequency : 2.90E-06

For Gas Wells:

- Well Blowout frequency : 1.80E-05
- Well Release frequency : 2.00E-05

Possible external causes of blowouts include:
- Escalation from process fire or riser fire such as at Piper Alpha;
- Ship collision;
- Structural collapse in severe weather; and
- Military or pirate attacks.

These are not included in the analysis of blowouts if they are separately modelled under the other hazard categories, as is the case in present study. However, for simple studies that do not model such escalations in full, it is appropriate to include them as blowouts.

The calculations for frequencies therefore are as under:

For Oil Well

Blow out: [Blow out frequency from producing well/per year] x No. of producing wells [2.6 x 10-6] x 3 = 7.8 x 10^{-6} per year

Well Release: Same way the well release frequency calculated is [2.9 x 10-6] x 3 = 8.7 x 10-6 per year

For Gas Well

Blow out: [Blow out frequency from producing well/per year] x No. of producing wells [1.8 x 10-5] x 3 = 5.40 x 10^{-5} per year

Well Release: Same way the well release frequency calculated is [2.0 x 10-5] x 3 = 6.0 x 10-5 per year

Consequence Analysis

The Consequence Analysis results for jet fire, pool fire and flash fire are presented as following:

Jet Fire Results

Ignited gaseous hydrocarbon releases have been modelled as jet flames. The flame length is based on the release rate and is calculated using the Shell Chamberlain model. Using the flame length, contours can be determined for different radiation levels using factors derived from the Shell Chamberlain model within DNV's PHAST software package. For this RA, 100% fatalities are assumed if personnel are inside the 37.5kW/m2 radiation contour. The fatality rate for a given area is assumed to be equal to the ratio of the area of the 37.5kW/m2 radiation contour and the floor area of the module.

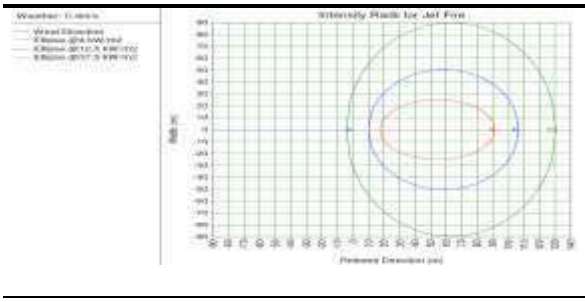
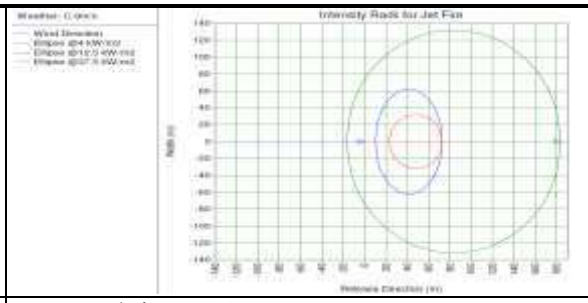
The Jet fire results are presented in the ***Table 7.35.*** The maximum distance of jet fire for 12.5 kW/m2 of heat flux will be at 177.6 m of length and 198.5 m of width while for 4 kW/m2 of heat flux, the maximum distance has been worked out as 267.9 m of length and 344.4 m of width.

Table 7.35 Jet Fire Radiation Results (in meters) for all weather conditions

S N	Leak Size	Event Name	Release Rate (kg/s)	Jet Fire Flame Length	1 m/s F Stability				5 m/s D Stability				9 m/s C Stability			
					12.5 kW /m² length	12.5 kW/m² width	4 kW/m² length	4 kW/m² width	12.5 kW/m² length	12.5 kW/m² width	4 kW/m² length	4 kW/m² width	12.5 kW/m² length	12.5 kW/m² width	4 kW/m² length	4 kW/m² width
1	S	ISO05_PL_L200m-D100 mm _V_S	0.16	5.6	0.0	0.0	4.3	3.6	0.0	0.0	3.8	2.8	0.0	0.0	3.1	1.7
2	M	ISO05_PL_L200m-D100 mm_V_M	4.04	70.1	23.2	22.6	32.8	42.2	24.7	21.9	33.0	41.8	26.1	20.6	33.2	40.6
3	L	ISO05_PL_L200m-D100 mm_V_L	64.67	22.7	90.8	99.7	154.	177.7	93.1	100.7	144.2	178.5	96.8	100.8	134.8	179.5
4	R	ISO05_PL_L200m-D100 mm_V_R	64.67	70.07	90.8	99.7	154.4	177.7	93.1	100.7	144.2	178.5	96.8	100.8	134.8	179.5
5	S	ISO06_PL_L20m-D150mm_V_S	0.16	5.65	0.0	0.0	4.3	3.6	0.0	0.0	3.8	2.8	0.0	0.0	3.1	1.7
6	M	ISO06_PL_L20m-D150 mm_V_M	4.04	70.07	23.2	22.6	32.8	42.2	24.7	21.9	33.0	41.8	26.1	20.6	33.2	40.6
7	L	ISO06_PL_L20m-D150 mm_V_L	64.67	22.71	90.8	99.7	154.4	177.7	93.1	100.7	144.2	178.5	96.8	100.8	134.8	179.5
8	R	ISO06_PL_L20m-D150 mm_V_R	145.50	95.08	134.3	146.3	235.0	259.2	136.0	149.3	219.7	261.3	62.6	123.9	200.9	263.5
9	S	ISO06_PL_L40m-D200 mm_V_S	0.16	5.65	0.0	0.0	4.3	3.6	0.0	0.0	3.8	2.8	0.0	0.0	3.1	1.7
10	M	ISO06_PL_L40m-D200 mm_V_M	4.04	70.07	23.2	22.6	32.8	42.2	24.7	21.9	33.0	41.8	26.1	20.6	33.2	40.6
11	L	ISO06_PL_L40m-D200 mm_V_L	64.67	22.71	90.8	99.7	154.4	177.7	93.1	100.7	144.2	178.5	96.8	100.8	134.8	179.5
12	R	ISO06_PL_L40m-D200 mm_V_R	258.66	119.04	177.1	190.9	314.0	337.3	179.3	196.1	295.7	340.9	177.6	198.5	267.9	344.3
13	S	ISO07_PL_L50m-D150 mm_V_S	0.16	5.65	0.0	0.0	4.3	3.6	0.0	0.0	3.8	2.8	0.0	0.0	3.1	1.7
14	M	ISO07_PL_L50m-D150 mm_V_M	4.04	70.07	23.2	22.6	32.8	42.2	24.7	21.9	33.0	41.8	26.1	20.6	33.2	40.6
15	L	ISO07_PL_L50m-D150 mm_V_L	64.67	22.71	90.8	99.7	154.4	177.7	93.1	100.7	144.2	178.5	96.8	100.8	134.8	179.5
16	R	ISO07_PL_L50m-D150 mm_V_R	145.50	95.08	134.3	146.3	235.0	259.2	136.0	149.3	219.7	261.3	62.6	123.9	200.9	263.5
17	S	ISO08_PL_L3900m-D200 mm_V_S	0.16	5.65	0.0	0.0	4.3	3.6	0.0	0.0	3.8	2.8	0.0	0.0	3.1	1.7
18	M	ISO08_PL_L3900m-D200 mm_V_M	4.04	70.07	23.2	22.6	32.8	42.2	24.7	21.9	33.0	41.8	26.1	20.6	33.2	40.6
19	L	ISO08_PL_L3900m-D200 mm_V_L	64.67	22.71	90.8	99.7	154.4	177.7	93.1	100.7	144.2	178.5	96.8	100.8	134.8	179.5
20	R	ISO08_PL_L3900m-D200 mm_V_R	258.66	119.04	177.1	190.9	314.0	337.3	179.3	196.1	295.7	340.9	177.6	198.5	267.9	344.3
21	S	ISO09_PL_L2200m-D100 mm_V_S	0.37	7.98	4.5	2.4	8.3	8.1	7.6	0.4	8.1	7.2	1.3	0.7	7.7	6.0
22	M	ISO09_PL_L2200m-D100 mm_V_M	9.16	32.32	35.4	36.8	53.3	67.2	37.8	36.4	51.5	66.9	40.0	35.2	51.7	66.3
23	L	ISO09_PL_L2200m-D100 mm_V_L	146.59	95.35	134.8	146.8	235.9	260.1	136.5	149.8	220.6	262.3	137.7	150.9	201.6	264.5
24	R	ISO09_PL_L2200m-D100 mm_V_R	146.59	95.35	134.8	146.8	235.9	260.1	136.5	149.8	220.6	262.3	137.7	150.9	201.6	264.5
25	S	ISO10_PL_L30m-D100 mm_V_S	0.37	7.98	4.5	2.4	8.3	8.1	7.6	0.4	8.1	7.2	1.3	0.7	7.7	6.0
26	M	ISO10_PL_L30m-D100 mm_V_M	9.16	32.32	35.4	36.8	53.3	67.2	37.8	36.4	51.5	66.9	40.0	35.2	51.7	66.3
27	L	ISO10_PL_L30m-D100 mm_V_L	146.59	95.35	134.8	146.8	235.9	260.1	136.5	149.8	220.6	262.3	137.7	150.9	201.6	264.5
28	R	ISO10_PL_L30m-D100 mm_V_R	146.59	95.35	134.8	146.8	235.9	260.1	136.5	149.8	220.6	262.3	137.7	150.9	201.6	264.5
29	S	ISO10_PL_L50m-D50 mm_V_S	0.37	7.98	4.5	2.4	8.3	8.1	7.6	0.4	8.1	7.2	1.3	0.7	7.7	6.0
30	M	ISO10_PL_L50m-D50mm_V_M	9.16	32.32	35.4	36.8	53.3	67.2	37.8	36.4	51.5	66.9	40.0	35.2	51.7	66.3
31	L	ISO10_PL_L50m-D50mm _V_L	36.65	56.58	69.2	75.6	114.4	135.7	72.0	76.0	107.5	135.9	75.9	75.5	102.5	136.3
32	R	ISO10_PL_L50m-D50mm_ V_R	36.65	56.58	69.2	75.6	114.4	135.7	72.0	76.0	107.5	135.9	75.9	75.5	102.5	136.3

The Jet Fire Intensity Radii for Rupture cases for wind speed 9 m/s and stability class C have been presented as per ***Figure 7.24.***

Figure 7.24 Intensity Radii of Jet Fire Scenarios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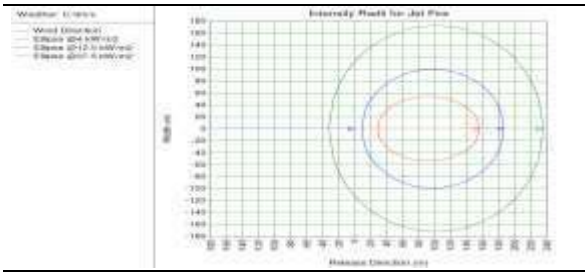
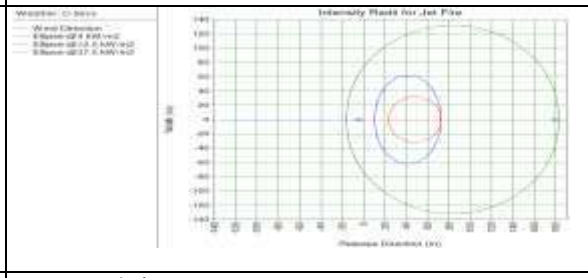
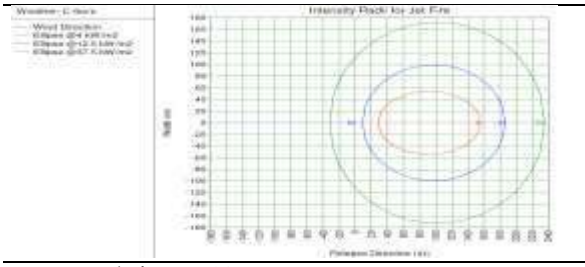
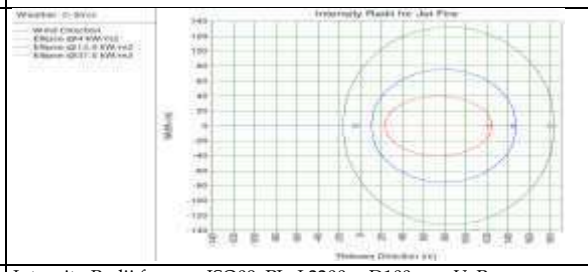
	
Intensity Radii for case ISO06_PL_L40m-D200mm_V_R	Intensity Radii for case ISO07_PL_L50m-D150mm_V_R
	
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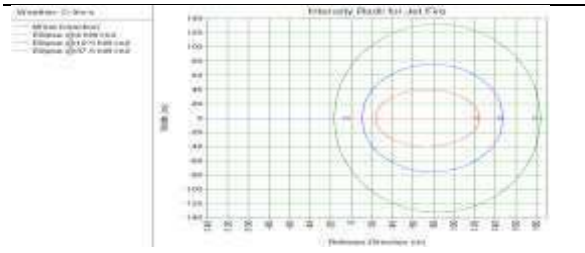
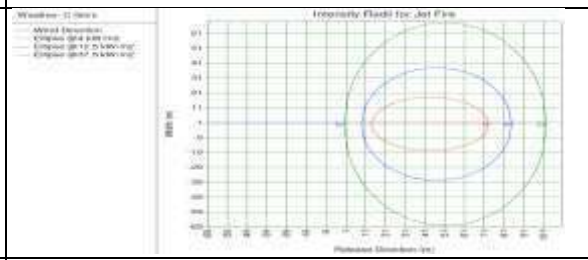
	
Intensity Radii for case ISO10_PL_L30m-D100mm_V_R	Intensity Radii for case ISO10_PL_L50m-D50mm_V_R

Pool Fire Results

Pool fire dimensions and surrounding radiation contours are generated based on models within RA model. The flame is assumed to be a cylinder sheared by the wind and has a circular cross section parallel to the ground. The flame height is based on the bund size, leak rate and drainage rate. If personnel are within the 37.5kW/m² radiation contour, then a 100% fatality rate is applied. Personnel outside of the contour are assumed to evacuate the area and hence survive. Significant pool fires are expected to happen only in case of large leaks and ruptures and the heat radiations are not expected to vary for different weather conditions. Hence, the results have been presented for large and rupture cases for 1 F weather condition.

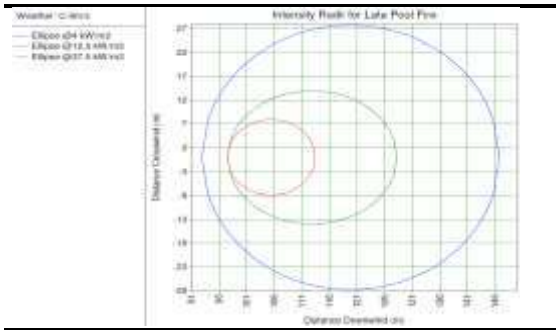
The pool fire results are presented in the ***Table 7.36***. The maximum distance of pool fire for 12.5 kW/m2 of heat flux will be at 112.1 m while for 4 kW/m2 of heat flux, the maximum distance has been worked out as 189.0 m.

Table 7.36 Pool Fire Radiation Results (in meters) for 1F weather condition

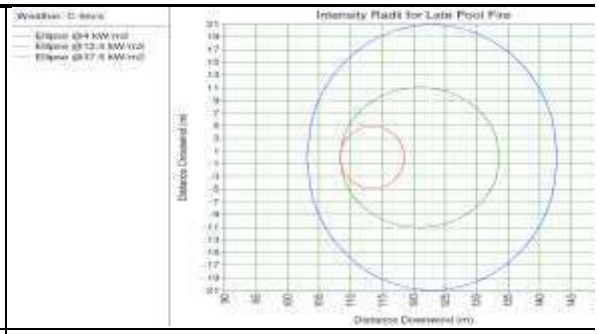
S. N	Leak Size	Event Name	Release Rate (kg/s)	Pool Fire dia (m)	Flame Height (m)	37.5 kW/ m2 length	37.5 kW/ m2 width	12.5 kW/ m2 length	12.5 kW/ m2 width	4 kW/ m2 length	4 kW/ m2 width
1	L	ISO01_PL_L200m-D100mm_L_L	261.94	14.62	27.23	16.62	16.62	22.46	21.48	52.96	51.51
2	R	ISO01_PL_L200m-D100mm_L_R	261.94	14.62	27.23	16.62	16.62	22.46	21.48	52.96	51.51
3	L	ISO02_PL_L20m-D150mm_L_L	261.94	7	17	9.31	9.31	19.01	17.84	40.74	40.22
4	R	ISO02_PL_L20m-D150mm_L_R	589.38	7	17	9.48	9.48	19.16	17.99	41.19	40.65
5	L	ISO02_PL_L40m-D200mm_L_L	261.94	13	25	15.08	15.08	22.04	21.00	51.25	49.98
6	R	ISO02_PL_L40m-D200mm_L_R	1047.78	15	28	17.27	17.27	22.59	21.67	53.60	52.08
7	L	ISO03_PL_L50m-D150mm_L_L	261.94	11	22	12.97	12.97	21.30	20.21	48.35	47.35
8	R	ISO03_PL_L50m-D150mm_L_R	589.38	12.32	24.16	14.32	14.32	21.81	20.73	50.28	49.11
9	L	ISO04_PL_L2100m-D200mm_L_L	261.94	94.31	99.45	0.00	0.00	96.31	96.31	164.92	160.07
10	R	ISO04_PL_L2100m-D200mm_L_R	1047.78	110.07	110.72	0.00	0.00	112.07	112.07	189.00	183.69

The pool Fire Intensity Radii for Rupture cases for wind speed 9 m/s and stability class C have been presented as per ***Figure 7.25.***

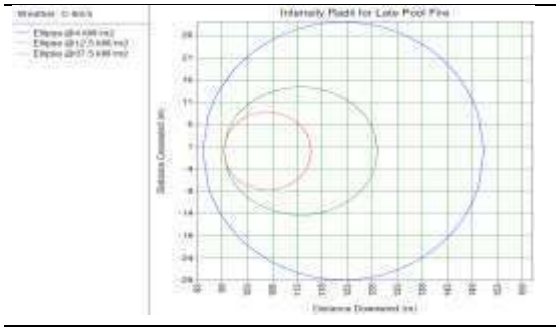
Figure 7.25 Intensity Radii of Pool Fire Scenarios



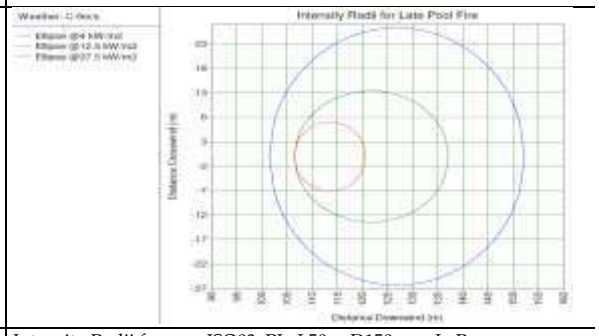
Intensity Radii for case ISO05_PL_L200m-D100mm_V_R



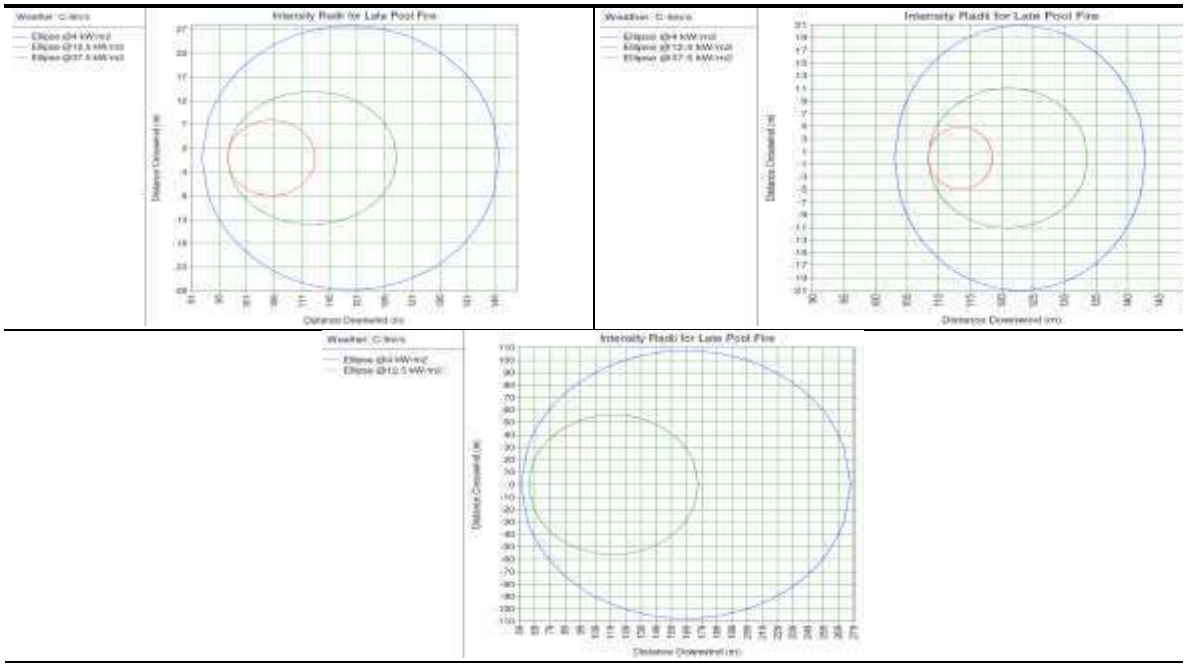
Intensity Radii for case ISO06_PL_L20m-D150mm_V_R



Intensity Radii for case ISO02_PL_L40m-D200mm_L_R



Intensity Radii for case ISO03_PL_L50m-D150mm_L_R



Intensity Radii for case ISO04_PL_L2100m-D200mm_L_R

Flash Fire Results

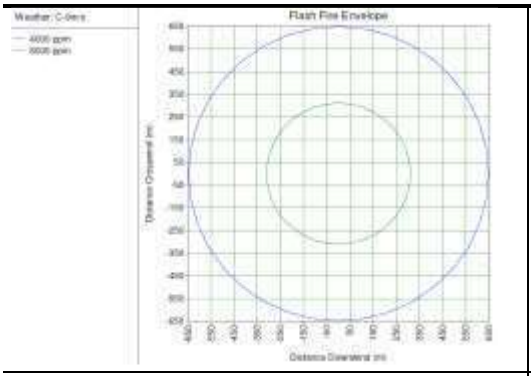
The flash fire consequence results are presented in ***Table 7.37***. The maximum distance of flash fire related LFL distance has been worked out as 294 m.

Table 7.37 Flash Fire distances (in meters) for all weather conditions

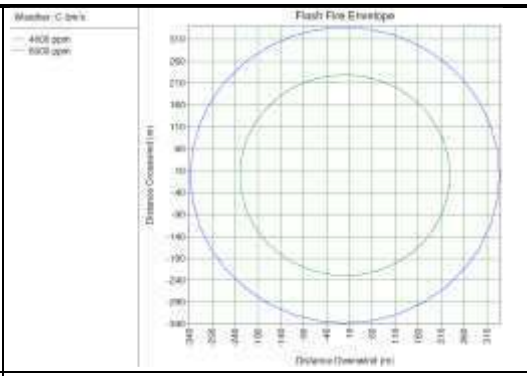
S. N	Leak Size	Event Name	Release Rate (kg/s)	1F	1F	5D	5D	9C	9C
				Length (LFL Distance)	Length (1/2 LFL Distance)	Length (LFL Distance)	Length (1/2 LFL Distance)	Length (LFL Distance)	Length (1/2 LFL Distance)
1	S	ISO01_PL_L200m-D100mm_L_S	0.65	12	22	12	21	10	17
2	M	ISO01_PL_L200m-D100mm_L_M	16.37	86	153	91	200	91	191
5	S	ISO02_PL_L20m-D150mm_L_S	0.65	12	22	12	21	10	17
9	S	ISO02_PL_L40m-D200mm_L_S	0.65	12	22	12	21	10	17
10	M	ISO02_PL_L40m-D200mm_L_M	16.37	86	153	0	200	0	191
13	S	ISO03_PL_L50m-D150mm_L_S	0.65	12	22	12	21	10	17
17	S	ISO04_PL_L2100m-D200mm_L_S	0.65	12	22	12	21	10	17
18	M	ISO04_PL_L2100m-D200mm_L_M	16.37	86	153	91	200	91	191
19	L	ISO04_PL_L2100m-D200mm_L_L	261.94	215	370	262	506	294	620
20	R	ISO04_PL_L2100m-D200mm_L_R	1047.78	97	563	0	710	0	855

The flash fire envelope for rupture cases for wind speed 9 m/s and stability class C have been shown in ***Figure 7.26.***

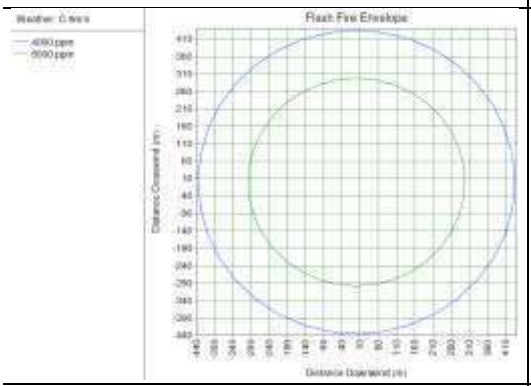
Figure 7.26 Intensity Radii of Flash Fire Envelop Scenarios



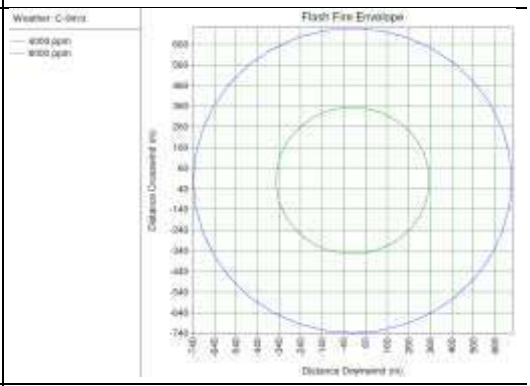
Flash Fire Envelope for case ISO01_PL_L200m-D100mm_L_R



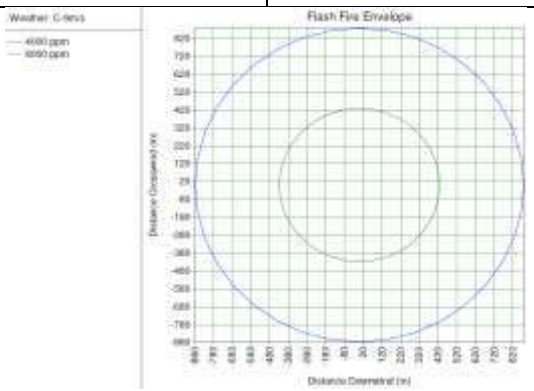
Flash Fire Envelope for case ISO02_PL_L20m-D150mm_L_R



Flash fire Envelop for case ISO02_PL_L40m-D200mm_L_R



Flash Fire Envelope for case ISO03_PL_L50m-D150mm_L_R



Flash Fire Envelope for case for ISO04_PL_L2100m-D200mm_L_R

Results of the QRA Study

The distribution of frequency based on 6 hole sizes (5mm, 12.5mm, 25mm, 50mm,100mm & 200mm) ranging from 5 to 200 mm (or maximum pipe diameter) is considered for each leak source.

Grated floors are assumed to offer no resistance to fire or smoke. A plated floor in topside offers a barrier against smoke, fire and liquid until its specified resistance is exceeded. These barriers can lead to liquid hold up and thus, pool fire generation is possible.

Fatality rates of Jet / Pool fire, Platform damage, smoke in module & Flash fire.

Table 7.38 Fatality Rates

Fatality Rates	Fraction
Fatality rate Explosion	0.5
Fatality rate Damage	0.2
Fatality rate Jet Fire	0.15
Fatality rate Pool Fire	0.05
Fatality rate Flash Fire	0
Fatality rate Smoke	0.25

Explosion Overpressure failure of piping, vessel, wall & floor [Ref OGP-March 2010]:

Table 7.39 Explosion Overpressure for structural failure

Component	Failure Overpressure (bar g)
Fire Wall	0.5
Pipe Section	1 to 2
Floors	2
Tanks	0.35
Vessel	2
Wall	0.1 to 0.25

The highest explosion overpressure is assumed to be 3bar g which lasts for a few seconds and is generally accepted 2 bar g. taking this as the peak explosion overpressure; probability distribution is used to compute explosion overpressure in each module.

On wellhead platform by life rafts as primary means and followed by transfer to OSV.

The open well flow rate in case of blow out is considered 5 times the normal flow rate. Risk summation and assessment

a) Potential loss of life

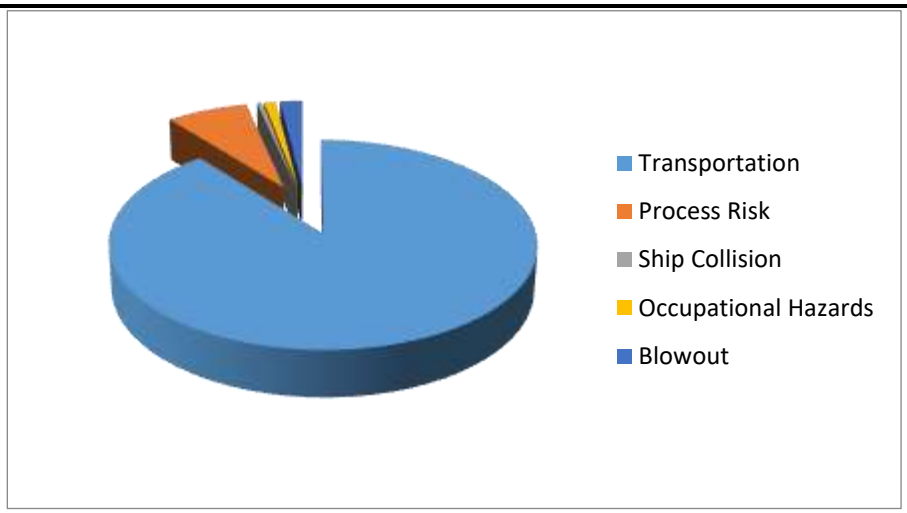
The overall PLL for the Platform operations was estimated to be 5.89E-04 per year, taking into account the presence factor of the personnel at the Platform during normal operations only. The breakdown of PLL results by hazard categories are presented in ***Table 7.40*** and ***Figure 7.27***.

Table 7.40 Overall PLL for the Platform

Hazard Category	PLL (per year)	% Contribution
Transportation	4.1E-04	89.38%
Process Risk	3.3E-05	7.19%
Ship Collision	2.0E-06	0.44%
Occupational Hazards	4.7E-06	1.02%
Blowout	1.5E-06	1.96%
Total	4.50E-04	100.00%

The major contributor was found to be the transportation risk, which accounted for approximately 91% of the overall risks. Personnel are currently anticipated to visit the platform daily (duration for a single trip is anticipated to be 10 minutes, resulting in higher risk exposure compared to other hazard categories, particularly where the hydrocarbon related risks are low due to minimum facilities comprising mainly piping and riser.

Figure 7.27 PLL Breakdown by Different Hazard Categories



b) Potential Loss of Life (PLL) due to Hydrocarbon Releases

The process hydrocarbon releases events, which include topside process, riser/pipeline and blowout, were assessed to have minor risk contribution, approximately 7.0% of the total PLL. The breakdown of PLL by immediate, escape and evacuation fatality phrases for the Platform due to hydrocarbon releases is summarised in ***Table 7.41*** and shown graphically in ***Figure 7.28.***

Table 7.41 Platform Hydrocarbon Risk Breakdown by Fatalities Phases

Phases	PLL (per year)				% Contribution
	Topside Process	Riser/ Pipeline	Blowout	Total	
Immediate	2.09E-05	4.17E-05	6.54E-06	6.91E-05	69.55%
Escape	1.19E-05	1.62E-05	1.51E-07	2.83E-05	28.42%
Evacuation	7.22E-11	6.64E-09	2.02E-06	2.02E-06	2.03%
Total	3.28E-05	5.79E-05	8.71E-06	9.94E-05	100.00%

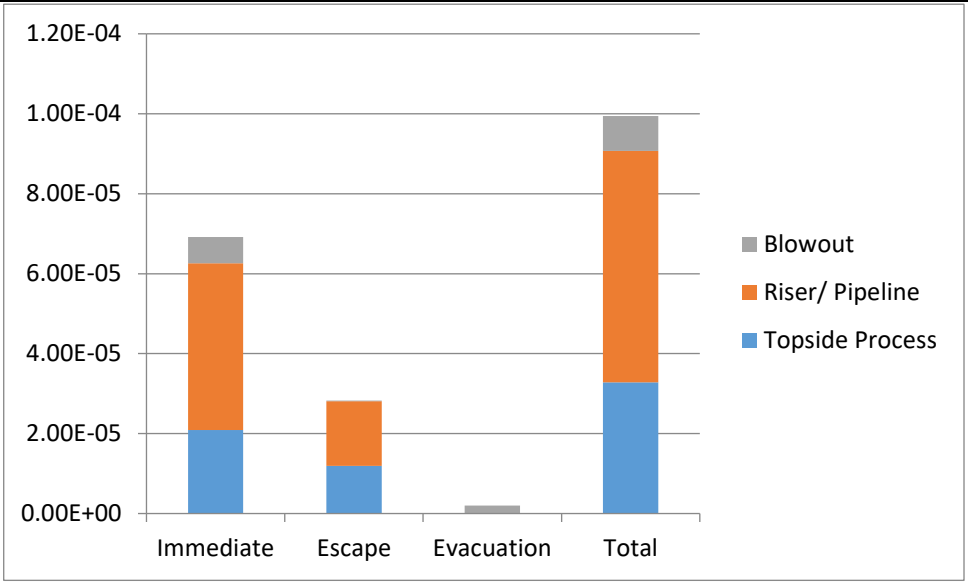
The PLL during immediate fatality phase was found to be the highest contributor among the hydrocarbon releases associated PLL, accounting for approximately 69%. This is due to the relatively small deck areas on the platform, where an initial medium or large jet flame can potentially engulf the entire platform, resulting in immediate fatality of personnel located within the exposed area.

The fatalities associated with escape phase were estimated to contribute approximately 28% to the total hydrocarbon PLL. Although stairways are provided on the platform on each of the decks, they are likely to be impaired by scenarios originating from the deck itself and riser/ pipeline failure events where the entire platform could possibly be engulfed by the fire impeding escape of personnel. The resulting thermal radiation associated with fire due to riser/ pipeline failures is anticipated to engulf all the decks leading to escape routes impairment. However, the contribution of riser and pipeline failures to the overall PLL is not very high due to lower initiating event frequencies.

Due to the relatively small platform, the effects of fire are considered to cause fatality during immediate and escape phases. As such, there might be very low number of personnel that

would need to go through evacuation and to subsequent fatality due to inability to reach evacuation means. The contribution from this phase was therefore found to be insignificant.

Figure 7.28 ***PLL Breakdown by Fatalities Phases due to Hydrocarbon Events***



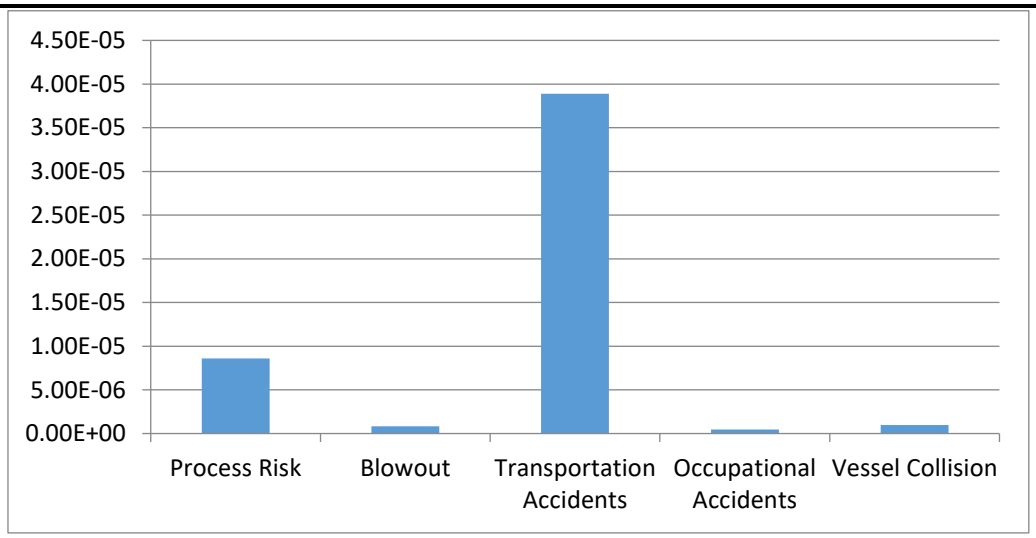
c) Individual Risk per annum (IRPA)

The Individual Risk per Annum (IRPA) for the different worker groups is presented in ***Table 7.42*** and shown graphically in ***Figure 7.29***. The results show that each of the personnel working on the Platform will be exposed to an Individual Risk of 4.98 x 10^{-5} per since these personnel are having the same amount of time spent in each area.

Table 7.42 ***Individual Risk Per Annum for different hazard categories on the Platform***

No of worker on board	Process Risk	% Contribution	Blowout	% Contribution	Transportation Accidents	% Contribution	Occupational Accidents	% Contribution	Vessel Collision	% Contribution	Total
3	8.60E-06	17.28%	8.40E-07	1.69%	3.89E-05	78.16%	4.50E-07	0.90%	9.78E-07	1.97%	4.98E-05

Figure 7.29 Individual Risk Per Annum for different hazard categories on the Platform



d) Uncertainties in Risk Assessment

There are a number of sources of uncertainty in the risk assessment process. The points below highlight some of the uncertainties that exist within the platform risk analysis:

- Statistical uncertainty in data sources – the risks on the Platform have been calculated using industry generic event frequency or leak frequency data as a basis. The databases reflect the experience of the industry over a large number of exposure years. As offshore systems are designed not to suffer catastrophic failure, however, the "population" of failure data is generally small and hence introduces a degree of uncertainty.
- Applicability of the data sources and models to the Platform – the data sources for the assessment has been selected from both offshore experience and marine experience as appropriate. In general, the hazards identified for the Platform are common to other installations intended for similar service and the use of existing databases representing good practice is considered appropriate for assessing those hazards for which there is wide experience.
- When considering explosion overpressures, the risk assessment model is conservative in that it uses the worst case predicted explosion overpressure exceedance curve for a given release rate, for a specific area / module and applies it to all releases (of the same release rate and material) within the entire process area.
- Engineering judgement is applied to a large number of areas and assumptions within the risk assessment model. In areas where engineering judgement is applied, there is always a large degree of uncertainty. Where uncertainty exists, however, a conservative (worst case) approach has been taken and subsequently this has an influence on the risk results generated.

Conclusion – Risk Assessment

a) Hydrocarbon Hazards Analysis

The total leak frequency from topside hydrocarbon sections was estimated to be 2.2×10^{-1} per year. The total leak frequency for the riser and pipeline was estimated to be 2×10^{-3} per year;

The total fire frequency for topside hydrocarbon releases was estimated to be 8.6 x 10^{-4} per year. The total fire frequency for the riser and pipeline estimated at 8.7 x 10^{-6} per year was found to be dominated by the releases from the riser above sea section;

Taking into account oil & gas production wells, the total ignited blowout frequency was estimated to be 7.8 x 10^{-6} for oil well & 5.4 x 10^{-5} for gas wells per year;

The Consequence Analysis results are presented in ***Section 7.2.7***.

b) Non-Flammable Hazard Analysis (NFHA)

b1) Vessel Collision

Collision frequency of visiting vessel for fixed platform: 7.6 E-05 per year. Collision frequency of visiting supply vessel for fixed platform: 5.4 E-04 per year

The estimated Individual Risks associated with a ship collision with the Platform is 9.78 x 10^{-7}. The estimated PLL associated with a ship collision with the Platform is 1.97 x 10^{-6}

B2) Transportation Risk

The PLL for the risk arising from helicopter transfers was estimated to be 4.1 x 10^{-4} per year; and IRPA due to transportation risk was estimated to be 3.98 x 10^{-5} per year. It is highlighted that the risk presented only accounted for the risk when personnel are required to work on the platform and their transportation to and from the platform.

B3) Occupational Risk

All of the personnel on the Platform will be exposed to similar occupational risk with an estimated individual risk of 4.5 x 10^{-7} per year and PLL of 4.7x$10^{-6.}$

B4) Quantitative Risk Assessment (QRA)

The main conclusions of the QRA Study are as follows:

The overall PLL for the Platform operations was estimated to be 4.59 x 10^{-4} per year. The transportation accident risk was found to be the highest risk contributor to the overall risk which accounts for approximately 89% of the total PLL due to the high frequency;

The Individual Risk for workers working on the Platform was calculated to be 4.98 x 10^{-5} per. Again the transport risk is the highest contributor.

7.2.3 Emergency Response Plan for Ravva Field

Vedanta Ltd (Cairn Oil & Gas) has the following protection priorities in the event of an emergency:

1. *Safety of employees and local community.*
2. *Minimizing the impacts on environment.*
3. *Safeguarding of commercial considerations with respect to assets / production.*

A **Ravva Field Emergency Response Plan (RFERP)** has been specifically developed by Vedanta Ltd (Cairn Oil & Gas) for operations associated to the Ravva field.

Purpose of RFERP

The purpose of this RFERP is to define and detail Emergency Response Organizational roles, responsibilities, actions, reporting requirements and support resources available to ensure effective and timely management of emergencies at, or affecting, any of Ravva operations, which are associated to Vedanta Ltd (Cairn Oil & Gas)'s Production Operations activity at Ravva Offshore & Onshore Facilities.

It achieves this by:
- Defining the roles and responsibilities of supervisory personnel at the Ravva field
- Describing procedures to deal with emergencies affecting personnel, equipment, third party contractors, local communities or the environment.

Scope of RFERP

This plan applies to the emergency situations that are likely to arise in the following operations at Ravva:
- On-shore Terminal
- Off-shore Platforms
- Marine Operations
- Helicopter Operations
- Living Quarters and
- Vehicle Transport Operations (Including RJY to site operations & KKD to site operations)

It is intended for the RFERP to act as an emergency support tool to standard operating policies and procedures of Cairn.

Temporary Additional Facilities

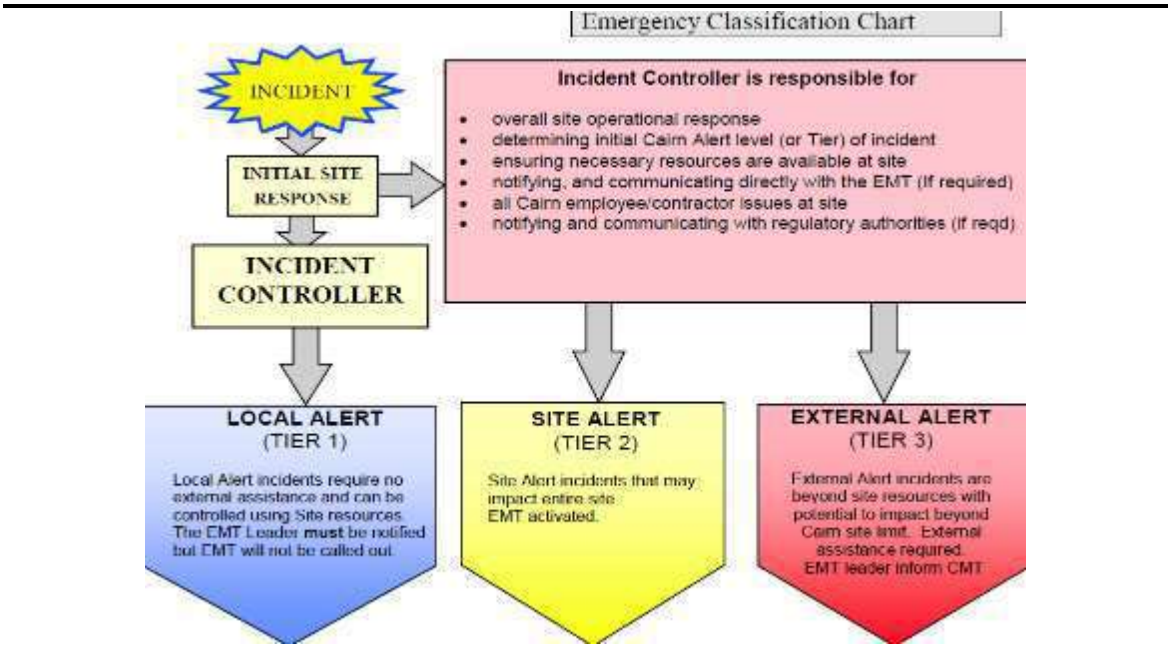
From time to time additional facilities may be brought to the Ravva Field to carry out particular work. These may include drilling rigs, work-over barges, Pipe laying barges, diving support vessels, construction barges, Drilling/Pipe laying support vessels etc. Additional emergency procedures will be generated to cover these activities, either a stand-alone documents or as addendum to RFERP. In the present case, additional procedures associated with onshore and offshore drilling have to be developed prior to initiation of works.

Emergency Classification

Vedanta Ltd (Cairn Oil & Gas) defines emergency situations in three tiers of severity, related to the scale of the incident and the capability of the organisation to respond effectively. The following two figures shows the details of the tier levels and is based on the Vedanta Ltd (Cairn Oil & Gas)Risk Evaluation guidelines.

The emergency situations have been classified in three categories depending upon their magnitude and consequences. Different types of emergencies that may arise at the project site can be broadly defined in ***Figure 7.43***.

Figure 7.30 Emergency Classification Chart



Source: Ravva Field Emergency Response Plan (RFERP-000-001), Date of Issue: 01 Dec 2017

Table 7.43 Emergency Calssification

Emergency Levels	Category	Response	Health & Safety	Environment	Security
Tier 3 Strategic	Crisis situation appear likely. Duty CMT leader's decide to call out CMT Members Duty CMT leader must notify the Chief Executive Officer	Crisis Management Team (CMT)	• Incident leading to loss of facility • Incident leading to significant financial loss • Incident leading to multiple injuries or fatality • Total loss of marine vessel • Well blowout • Incident which could lead to international media interest • Major traffic incident with multiple casualties	• 1000T (7000bbls) • Effluent discharge / flaring beyond acceptable limits • Flood or Cyclone warning Yellow alert – within 12 hours • Major Earthquake	• Terrorist activities / bomb threat • Kidnap or extortion / threat • Major civil unrest
Tier 2 Tactical	Substantial Incident Duty EMT leaders decision to call out EMT leaders Duty EMT leader must notify duty CMT Leader	Emergency Management Team (EMT	• Fire or Explosion • Injury or illness requires evacuation • Traffic accident requires external assistance • Marine incident e.g. Vessel collision	• Oil spill from > 100T but < 1000T (700 – 7000BBLS • Offshore environmental exposure contained with outside help • Earthquake • Flood or Cyclone warning Blue alert – within 48hrs	• Civil unrest or security breach • Major criminal activity
Tier 1 Field & regional Support Reactive	A minor incident where site / location requires no external assistance and can control the incident with local resources Incident Controller must notify the leader of the ERT or EMT of the situation	Emergency Response Teams (IRT)/(ERT)	• Minor medical or injury case requires no external support • Equipment damage with loss of production • Minor fire without injury or plant damage • Rescue of trapped and injured personnel	• Minor oil spill < 100T(700bbls) • Onsite environmental exposure contained with internal efforts e.g. chemical spill • Notification of cyclone within 72 hrs	• Minor security breach • Theft from site • Local unrest

Source: Ravva Field Emergency Response Plan (RFERP-000-001), Date of Issue: 01 Dec 2017

Emergency Response Team

The following teams constitutes the Emergency Response Team:

Medical Response team: A team of Vedanta Ltd (Cairn Oil & Gas) personnel comprising of trained & certified first aiders (by St. John Ambulance Association), assist site Occupational Health Physician during medical emergency situations. These personnel shall be on stand-by at the first aid centre and respond immediately to the scene along with the Medical Support on call.

Fire and rescue team: A team of Vedanta Ltd (Cairn Oil & Gas) personnel comprising of

- Emergency Response Technicians (ERTs) and
- Personnel trained in Fire Training Modules and listed as ERT
- Any other personnel deployed at the incident location as required under this plan.

This team is responsible for Search and Rescue as well as fire fighting at the scene of the incident. This team will be lead by Fire Chief.

Table 7.44 Communication Protocol during Emergencies

On-shore Emergencies	Channel 3	HSE support, Doctor, Muster Point Controller, Security & Asst Manager-HR. Technical Support if required to communicate with the respective maintenance staff.
	Channel 13	Production Support, Fire Chief, Site Support, Control Room
Off-shore Emergencies	Channel 11	Production Support, Platform Support, MUV/Supply vessels.
Tanker Emergencies	Channel 77	RO, Mooring master, Mooring support vessels, Tug Boats and Oil tanker

Source: Ravva Field Emergency Response Plan (RFERP-000-001), Date of Issue: 01 Dec 2017

Gurgaon Emergency Management Organization

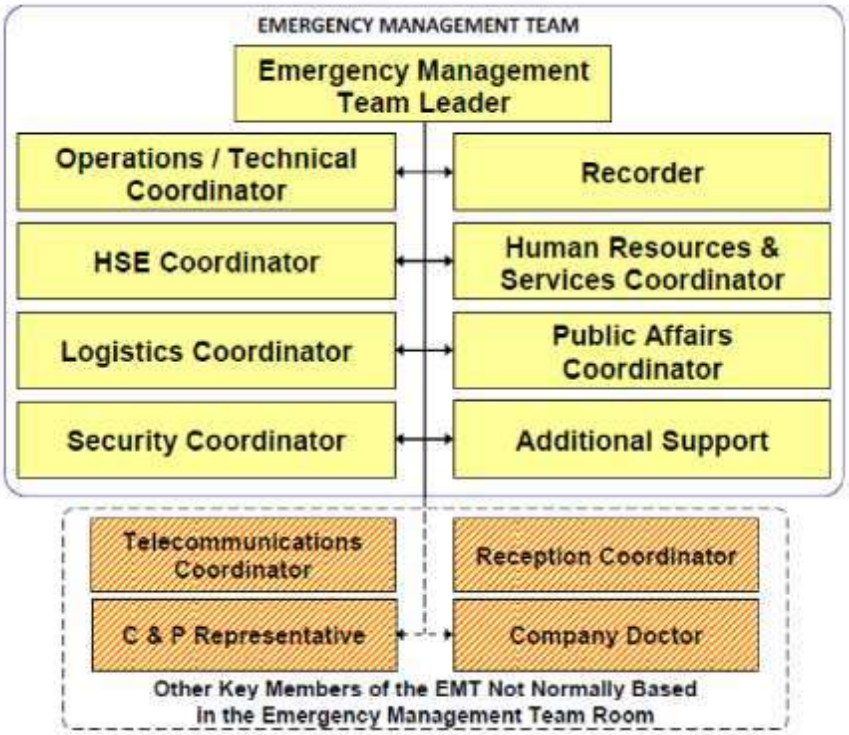
The Gurgaon Emergency Management Organisation consists of the following:

- Emergency Management Team (EMT)
- Crisis Management Team (CMT)

Depending on the seriousness of the incident EMT or CMT will be activated. The contact details of EMT and CMT are updated on a weekly basis and displayed in the Incident Response Center.

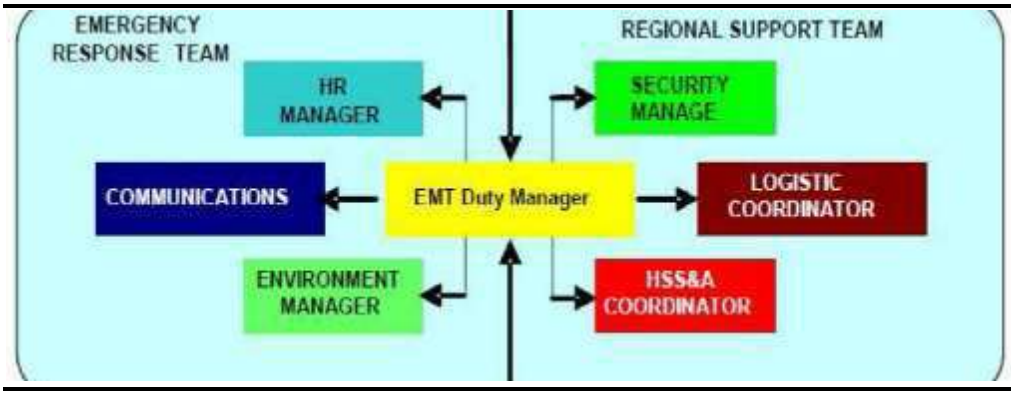
The structure of the Emergency Management Team at Vedanta Ltd (Cairn Oil & Gas) Corporate (i.e. the Gurgaon Emergency Management Organisation) including the EMT and CMT, the Emergency Management Organisation Reltionship and the Emergency Management Organisation's structure and linkages are represented through **Figure 7.31 to Figure 7.35.**

Figure 7.31 Emergency Management Team – Vedanta Ltd (Cairn Oil & Gas) Corporate



Source: Ravva Field Emergency Response Plan (RFERP-000-001), Date of Issue: 01 Dec 2017

Figure 7.32 Emergency Management Team – Flow Chart

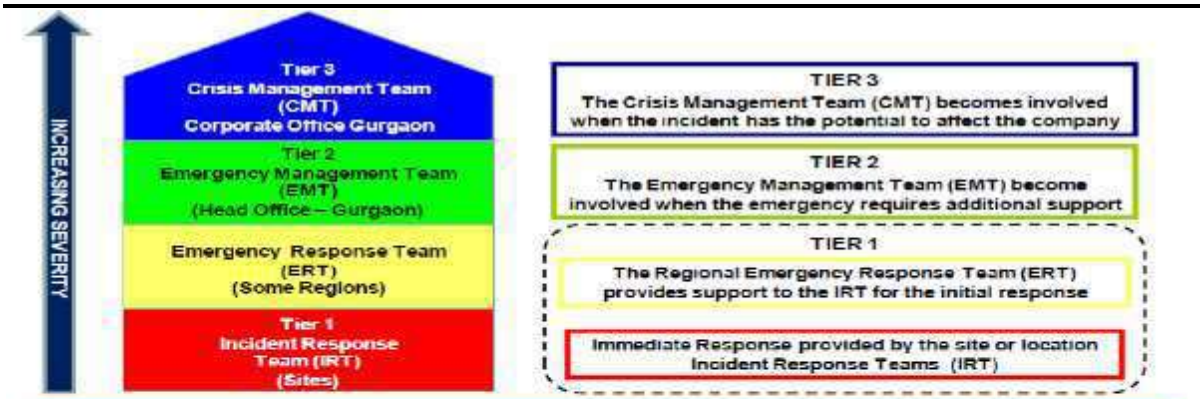


Source: Ravva Field Emergency Response Plan (RFERP-000-001), Date of Issue: 01 Dec 2017

Figure 7.33 Crisis Management Team – Flow Chart

Source: Ravva Field Emergency Response Plan (RFERP-000-001), Date of Issue: 01 Dec 2017

Figure 7.34 Emergency Management Organisation Relationship



Tier 1 Incident Response Team (IRT)

- The emergency or incident can be effectively and safely managed, and contained within the site, location or facility by operations staff
- Emergency or incident has no impact outside the site, location or facility
- There is unlikely to be danger to life, the environment, the assets or

Tier 1 incidents are managed by the site Incident Response Team (IRT). Each site will have its own IRT .

Tier 1 Emergency Response Team (ERT)

- The ERT provide assistance and local support to the IRT's in their area.
- The ERT have access to local emergency services throughout the state.
- For Tier 2 events the ERT acts as the interface between the EMT and IRT

Tier 1 In some states or districts the IRT's are supported by an additional organisation the Emergency Response Team (ERT).

Tier 2 Emergency Management Team (EMT)

- The incident cannot be effectively and safely managed or contained at the site, location or facility by operational staff and additional support is required
- The incident is having, or has the potential to have an effect beyond the site, location or facility and external support may be involved
- There is likely to be danger to life, to the environment, assets or reputation

Tier 2 The Emergency Management Teams (EMT) role is primarily for tactical response to the incident but may on occasions act in a reactive mode. Presently there is only one EMT organisation responsible for supporting all Cairn India businesses.

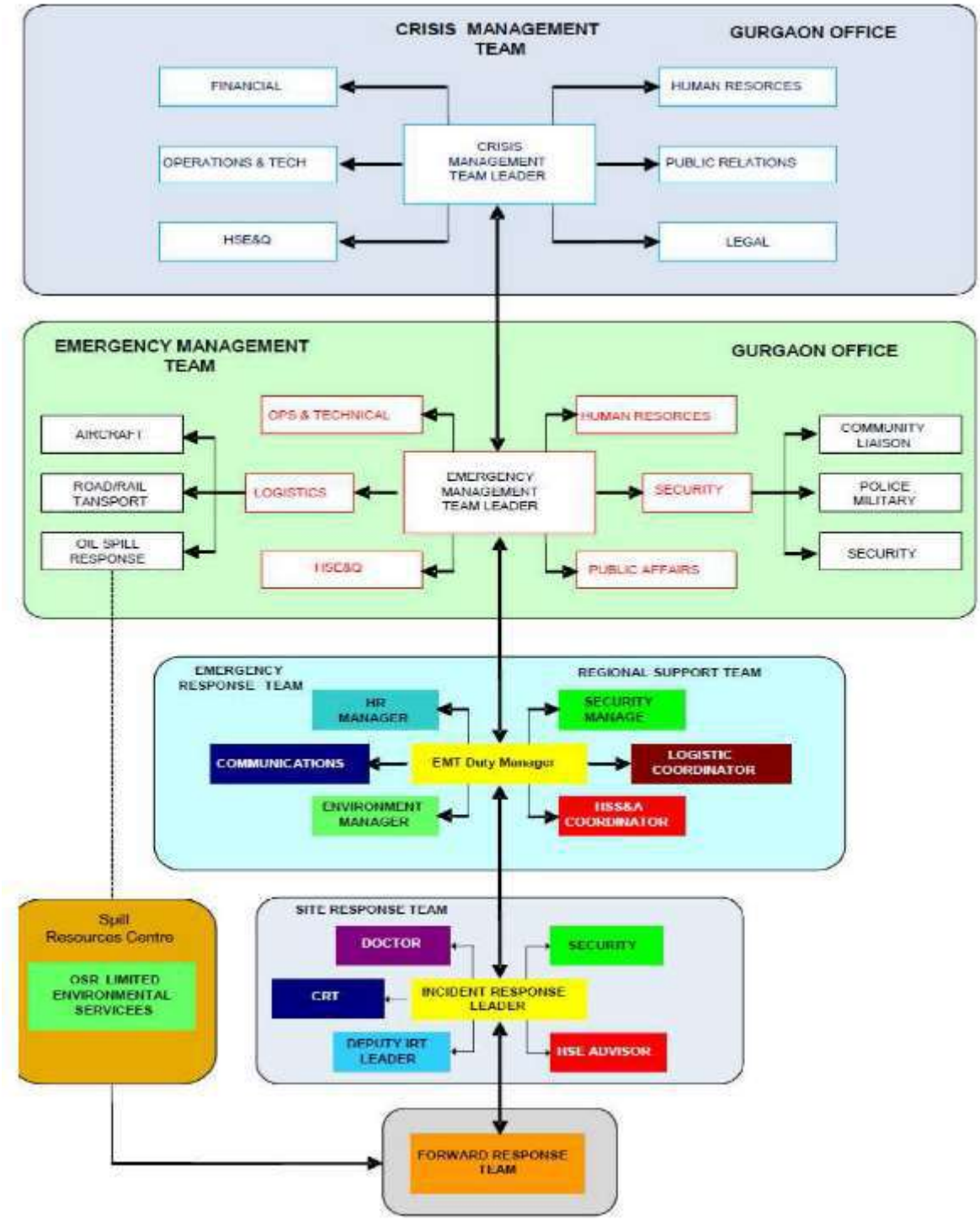
Tier 3 Crisis Management Team (CMT)

- The incident has ESCALATED to a level where it has, or has the potential to adversely affect the public, the company's operations or its reputation
- The incident will have technical, media, public affairs and personnel implications which require immediate action

Tier 3 covers incidents that have escalated to the point where the Crisis Management Team (CMT) need to be involved. There is only one CMT responsible for dealing with any crisis in any of Cairn's areas of operation.

Source: Ravva Field Emergency Response Plan (RFERP-000-001), Date of Issue: 01 Dec 2017

Figure 7.35 Emergency Management Organisation – Structure and Linkages



Source: Ravva Field Emergency Response Plan (RFERP-000-001), Date of Issue: 01 Dec 2017

Emergency Communication

Communications that can be utilised during a Vedanta Ltd (Cairn Oil & Gas) incident include any, or all, of the following:

- Land VHF mobile radio (walkie-talkies)
- VHF Marine radio
- Aero VHF radio
- HF radio

- AIS (Automatic Identification System)
- Digital Weather Monitoring System
- PA System(Paging System within the onshore operational areas and control room)
- Public Switched Telephone Network (PSTN)
- V-SAT
- INMARSAT
- Mobile phones-IS

Site ERO-communications arrangement chart with the designated emergency radio channels indicated has been included in the RFERP. It is essential that all emergency communications are relayed to the Incident Controller (or Alternate) and/or the EMT Leader (or Alternate) as soon as possible after an emergency situation has occurred. All nominated and dedicated emergency response staff will carry VHF radios programmed with the relevant Watch Keeping / Emergency Frequency.

All emergency communication telephone numbers have been listed out as part of the RFERP. As far as possible, all Emergency Calls from Offshore, Helicopter and Plant should be channelled on through the Site Radio Room. The Radio Officer will allocate a dedicated emergency frequency and will advise the Incident Controller of the emergency situation and frequency. ·Upon the commencement of an emergency, the Radio Officer will inform Vedanta Ltd (Cairn Oil & Gas) radio stations that there is an emergency and to clear all non-essential radio traffic on the designated emergency radio channel/frequency. The Radio Officer will further inform all respondents to use the designated emergency radio channel/frequency for communications.

If an incident occurs after normal business hours, the Site Radio Room will make contact with the Gurgaon Radio Room who will inturn activate the EMT Leader and other personnel as advised. Irrespective of the working hours, IC will call the EMT leader directly or through Radio Officer to Establish contact in all emergencies.

Emerency Response Procedures

The RFERP has included a list of compiled emergency response procedures to identified threats and hazards/risks to Ravva field operations. The procedures are not designed as hard and fast prescribed rules, merely suggested prompts to encourage respondents to address potential hazards or actual incidents.

The following are a series of Emergency Response Procedures that provide a template for dealing with emergencies, which the Company requires the designated personnel to follow when called upon to deal with an emergency situation. The Company requires all personnel to be familiar with the content of these Emergency Response Procedures.

Table 7.45 Emergency Events & Procedures

SN.	Emergency Events & Procedures	Refernce to RFERP
A.	*Introduction*	
B.	*Offshore Emergency Events*	
1	Vessel Collision - Offshore	004-003
2	Fire or explosion - Offshore	004-004

SN.	Emergency Events & Procedures	Refernce to RFERP
3	Gas release - Offshore	004-005
4	Platform Evacuation / Abandonment	004-006
5	Helicopter missing	004-007
6	Helicopter emergency landing/crash - Offshore	004-008
7	Person overboard	004-009
8	Structural failure - Offshore	004-010
9	Vessel Emergency	004-011
10	Well Control Incident	004-012
11	Radioactive Material Spill	004-013
12	Loss of Telemetry in Offshore	004-014
C.	*Pollution Response Procedures*	
1	Oil Spill –Offshore	004-015
2	Tanker Oil Spill	004-016
3	Oil spill- Onshore	004-017
D.	*On-shore Emergency Events*	
1	Fire or explosion - Onshore	004-018
2	Gas leak - Onshore	004-019
3	Helicopter emergency landing/crash -Onshore	004-020
4	Road transport accident	004-021
5	Tank fire	004-022
6	Evacuation - Onshore	004-023
7	Search and Rescue (SAR)	004-024
8	Fire at Living Quarters	004-025
E.	*Medical Emergency Response Procedures*	
1	Serious illness / injury / death	004-026
2	Medevac (Medical Evacuation)	004-027
3	Radioactive material spill emergency	004-028
F.	*Weather Emergency Procedures*	
1	Storm Threat	004-029
2	Torrential Rains	004-030
3	Tsunami	004-031
G.	*Security Events*	
1	Bomb Threat	004-032
2	Criminal Acts	004-033
3	Kidnap / Extortion	004-034
4	Terrorist Activity Onshore	004-035
5	Terrorist Activity Offshore	004-036
H.	*Additional Emergency Events*	
1	Hydrogen Sulphide Release in RB Platform – Offshore Event	004 – 037
2	Loss of Flare Ignition – Onshore Event	004 – 038
3	PLC Failure	004 – 039
4	Liquid Carry over to flare	004 – 040
5	Radioactive Source Damage due to Fire on Platform	004 – 041
6	Radioactive Source Fall from height	004 – 042
7	Radioactive Source Theft	004 – 043
8	Receipt of an IRGD/nucleonic device from the supplier in a damaged condition	004 – 044

Source: Ravva Field Emergency Response Plan (RFERP-000-001), Date of Issue: 01 Dec 2017

The Emergency Response Procedures have been developed for a number of possible emergency situations. However, emergencies by their very nature are unpredictable and do not always follow a predictable route. The best course of action to prevent emergencies escalating and becoming out of control is to take early response and decisive action.

The Emergency Response flow charts are made for all emergency situations, developed with a series of actions by the Incident Controller and his Response Teams, which should result in

a successful resolution/control of the situation. There are a number of decision points where the emergency situation is either successfully resolved or continues to deteriorate. If the emergency continues to deteriorate, the procedure authorizes the Incident Controller, through a series of processes, to eventually abandon the facility.

Additional Emergency Measures

As stated earlier the scope of the RFERP presently does not cover additional events like drilling, pipeline laying, etc. Additional emergency procedures will be generated to cover these activities, either a stand-alone documents or as addendum to RFERP. Key preventing and mitigation measure associated with site development, drilling of onshore wells and laying of pipelines have been listed below and will be duly considered by Vedanta Ltd (Cairn Oil & Gas) prior to developing the additional emergency procedures required for the present oil and gas development program.

Preventive and Mitigation Measures for Blow Outs

Blowouts being events which may be catastrophic to any well operation, it is essential to take up as much a preventive measures as feasible. This includes:

- Necessary active barriers (eg. Well-designed Blowout Preventer) be installed to control or contain a potential blowout.
- Weekly blow out drills be carried out to test reliability of BOP and preparedness of drilling team.
- Close monitoring of drilling activity be done to check for signs of increasing pressure, like from shallow gas formations.
- Installation of hydrocarbon detectors.
- Periodic monitoring and preventive maintenance be undertaken for primary and secondary barriers installed for blow out prevention, including third party inspection & testing
- An appropriate Emergency Response Plan be finalized and implemented by Vedanta Ltd (Cairn Oil & Gas).
- Marking of hazardous zone (500 meters) around the well site and monitoring of human movements in the zone.
- Training and capacity building exercises/programs be carried out for onsite drilling crew on potential risks associated with exploratory drilling and their possible mitigation measures.
- Installation of mass communication and public address equipment.
- Good layout of well site and escape routes.

Additionally, Vedanta Ltd (Cairn Oil & Gas) will be adopting and implementing the following Safe Operating Procedures (SOPs) developed as part of its Onsite Emergency Response Plan to prevent and address any blow out risks that may result during drilling and work over activities:

- Blow Out Control Equipment
- Choke lines and Choke Manifold Installation with Surface BOP
- Kill Lines and Kill Manifold Installation with Surface BOP
- Control System for Surface BOP stacks
- Testing of Blow Out Prevention Equipment
- BOP Drills

Preventive Measures for Handling of Natural Gas

- Leak detection sensors to be located at areas prone to fire risk/ leakages;
- All safety and firefighting requirements as per OISD norms to be put in place;
- High temperature and high pressure alarm with auto-activation of water sprinklers as well as safety relief valve to be provided;
- Flame proof electrical fittings to be provided for the installation;
- Periodical training/awareness to be given to work force at the project site to handle any emergency situation;
- Periodic mock drills to be conducted so as to check the alertness and efficiency and corresponding records to be maintained;
- Signboards including emergency phone numbers and 'no smoking' signs should be installed at all appropriate locations;
- Plant shall have adequate communication system;
- Pipeline route/equipment should be provided with smoke / fire detection and alarm system. Fire alarm and firefighting facility commensurate with the storage should be provided at the unloading point;
- 'No smoking zone' to be declared at all fire prone areas. Non sparking tools should be used for any maintenance; and
- Wind socks to be installed to check the wind direction at the time of accident and accordingly persons may be diverted towards opposite direction of wind.

Preventive Measures for Interconnecting Pipeline Risk Management

- Design all pipes and vessels to cope with maximum expected pressure;
- Install pressure transmitters that remotely monitor high- and low-pressure alarms;
- Design equipment to withstand considerable heat load;
- Conduct regular patrols and inspections of pipeline easements;
- Fit pumps with automatic pump shutdown or other safety devices;
- Minimise enclosed spaces where flammable gas may accumulate;
- Where necessary, automate emergency shutdown systems at production facilities;
- Consider installing flow and pressure instrumentation to transmit upset conditions and plant shutdown valves status;
- Install fire and gas detection systems;
- Implement security controls;
- Install emergency shutdown buttons on each production facility;
- Bury gathering lines at a minimum depth of 600 mm and where above ground, maintain a clear area;
- Implement management of change processes; and
- Conduct pressure testing and inspection of equipment and pipelines.

Preventing Fire and Explosion Hazards

- Proper marking to be made for identification of locations of flammable storages;
- Provision of secondary containment system for all fuel and lubricating oil storages;
- Provision of fire and smoke detectors at potential sources of fire and smoke;
- Storing flammables away from ignition sources and oxidizing materials;

- Providing specific worker training in handling of flammable materials, and in fire prevention or suppression;
- Equipping facilities with fire detectors, alarm systems, and fire-fighting equipment;
- Fire and emergency alarm systems that are both audible and visible;
- For safety of people the building, regulations concerning fire safety to be followed. Some of the requirements include:
- Installation of fire extinguishers all over the building;
- Provision of water hydrants in operative condition;
- Emergency exit;
- Proper labelling of exit and place of fire protective system installation;
- Conducting mock drills;
- Trained personnel to use fire control systems.

General Health and Safety

- The facility will adopt a total safety control system, which aims to prevent the probable accidents such as fire accidents or chemical spills.
- Fire fighting system, such as sprinklers system, portable extinguishers (such as CO_2) and automated fire extinguishers shall be provided at strategic locations with a clear labelling of the extinguisher so the type of the extinguisher is easily identifiable. Also a main hydrant around the buildings will be available. On all floors an automated fire detection system will be in place.
- The site operations manager will take steps to train all emergency team members and shall draw up an action plan and identify members. The appointed emergency controller shall act as the in-charge at the site of the incident to control the entire operation.
- The staff shall be trained for first-aid and firefighting procedures. The rescue team shall support the first-aid and firefighting team.
- A first-aid medical centre will be onsite to stabilise the accident victim. The emergency team will make contact with a nearby hospital for further care, if required.
- A training and rehearsal of the emergency response by emergency team members and personnel on site will be done regularly.
- A safe assembly area will be identified and evacuation of the premises will be practised regularly through mock drills.
- In case an emergency is being declared, the situation shall be reported to the authorities such as local police, the chief inspector of factories and the state pollution control board as per rules and regulation of law of the land.
- Safety manual for storage and handling of Hazardous chemicals shall be prepared.
- All the personnel at the site shall be made aware about the hazardous substance stored and risk associated with them.
- Personnel engaged in handling of hazardous chemicals shall be trained to respond in an unlikely event of emergencies.
- A written process safety information document shall be compiled for general use and summary of it shall be circulated to concerned personnel.
- MSDS shall be made available and displayed at prominent places in the facility. The document compilation shall include an assessment of the hazards presented including (i) toxicity information (ii) permissible exposure limits. (iii) Physical data (iv) thermal and chemical stability data (v) reactivity data (vi) corrosivity data (vii) safe procedures in process.

- Safe work practices shall be developed to provide for the control of hazards during operation and maintenance
- In the material storage area, hazardous materials shall be stored based on their compatibility characteristics.
- Near miss and accident reporting system shall be followed and corrective measures shall be taken to avoid / minimize near miss incidents.
- Safety measures in the form of Do's and Don'ts shall be displayed at strategic locations.
- Safety audits shall be conducted regularly.
- Firefighting system shall be tested periodically for proper functioning.
- All hydrants, monitors and valves shall be visually inspected every month.
- Disaster Management Plan shall be prepared and available with concerned personnel department.

Personal Protective Equipment

In certain circumstances, personal protection of the individual maybe required as a supplement to other preventive action. It should not be regarded as a substitute for other control measures and must only be used in conjunction with substitution and elimination measures. PPEs must be appropriately selected individually fitted and workers trained in their correct use and maintenance. PPEs must be regularly checked and maintained to ensure that the worker is being protected.

First Aid

First aid procedures and facilities relevant to the needs of the particular workforce should be laid down and provided in consultation with an occupational physician or other health professional.

Health assessment should form a part of a comprehensive occupational health and safety strategy. Where employees have to undergo health assessment, there should be adequate consultation prior to the introduction of such program. Medical records should be kept confidential. Site should be able to relate employee health and illness data to exposure levels in the workplace.

7.3 ADDITIONAL STUDIES – OIL SPILL RISK ASSESSMENT & CONTROL

7.3.1 Purpose, Scope & Structure of the Plan

The Oil Spill Contingency Plan (OSCP) for Ravva operations as developed by Vedanta Ltd (Cairn Oil & Gas)[1] is intended to respond to any unforeseen oil spills from the operations in the Ravva field with the involvement of all line personnel in a timely and duty bound manner in order to reduce the effects of such spills on loss of property, damage to marine environment and effect on Company's reputation. The plan is to primarily deal with oil spill emergencies resulting from exploration, production and transportation of crude oil from the Ravva offshore

[1] Based on Oil Spill Modelling Study by Environ Software, 2017 sponsored by Cairn

facilities and include the surface facilities viz., platforms, drilling rigs, vessels and subsurface pipelines and all other associated infrastructure required for the production operations.

The plan, however does not address the well control contingencies in the exploratory or drilling operations whose risks could vary and require specialist services. In such cases, the well control contingency plans of the Drilling Group shall be aligned with this OSCP.

The primary objectives of this plan are:

- to conform to the Vedanta Ltd (Cairn Oil & Gas)'s HSE policy of mitigating any emergencies with planned and tested arrangements;
- to comply with the obligations of Vedanta Ltd (Cairn Oil & Gas) under the Production Sharing Contract with the joint venture and government and also commitments for environment protection in offshore operations;
- to comply with the obligations for emergency response with various regulating agencies for timely intervention with trained manpower, tested facilities and planned emergency arrangements;
- to ensure minimization of damage to environment, losses to the assets and reputation by minimizing oil spill impacts; and
- to align with the regional and national oil spill contingency plans of Indian Coast Guard.

This OSCP is structured based on the directives and guidelines of Indian Coast Guard and general guidelines of IPIECA and primarily divided into three sections apart from the introduction part.

- A strategy section defining details of operational and environmental risk assessment, strategies for oil spill response, response plan organization of the Cairn aligned for oil spill response and associated activities like media briefing, training and documentation etc.
- An action plan describing how to activate the OSCP in terms of notification, mobilization and response decisions in case of dynamic situations of oil spill hitting various coastal resources. Operational planning and coordination among other participants, stakeholders and monitoring of the response actions till the close out of the activities are covered in this section.
- A data directory compiling the details of location maps and charts, equipment and services available for response and technical database on the equipment, deployment methodology and supporting documents for response.

The plan has been prepared by Vedanta Ltd (Cairn Oil & Gas) involving all internal stakeholders via, operational teams at the site, decision makers in management for emergency response and their views are duly incorporated with a series of reviews.

7.3.2 Alignment with Statutory Contingency Plans

Under the mandate to coordinate the oil spill response in Indian national waters and exclusive economic zone, the Indian Coast Guard has developed National Oil Spill Disaster Contingency Pan (NOSDCP) and circulated to various stakeholders. List of equipment available with various companies and the response arrangements of each of the operators are to be integrated with the NOSDCP. Broad guidelines are framed by Coast Guard to prepare the OSCPs and circulated vide their circular dated Aug 2012. All the offshore operators are required to prepare contingency plans as per these guidelines to align with the NOSDCP. In addition to the above,

each Coast Guard region has a local Regional Oil Spill Contingency Plan (ROSDCP) for the defined geographical region. Contingency plan for east coast is developed for a large of spills up to 10,000 tons and coordinated by the Commander Eastern Region. Operations falling under various regions are coordinated by the respective regional commanders of the Coast Guard.

The primary attributes of this alignment include:

- Drafting the OSCP as per ICG guidelines
- Information sharing and updating on the oil spill response resources
- Communications update to ICG
- Participation in ICG mock drills, exercises and coordination meetings
- Sharing of any technical expertise among the stakeholders

In addition to the NOSDCP and ROSDCP, the oil spill contingency plans, especially the plans pertaining to the coastal cleanup and remediation should align with the local emergency response plans developed by the district disaster management authority controlled by the concerned district collector of East Godavari district. Operational arrangements for response, communications with the local and district environmental and administration authorities should be aligned in the OSCP.

7.3.3 Authorities, Responsibilities & Coordination

Ravva Joint Venture is responsible for any exigencies occurring in the operations of Ravva field in the east coast. Being the operator of the block, Vedanta Limited has the responsibility and authority to implement the measures required for prevention and control of any oil spills occurring in the operations where the reasonable operational controls fail to contain the slicks within their operational jurisdiction. In exercising such controls, the operator shall coordinate the JV partners for necessary budgets and financial support and decisions for any external intervention. The governmental directives viz Indian Coast Guard and Ministry of Environment and Forests overweigh any deployment strategies of the operator where in Vedanta Ltd (Cairn Oil & Gas) will closely liaise with such regulating agencies during crisis situations, which are beyond their operational control.

7.3.4 Regional Cooperation Agreements

The need for mutual cooperation during oil spill response was realized by the operating oil companies in the KG Basin (viz ONGC, Cairn, Reliance and GSPC) and based on broader guidelines given by the OISD and MoPNG, a regional cooperation arrangement was worked out through a Memorandum of Understanding (MOU) in June 2017. As per this MOU, each operator is obliged to provide necessary equipment and services to the requesting party during oil spill emergencies without any profit motive. The guiding principle is to extend all necessary help without sacrificing any inherent risks to their own facilities at the time of emergency. This mandates each company to have certain facilities available with them all the time. After completion of exposure to the emergency, the equipment shall be returned to assisting party in near original state or replaced/cost refunded by the requesting party in certain time frame. Such regional cooperation agreements are actively pursued by various operators in the areas like Gulf of Kutch, Port of Mumbai, and Gulf of Khambhat and in the

west coast and several other operators are coming forward for forming such pooled resource bases in the other coastal regions.

7.3.5 Agreements with External Agencies

While the company's own facilities and the response facilities with the nearby operators can help tackle small and medium spills, it is inevitable to depend on external agencies for larger spills for longer periods. Apart from the facilities of Coast Guard available at the nearby region, additional facilities of external agencies would also be sought for large spills. A few such Oil Spill Response Organizations (OSROs) are available globally among which the service of Oil Spill Response Ltd (M/s OSRL), a non-profit, industry supported OSRO in Singapore are considered to logistically relevant and technically competent. The services of M/S OSRL are also sought by several other operators in India. Vedanta (Cairn Oil & Gas) took associate membership with M/S OSRL for support in case of spills of larger magnitude and inclusive of offering equipment for mobilization and help of experts for technical coordination and guidance. Other oil industries in India viz ONGC, RIL and several refineries took similar membership with M/S OSRL.

A copy of the agreement with OSRL is enclosed as ***Annex 24 of EIA Volume 2***.

7.3.6 Strategy Plan

The most important part of OSCP is the development of a strategy plan which deals with identification all possible risks, attributing significance and identifying potential risks which can cause significant consequences to the amenities and environment. Strategies for response including decision making for the response actions, various methodologies adopted for mitigating the effects of spills are addressed in this plan. This plan is required for use by all the personnel involved in the oil spill response and adequately trained for familiarity and decision making.

Risk Assessment

An important segment in the Strategy Plan is the assessment of risks which lead to release of oil spills (loss of containment), prioritization of response and mobilization strategies under diverse geo climatic conditions. The strategy plan starts with identification of potential risks involved in the operations and environmental consequences of the spills followed by various strategies for response and organizational arrangements for such response. The risk assessment is done for both the operational risks and also for environmental resources using established industry practices

Operational Risk Assessment

The core element of a strategy plan for any emergency response is the assessment of risks and attributing significance to the consequences. Risk assessment aims at identifying various hazards associated with the marine operations in the Ravva Field and assess the probability of occurrence and resulting consequences. A structured risk assessment approach is followed for identifying potential oil spill scenarios in the operations and assessing the environmental risks associated with such spills.

Methodology of Risk Assessment

Several approaches are available for risk assessment among which the Hazard and Effects Management Process (HEMP) is generally used by the oil industry. This approach identifies all the hazards perceivable in an operation and attributes significance in terms of probability of occurrence and resultant consequences and identifies the risks in various categories for priority mitigation. Broad risk assessment process followed in this Field is depicted below in ***Figure 7.36***.

Figure 7.36 Oil Spill Risk Assessment Methodology

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

The detailed procedure of risk assessment is given below. The process broadly involves the following steps:

- Preparation of risk registers for all the hazards identified in the operations
- Evaluation of each risk in terms of probability of occurrence based on the industry experience in general and experience of the site in particular using a panel evaluation method.
- Identification of consequences for each risk and attributing significance in terms of impact on environment, materials and resources including reputation of the organization
- Categorizing the risks in terms of priority attention viz Low, Medium, Moderate and High significance
- Identification of risk mitigation strategies for reducing risk to minimal or acceptable residual levels.
- Entrusting responsibilities for minimizing risk and follow up of risk reduction Measures

Methodology of risk assessment used is in line with the Vedanta Limited Risk Assessment and Indian Oil Industry Safety Directorate Guidelines (GDN-232). The risk matrix is considered for both qualitative and semi quantitative models for attributing significance and

measurement. The basis & risk matrix used in the Ravva Risk Analysis is given ***Table 7.46 & Table 7.47***.

Table 7.46 Numerical Factors for Likelihood of Exposure/Impact

Rank	Frequency	Criteria Definition
5	Almost Certain	The unwanted event has occurred one or more times per year at the site and is likely to happen again within 1 year.
4	Likely	The unwanted event has occurred less than once per year at the site but is likely to happen again within 5 years
3	Possible	The unwanted event/has occurred in the business at some time: or could happen within 10 years.
2	Unlikely	The unwanted event has occurred in the industry at some time: or could happen within 20 years.
1	Rare	The unwanted event has never been known to occur in the industry: or it is highly unlikely to occur within 20 years.

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Table 7.47 Consequence of Exposure/Impact

Score	Classification	Environment	H&S	Social	Reputational
5	Catastrophic	Serious environmental harm/ damage from uncontrolled releases, with medium-term effect, requiring significant remediation	Fatality (or fatalities); Extensive operational shutdowns.	Receipt of multiple complaints/grievances on same topics from (or to) government agencies/ bodies; Work interrupted.	Very significant legal penalties; sustained national adverse media coverage; boycotting of the company; site closure from regulatory intervention.
4	Serious	Major harm/ damage from Uncontrolled releases, with short-term effect and significant remediation.	Major injuries; Prolonged operational shutdowns.	Receipt of multiple complaints on same topics from (or to) government agencies/ bodies. Work temporarily interrupted	Major breach of Legislation considerable legal penalties; major national media coverage and stakeholder concerns.
3	Moderate	Moderate reversible impact with short-term effect and moderate remediation.	Restricted work injuries. Temporary operational area shut-downs.	Receipt of multiple complaints on varying topics from (or to) government agencies/bodies or from stakeholders. Work not interrupted.	Serious breach of legislation and possible warnings, moderate legal penalties. Short-term stakeholder and media concerns / coverage.
2	Minor	Releases primarily limited to within the operational area. External impact minor and reversible requiring minor remediation.	Medical treatment injuries. Minor operational disruption/changes	Receipt of multiple complaints from external sources or employees	Minor legal issue of non-compliance, minor media coverage or attention

Score	Classification	Environment	H&S	Social	Reputational
1	Low	Minimal harm/ damage: no operation disruption, low-level legal issue	First aid cases. No operational Disruption or changes	Localised Community complaints or grievances.	No operation disruption, low-level legal issue. No media coverage or attention.

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Figure 7.37 Oil Spill Risk Assessment Matrix

		LIKELIHOOD				
SEVERITY		1	2	3	4	5
		Rare	Unlikely	Possible	Likely	Almost Certain
Catastrophic	5	5	10	15	20	25
Serious	4	4	8	12	16	20
Moderate	3	3	6	9	12	15
Minor	2	2	4	6	8	10
Negligible	1	1	2	4	4	5

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Oil Spill Risks Associated with Operations

The oil spill may occur generally during exploration, production and transportation of crude oil from the offshore facilities and include the surface facilities viz., platforms, drilling rigs, vessels and subsurface pipelines and all other associated infrastructure required for the production operations. The operations of Vedanta Ltd (Cairn Oil & Gas) in the East coast are broadly defined under the following:

- Seismic exploration (deployment of seismic vessels)
- Offshore drilling (deploying offshore mobile drilling units)
- Offshore production (unmanned installations, submarine pipelines)
- Storage & Transportation (Storage tanks in the coastal installation, submarine
- pipeline, SPM and shuttle tanker)
- Effluent disposal (submarine pipeline and marine outfall)

As with any hydrocarbon development, oil spill risks are associated with Vedanta Ltd (Cairn Oil & Gas) operations also. They may vary from a few liters of accidental spill of diesel from offshore vessels to several thousands of tons of oil during unexpected blow out situations. No oil company can afford to prepare itself for mitigating all the possible accident scenarios due to prohibitive costs associated with the oil spill combat. In line with the standard industry practice, Vedanta Ltd (Cairn Oil & Gas) is also prepared to mitigate spills of importance from routine operations (Tier-1), while oil spill situations of higher magnitude are dealt with industry co-operation and external intervention. However, it is required to have a fair understanding of the risks and probability of spills arising out of its operations and their consequences due to movement and landing along the coast. In its internal assessment of oil spills, the following risks are identified in its operations:

- Undetected flow line leakage
- Flow-line rupture

- Leakage at wellhead
- Hose failure at SPM
- Detached break-away coupling at SPM
- Rupture of export line
- Oil wells blow out
- Major accident at shuttle tanker

Risk Register and categorization of risk

From among the 8 of hazards identified in the Field (list given in below ***Table 7.48***), the following risks fall in the Yellow and Red categories which require risk mitigation and bringing the risk levels to As Low as Reasonably Practicable (ALARP).

Table 7.48 List of identified maximum oil spill risks in the Ravva operations

No.	Nature of the risk	Location	Quantity of likely spillage and duration	Risk category	Risk mitigation measures
1.	Operational spills during diesel transfer	Platforms	<0.16m^3	Low	OSCP
2	Leakage at wellhead	Platforms	<2m^3	Low	OSCP
3	Utility spills from platform/ships	Marine	<0.16-8m^3	Low	OSCP
4	Flow line rupture / leak	Between terminal and Platform	< 652 tons	High	OSCP
5	Release of oil at SPM due to failure of transfer hose.	Between SPM and Tanker	<100m^3	Medium	OSCP
6	Diesel spill from support vessel (single tank/entire parcel)	Ravva field offshore	< 500 m^3	High	OSCP
7	Blowout and BOP failure(Dependent on well flow and response times)	Ravva field	< 102-2040 Tons	High	OSCP,MUTUAL AID, Membership agreement with MIS OSRL
8	Major Accident at Shuttle tanker	Ravva Field	< 2500 tons	High	OSCP,MUTUAL AID, Membership agreement with MIS OSRL

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Oil Spill Risk Summary

The exact quantities from each incident is difficult to predict due to the variables of operating conditions and the length of risk exposure, a maximum risks associated with the events may be considered while devising the oil spill contingency plan. For the purpose of simulation, three scenarios are taken into account considering the above spill risks: 100, 1000, and 5000 tons of Crude oil spill. The spill scenarios range from extremely negligible quantities to enormous quantities in rare catastrophic events. The simulation of oil spills does not vary significantly in various scenarios except the magnitude of Impact zone and the quantity involved in such Impacts. The computational runs have been carried out for various spill quantities and for all months considering the worst-case scenarios.

Environmental Risk Assessment

Once spilled in the sea, the fate of oil spills and resultant slick formation is dependent on several climatological and ocean features in addition to the nature of oil which is spilled. Thus environmental assessment of fate of oil, both in terms of its movement in various seasons, dispersion and shore landing highly influence the spill response strategies.

Nature of Ravva crude oil:

Physical characteristics and chemical composition of crude oil highly influences the impact on the marine environment upon spillage. Fluidity of the crude, rate of initial evaporation and chemical constituents of the crude significantly differ from one oil type to the other. Based on the physical characteristics of various kinds of oils, these are grouped under four categories. Detailing of the Ravva crude characteristics is necessary for understanding the fate and weathering and environmental risks during a spill. The details of physic chemical nature of Ravva crude and natural gas are given in the ***Table 7.49*** below.

Table 7.49 Characteristics of Ravva Crude and Natural Gas

Ravva Crude Oil Characteristics (Untreated)		**Ravva Natural Gas Characteristics**	
Density	0.8526	Methane	85.95
API Gravity	37.5	Ethane	5.20
Kinematic Viscosity, CST at 40°C	3.923	Propane	4.91
Pour point, deg. C	30	n-butane	1.20
Flash point		i-butane	0.83
Sulphur content	0.05	n-pentane	0.18
Aromatics		i-pentane	0.22
Asphaltene, %	0.3	Hexane	0.10
Resin, %		Other hydrocarbons	0.06
Wax, %	23	Hydrogen sulphide	Nil
Pristane/phytane		Carbon dioxide	1.29
Any other characteristics		Nitrogen and others	0.06

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

The above data shows that the Ravva Crude falls in the Group 2 category of oils while the gas associated with the production operations is devoid of any hydrogen sulfide (sweet gas).

Fate and weathering characteristics of Ravva crude upon spillage:

Oil is considered as a major pollutant of the ocean. It enters the marine environment through numerous sources. The most conspicuous source of oil pollution is, of course, accidental spills from tankers due to collision/grounding or from offshore drilling and production platforms.

When oil is spilled at sea, it undergoes a number of physical and chemical changes, some of which lead to its disappearance from the sea surface, whilst others cause it to persist.

Although spilt oil is eventually assimilated by the marine environment, the time involved depends upon such factors as the amount of oil spilled; its initial physical and chemical characteristics; the prevailing climatic and sea conditions and whether the oil remains at sea or is washed ashore.

A knowledge of the process involved, and how they interact to alter the nature and composition of the oil with time is valuable in preparing and implementing contingency plan for oil spill response. On occasions, it may prove unnecessary to mount a clean-up response if it can be confidently predicted that the oil will drift away from vulnerable resources or dissipate naturally before reaching them. Often, however, an active response will be necessary, aimed either at accelerating the natural processes through the use of dispersants, or limiting spreading by means of containment methods. Once spilled on the sea, the oil undergoes several changes owing to the prevailing climatological and sea surface conditions like wind, relative humidity, waves, surface temperature and exposure to light. Surface winds and currents also drift the oil slicks in the predominant surface drift direction which may often result in soiling of the coast line. Some of the processes are shown in the figure and detailed below.

Properties of Oil

In considering the fate of spilled oil at sea, a distinction is frequently made between non-persistent oils, which tend to disappear rapidly from the sea surface, and persistent oils, which in contrast dissipate more slowly and usually require a clean-up response. Non-persistent oils include gasoline, naphtha, kerosene and diesel whereas most crude oils and heavy refined products have varying degrees of persistence depending on their physical properties and the size of the spill.

Weathering Processes

The physical and chemical changes, which spilled oil undergo are sometimes collectively known as weathering. Although, the individual processes which bring about these changes act simultaneously, their relative importance during the lifetime of an oil slick varies. The main processes are as follows:

- Spreading
- Evaporation
- Dispersion
- Emulsification
- Dissolution
- Oxidation
- Sedimentation
- Biodegradation

The processes of spreading, evaporation, dispersion, emulsification and dissolution are most important during the early stages of a spill whilst oxidation, sedimentation and biodegradation are long term processes which determine the ultimate fate of oil.

It should be appreciated that throughout the lifetime of an oil slick it continues to drift on the sea surface, independent of these processes. The actual mechanisms governing movement are complex but experience shows that oil drift can be predicted by taking into account wind-induced effects and surface water currents. These can be calculated separately and then combined using vector diagrams to determine the resulting oil movement. The wind induced effect is normally taken as 3% of the wind velocity, and the current effect as 100% of the current velocity. Reliable prediction of slick movement is clearly dependent upon the availability of good wind and current data. The latter is sometimes difficult to obtain. For some areas, it is

presented on charts or tidal stream atlases but for many other areas, only general information is available.

An understanding of the way in which weathering processes interact is important in forecasting their combined effect in changing the characteristics of different oils and the lifetime of slicks at sea. In order to predict such interactions, numerical models have been developed, based on theoretical or empirical considerations, or a combination of both.
Effects of Marine Oil Spills

The extent of damage caused by an oil spill depends upon the quantity of oil spilled, type of oil involved in the spillage and the oceanographic and meteorological conditions prevailing in the location where the spill has occurred. When the oil spills in large quantity, it temporarily affects the air-sea interaction, thus preventing the entry of oxygen from the atmosphere. The first set of organisms affected is the primary producers like phytoplankton which is the basis of the marine food chain. The other free-swimming organisms such as fish larvae and fish also get affected. Further, when the oil sinks during the course of time, it affects the benthic organisms such as clams and mussels. The other amenities that are affected include mangrove forests, coral reefs and several marine resources.

Oil spills can also have a serious economic impact on coastal activities and resources of the sea. In most cases, such damage is temporary and is caused primarily by the physical properties of oil creating nuisance and hazardous conditions. The impact on marine life is compounded by toxicity and tainting effects resulting from the chemical composition of oil, as well as by the diversity and variability of biological systems and their sensitivity to oil pollution. ***Table 7.50*** present effects of oil on marine populations and communities and in major ecosystem.

Table 7.50 Effects of oil on Marine Populations and Communities

Community or Population type	Expected degree of initial impact	Expected recovery rate
Plankton	Light to moderate	Fast to moderate
Benthic communities		
Rocky intertidal	Light	Fast
Sandy or muddy	Moderate	Moderate
Intertidal	Heavy	Slow
Sub-tidal, offshore		
Fish	Light to moderate	Fast to moderate
Birds	Heavy	Slow

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

7.3.7 Oil Spill Modelling

A dedicated software *Hydrodyn-OILSOFT* for fate and transport of oil spills in the rivers, seas and estuaries was developed by Environ Software (P) Ltd, Bangalore as part of a Vedanta Ltd (Cairn Oil & Gas) sponsored study. It was used for predicting the oil spill trajectory and weathering processes for various spill scenarios and weathering characteristics in the Ravva field.

In the present study, an extreme scenario has been considered for the model study. It is assumed that instantaneous discharges can occur at and around Vedanta Ltd (Cairn Oil & Gas)

platforms. Accordingly, Platforms locations were considered between the Longitudes 81° 20′ 00.00′′ E and 84° 12′ 00.0 E, Latitudes 14° 30′ 00.0′′ N and 17° 30′ 00 N in the Ravva oil field. An instantaneous spill of 100 tons, 1000 tons and 5000 tons has been specified at RA/RC, SBM and at specified location along the pipeline in the Ravva oil field.

Computational domain and input data

In the present study, an extreme scenario has been considered for modelling purposes. It is assumed that instantaneous spills can occur at RA/RC, SBM and along pipeline in the Ravva operations will be carried out. Accordingly, the locations were selected where the likely spill scenarios can take place. The model study area was selected covering all the blocks and including a 320 km stretch from the extreme end well location towards the offshore waters (away from the coast). The domain between the Longitudes 81° 20′ 00.00′′ E and 84° 12′ 00.0 E, Latitudes 14° 30′ 00.0′′ N and 17° 30′ 00 N in the east coast of India has been selected as the study area for the modelling of fate and movement of oil spills.

After successful validation of the hydrodynamic model, the same was coupled with the oil spill model to compute the oil spill trajectories of operational / accidental / disaster spillages. The oil characteristics, bathymetry, oceanographic parameters such as sea surface temperature, tides and currents, meteorological parameters such as wind speed and direction, etc. are given as inputs to the model. The finer mesh has been adopted for model to maintain the accuracy in prediction of flow field as well as spill trajectory.

The tides and currents in the study domain during the year 2016 were simulated. The meteorological data for the Ravva region for different seasons, oil characteristics; bathymetry, oceanographic parameters, etc. were given as an input to the model. It was presumed that group-2 crude oil would be handled.

Though the oil spill undergoes different physical and chemical changes, dissolution is the main factor to be considered for assessing the carrying capacity of coastal waters. The modeling was carried out by coupling the oil spill model with the hydrodynamic model. Several runs have been made and results were stored for every hour. The computational runs were carried for the following scenarios discussed in the following sections.

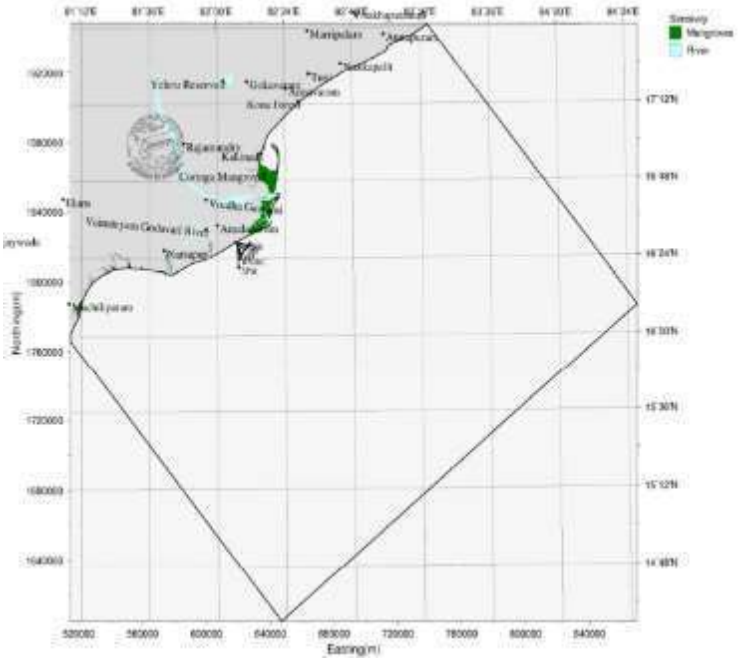
Ravva Platform Locations:

Simulations are made for the following scenarios

- *Ravva RA platform (Lat 16° 23′ 54.07′′, Long 82° 07′ 50.47′′)*
- *Ravva RC platform (Lat 16° 23′ 54.07′′, Long 82° 07′ 50.47′′)*
- *SBM (Lat 16° 20′ 42.19′′, Long 82° 07′ 19.94′′)*
- *Ravva Pipe (RE) -line leakage Location (Lat 16° 27′ 34.20′′, Long 82° 08′ 22.53′′)*

For the purpose of the modelling study, the above locations have been taken as the spill locations.

Figure 7.38 Computational study domain showing existing Ravva Facilities



Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Spill scenarios

Simulations are made for the following scenarios at SBM, RA/RC and pipeline leakage locations: Instantaneous spill of 100 tons, 1000 tons and 5000 tons of crude oil.

Oil Type

The following characteristics of crude oil are used for modelling study:

- Sp. Gr. : 0.8419
- API : 36.48
- Surface Tension : 3.0 e-03
- Vapour pressure of Oil (bar) : 0.184
- Viscosity of Oil (m^2/sec) : 95.5
- Molar Volume : 0.002
- Wax content : 12 – 19 %
- Pour point of untreated crude : 30^0C
- Pour point of treated crude : 18^0C

Weather Conditions

Currents have been stipulated from the model while the atmospheric temperature for 2016 has been provided in ***Table 7.51*** below.

Table 7.51 Atmospheric Temperature Details - 2016

Month	Minimum(°C)	Maximum(°C)
Jan	24.32	27.65
Feb	23.96	29.75
Mar	24.52	29 .97
Apr	25.77	32.10
May	28.35	32.90
Jun	28.37	33.37
Jul	27.58	31.13
Aug	26.81	30.77
Sep	26.73	30.33
Oct	27.23	32.42
Nov	24.73	28.43
Dec	23.39	28.58

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Computational Scenarios:

The following simulations are made to understand the seasonal behaviour of movement and weathering of oil spills / slicks in the sea.

Table 7.52 Scenarios Considered for Oil Spill Modelling

Month	Ravva Oilfield RA/RC (100 / 1000 / 5000 Tons)	SBM (100 / 1000 / 5000 Tons)	Ravva Field - Pipeline (RE) Leakage Location (100 / 1000 / 5000 Tons)
January	*	*	*
February	*	*	*
March	*	*	*
April	*	*	*
May	*	*	*
June	*	*	*
July	*	*	*
August	*	*	*
September	*	*	*
October	*	*	*
November	*	*	*
December	*	*	*

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Results of scenarios:

Movement of oil slicks- Knowledge of probable movement of an oil slick gives a distinct advantage while planning response strategies. Thus for instance, no major clean-up operation is necessary if the modelling results indicate that the spilled oil would remain at sea thereby sparing the shore ecology. On the contrary, if modelling results are suggestive of shoreward drift and predict that particular ecologically sensitive or important areas would be hit, effective counter measures such as deployment of deflection booms, containment and recovery of oil etc. can be effectively taken. *Hydrodyn-OILSOFT*, dedicated software for oil spill trajectory modelling is used for prediction of oil spill scenarios at selected Ravva field locations (RA/RC,

SBM, and RE pipeline) in and around offshore area for various meteorological and hydrological conditions.

The detailed results of various numerical runs are discussed and presented in the ***Annex 6* of EIA Volume 2**. Overall the model outputs indicated that the spills during January and March moves south-western coastal zone of Ravva block, during February, April and June spill moves towards North-eastern coast of Ravva block, during May moves to northern coast of Ravva Block, July, August and September moves towards north eastern direction open sea and October, November and December spill moves towards south-western direction open sea. The most vulnerable zone of shoreline landing is on either side of the Ravva basin; in north/south and west direction. The spilled oil will be moving towards the coast and hence there will be impact on the marine sensitive areas on the shore. The spills during July to December, moves towards open sea either in eastern or western open boundary. The spilled oil will be moving towards the open sea and hence there will not be impact on the marine sensitive areas on the shore.

The spilled crude oil undergoes a number of physical and chemical changes (weathering). The major weathering processes, as already described are spreading, evaporation, dispersion, emulsification, dissolution, oxidation, sedimentation and biodegradation. The last three processes are long-term processes, which determine the ultimate fate of the crude. The remaining processes are the most important during early stages of the spill, especially in coastal and inshore areas.

From the present model results, it can be observed from the figures that nearly 40% of oil is evaporated within 4 days and very small quantity of oil dissolved into the water. The weathering processes of oil spill are more or less similar in various scenarios irrespective of quantities oil spill, but it differs depending on the spill landing time, wind speed and temperature.

The detailed results of various numerical runs are discussed and presented in the ***Annex 6* of EIA Volume 2.**

7.3.8 Response Strategy

Response to oil spills depend on the magnitude of the spills occurred, nature of the oil and the availability of equipment for responding to spills near the source or spread. Hence a structured approach to spill response is propagated by various international agencies viz. International maritime organization (IMO) and International Petroleum Industry Environment Association (IPIECA) to facilitate optimization of resources and streamlining response actions.

Structure and Strategy for Ravva Operations

The PKGM-1 block of Vedanta Ltd (Cairn Oil & Gas) also known as Ravva field in the east coast is producing about 16,000 bopd from 8 nos. of unmanned well platforms and processing the crude at an onshore terminal followed by offloading the crude through a tanker at the SPM located at 15 km from the coast. Various risks associated with the operations are assessed in detail through a structured risk assessment process and the list of potential risks from operations is quantified. Based on the above assessment the potential spills from routine

operations in or near the installations are always less than 100 tons, though spills of larger magnitude viz. tanker collapse and blow outs may experience spills beyond 1000 tons. Hence the tiered response for Ravva operations is defined as under:

- Tier -1: upto 700 tons
- Tier -2: upto 700 to 10000 tons
- Tier -3: Beyond 10000 tons

While smaller incidents near the installations may be controlled at source, any uncontrolled event may escalate the incident from one tier to the other for which arrangements for response are integrated in this plan. The details have been provided in ***Table 7.53***.

Table 7.53 Tiered Oil Spill – Resource Details

Tier	Potential spills	Max quantity, tons	Internal Resources	External Resources
1	Operational spills during diesel transfer	<0.128 tons	Facilities available at offshore platforms, Onshore terminal & Kakinada port	Not required
2	Leakage at wellhead	<1.6 tons	As above	▪ Pooling of resources from ONGC,GSPC, RIL and Port as a part of Mutual aid agreement. ▪ Facilities of Coast Guard Station- Kakinada
3	Utility spills from platform/ships	<0.16-8tons	As above	▪ As above ▪ Facilities of any other industries in Vizag, Chennai ▪ Facilities of Coast Guard in the East coast ▪ Facilities of M/S OSRL, Singapore under membership agreement
4	Flow line rupture/leak	< 652 tons	As above	▪ Pooling of resources from ONGC, GSPC, RIL and Port as a part of Mutual aid agreement. ▪ Facilities of Coast Guard Station- Kakinada
5	Release of oil at SPM due to failure of transfer hose	<100tons	As above	▪ Not required
6	Diesel spill from support vessel (single tank/entire parcel)	< 500 tons	As above	▪ Pooling of resources from ONGC, GSPC, RIL and Port as a part of Mutual aid agreement. ▪ Facilities of Coast Guard Station-Kakinada
7	Blowout and BOP failure(Dependent on well flow and response times)	< 102-2040 Tons	As above	▪ As above ▪ Facilities of any other industries in Vizag, Chennai ▪ Facilities of Coast Guard in the East coast ▪ Facilities of M/S OSRL, Singapore under membership agreement
8	Major Accident at Shuttle tanker	< 2500 tons	As above	▪ As above ▪ Facilities of any other industries in Vizag, Chennai ▪ Facilities of Coast Guard in the East coast ▪ Facilities of M/S OSRL, Singapore under membership agreement

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Limiting and Adverse conditions for Response

The response strategies recommended herein will have direct dependence on the natural adverse conditions such as high sea states, excessive surface currents and wave conditions and inclement weather viz cyclones and storms prevalent in the region. The response decisions must take into account the following limiting factors:

- Proximity to shore while deploying the booms and skimmers to avoid
- shoaling/grounding

- Mud banks and shallow sand bars near the river mouths
- Excessive tidal currents near river mouths
- Excessive surface runoff through creeks and rivers during monsoon season
- High winds, waves and surface currents during cyclones/storms (monsoon and post monsoon)

The man made adverse conditions may at times cause disruption of operations beyond operator's control. These include:

- Road blocks by the villagers/trouble groups;
- Encircling and infringement of safety zones by the fishermen/fishing boats near the operational/safety zones around the vessels and installations;
- Obstruction of field activities by the local villagers or fishermen or communities;
- Regulating agencies viz Indian Coast Guard, AP Pollution Control board/MoEFCC may also dictate the type of strategies suited for the response based on local considerations. Such directives will supersede the actions already in vogue by the operator.

Response Strategies for oil spills from Ravva Operations

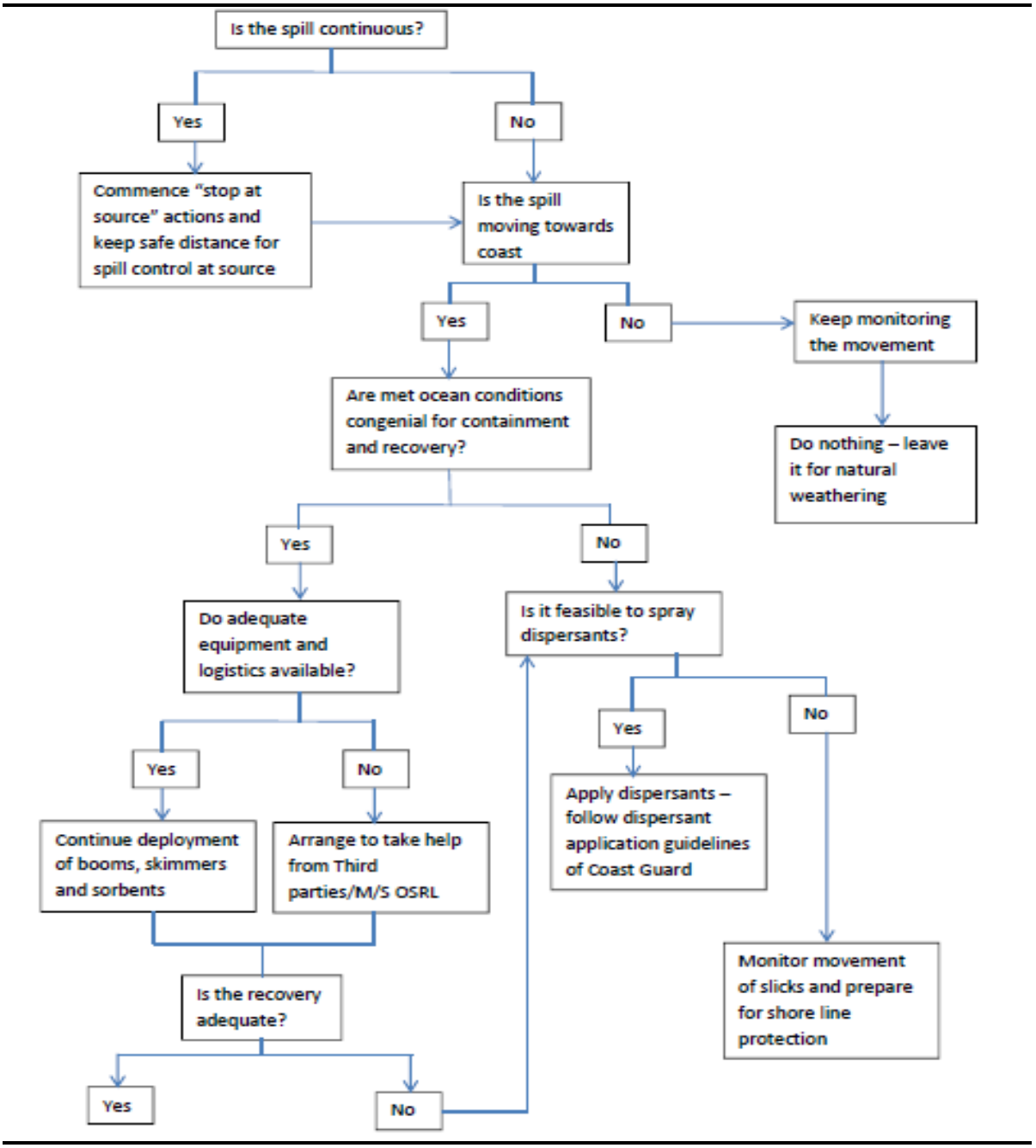
Choosing the appropriate method for oil spill response will depend on the particular circumstances of the incident. It is crucial, therefore, that the OSCP be a document that is both realistic and practical with respect to the capabilities and needs of the organization. The primary objective of any response strategy is to reduce the overall impact of an oil spill on both the natural and socio-economic resources. Specific objectives are:

- Ensure the safety of personnel in the event of an oil spill;
- Minimize the environmental impacts of an oil spill; and
- Protect the environmental and economic resources at risk

Response strategy for offshore region

Oil spill response strategies for offshore region are dependent on the met ocean conditions prevailing in the region coupled with fate and weathering of spilled oil. As a result of this, for most part of the year, any oil spills in the sea move away from the coast while during October-Feb, the slicks are expected to reach the coast. This season experiences low pressure depressions and worst cyclones in the region, making the deployment of any response activities difficult. Hence the response strategies are guided by a decision matrix as given in below ***Figure 7.39.***

Figure 7.39 Spill Response Decision Matrix



Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

The strategies for offshore response primarily aim at stopping at source, avoidance of spills reaching the coast by containment and recovery of dispersion at sea (considering the applicable guidelines).

A. Notification of oil spill incident

Anyone who notices the release of oil into the sea from any installation, vessel or pipeline should intimate the incident immediately to the Onshore Terminal of Ravva by radio/phone/email or any other fastest mode of communication. The likely sources of such observation of oil spill are:

- Instrumental observations in the process flow lines/trunk lines and hoses
- Observation of attendant security/support vessels
- Observation of helicopters
- Observation of passing vessels including fishing vessels
- Observations of working crew around the vessels/platforms
- Reports from Coast Guard, navy or any other public sources

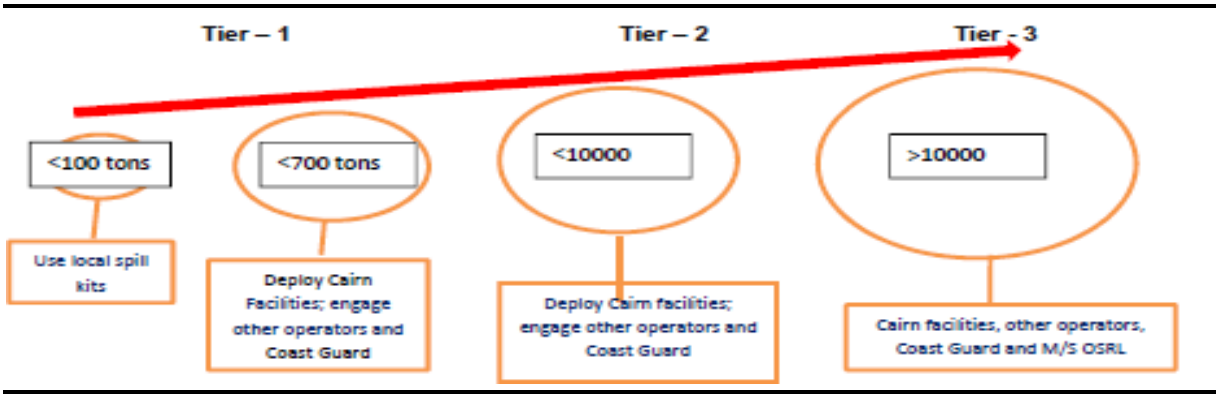
B. Stop at Source:

The immediate action of the operators in a spill incident is "stop at source". This can be achieved by activation of control actions for the spill incident thereby minimizing escalation of the event. The technology in-built into the operations shall be activated and where required, external intervention for stopping source is attempted. Such facilities for external intervention include deployment of multipurpose support vessels and offshore support vessels. Before deploying such vessels, it is necessary to assess the hazards and risks of such marine fleet moving in to the spill zone which experiences hazardous situation due to released oil and natural gas around. Safety precautions should be taken to minimize any fire and buoyance hazards around the spill location.

C. Tracking of spill movement

Upon notification of any spill incident from offshore, the likely movement of spill should be tracked using the software installed at the Ravva Onshore terminal. Using the historical wind data and ambient wind and currents at the time of spill, the likely movement of spill needs to be studied for decision making. The available vessels in the field and helicopters available at Ravva terminal can also be used for tracking spill movement. If the spill is moving towards the coast, detailed assessment of the location where the spill is likely to land should also be done using the available maps and ground information available at site. Information to the local authorities like district administration, pollution control board and fishery associations etc. should be conveyed about possible landing of spills on the coast. In case the spill is moving away from the coast, any likely installations which will be falling in the way of spill should be identified for monitoring and protection. The merchant fleet operating in the area should also be intimated about the spill through the Naval and Coast Guard arrangements. The general strategy of deployment of resources for various types of spills is discussed and presented in ***Figure 7.40.***

Figure 7.40 General Strategy of Deployment of Resources for Various Spill Types



Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Smaller spills from installations: The Tier-1 facilities available on the wellhead platforms, drilling rigs, support vessels and oil tanker should be adequate for dealing with smaller spills of less than 10 tons. These include dispersant spray unit, dispersant and sorbent pads etc. as a part of Oil Spill Tool kit. The content of the tool kit should be used to contain the oil spill onboard the installation/or within 500 m from the installation or pipeline and oil dispersed or collected (Contents of the spill kit and number of kits available are given in Data directory). If the spill quantity exceeds the handling capacity or if the spill moves outside the 500 m zone of the installation, the incident may be escalated to the next level for mobilization of additional resources.

Medium spills up to 700 tons: These tier-1 spills from the installations and vessels require mobilization of Vedanta Ltd (Cairn Oil & Gas) resources available in the field/base. The response facilities fall in three categories:

- Containment booms
- Recovery skimmers
- Dispersant spray units and dispersant stock

These equipment should be available onboard the support vessel in the field as a part of Tier-1 response. Where such facilities are located in the Shore Base, arrangements for their faster transportation should be made to deploy them within the required response time i.e. before the spills reach the coast line. The following strategies should be adopted:

- *Availability of dispersant spray sets onboard the production support vessel:* The dispersant spray set and adequate quantity of dispersant chemical (for a minimum 2 days application) should be available all the time on the PSV.
- *Containment booms and skimmers:* Should be preferably available on board the PSV all the time. However considering the manoeuvrability of vessel with heavy equipment during monsoon months, this equipment is normally stored in the Shore Base at Kakinada and mobilized on demand by any available boats at Kakinada port (List of equipment is placed in **Annex 6 of EIA Volume 2**). As the probability of spills reaching coast during south west monsoon is remote, the equipment may be kept in readiness when the spills are expected to reach the coast line i.e. during Post and North east monsoon season (October to February).
- *Resources of other operators:* Containment and recovery systems of Reliance Industries on board their MSV and PSVs of GSPC may also be kept in readiness in case of spillage in offshore during the Oct-Feb period with formal intimation under the mutual aid agreement. (List of equipment available with them is placed in **Annex 6 of EIA Volume 2**).
- *Vessels of opportunity:* During offshore deployment of resources, use of vessels of opportunity viz fishing trawlers, smaller fishing craft with winch facilities would be great value for holding the booms and driving the skimmers etc. List of such vessels of opportunity should be prepared and kept in the data base.

Moderate spills up to 10000 tons (Tier-2): The Tier -2 spills often escalate from Tier-1 incidents and also due to any major accident at the installation/vessels (see Risk Analysis section). Dealing with large spills requires mobilization of all the Vedanta Ltd (Cairn Oil & Gas) equipment, equipment of all the other operators and intervention of Indian Coast Guard. The general strategy of deployment is similar to Tier -1 case though it requires mobilization of additional resources. Mobilization of equipment and services with other operators and Coast Guard will require some mobilization time and local liaison. Arrangements for faster

mobilization through mutual cooperation agreement and trial tests of the arrangement should reduce the response time.

Coast Guard station at Kakinada, upon intimation of request for additional resources may mobilize their vessels in the Bay of Bengal. Response of these vessels may also take some time (2-3 days) as the vessels are expected to be anywhere in the Bay of Bengal and to be mobilized to the site. As the spill situation escalates to Tier-2 and beyond, the Indian Coast Guard may take over Command and Control as per NOSDCP in which all the operators including Vedanta Ltd (Cairn Oil & Gas) should follow the strategies suggested by Coast Guard.

Large scale (Major) spills beyond 10000 tons (Tier-3): Mega events involving large quantities of spillage such as uncontrolled blowout or tanker collapse are considered to be national events requiring resources of all the agencies. The strategies for deployment of individual operator's resources and facilities shall be dictated by Indian Coast Guard who takes the Command and Control of the situation. Vedanta Ltd (Cairn Oil & Gas) should deploy all their facilities under the above command with due records of events documented for future settlements. Mobilization of M/S OSRL shall be done by Vedanta Ltd (Cairn Oil & Gas) under the membership agreement. The Coast Guard shall decide the quantum and nature of equipment required for such clean-up along with services if any. Vedanta Ltd (Cairn Oil & Gas) shall abide by such directives of Indian Coast Guard and mobilize the equipment and services.

Deployment strategies

Local met ocean conditions are the determining factors for decisions on deployment of dispersant application and containment/recovery.

Dispersant application: Only low toxic, Coast Guard approved dispersants shall be used in the Indian waters as per NOSDCP guidelines (2009) of dispersant application. The dispersant application in shallow waters is prohibited. Following strategies shall be followed for dispersant application:

- Only low toxic dispersants with approved type by Coast Guard based on the tests conducted by National Institute of Oceanography or any other recognized Government research institute/laboratory shall be used.
- Dispersants of Type 2/3 – water dilatable concentrate shall be used with approved dispersant spray sets.
- Equivalent dispersants of type approval from other countries shall also be used where required with due approval from Indian Coast Guard.
- Dispersants with exceeded shelf life shall not be used
- Adequate quantity of dispersant chemical shall be stored at each potential source/nearby location for faster deployment/application.
- Dispersants shall not be used in shallow waters (<10 m) or in sensitive areas of river mouths etc.
- Use of dispersants shall follow guidelines of Indian Coast Guard.
- Dispersants shall not be used on weathered oils or diesel/condensate spills
- Dispersant application shall preferably from the bow end of vessels applying downwind to maximize effectiveness.

- Where possible, dispersants may be applied using aerial buckets with due safety of the aircraft concerned
- Dispersants should be applied on fresh/relatively fresh oils and preferably at the source with due consideration to the safety of the vessel
- Conduct a Net Benefit Analysis for various strategies of dispersant application.

Containment and recovery: Spill response using containment booms and recovery skimmers in the open sea depends on the met ocean conditions prevailing over the area and the status of weathering of the oil involved. This strategy shall be used when:

- Dispersant application on the spills is not feasible/practicable
- Spills reaching the coastal/sensitive locations
- Fair weather conditions (currents less than 1 knot and sea surface with
- 0.5-1 m waves)
- Storage facilities for recovered oil are available in the vicinity
- Conditions are safe for deployment near the source/oil slicks (no fire
- hazards)
- Prioritization of deployment depends on the potential areas to be protected. In offshore strategy, the priorities of deployment include:
- Diversion of spill away from existing installations/vessels in the path of spill zone
- Prevention of spills reaching the coast
- Protection of coastal sensitive locations (prioritization of protection among coastal resources is discussed above)
- Containment for oil recovery
- Dispersant application over contained slicks
- The containment and recovery operations and dispersant applications on a given spill should be complimentary in nature and supported by the provision of logistics required.

The strategies of oil spill response in open sea with containment and recovery systems are listed below in **Table 7.54.**

Table 7.54 Oil Spill Strategies in Open Sea

Spill Tier	Quantity of spillage, tons	Season	Sea state	Equipment deployment strategy	Limitations
1	<700 tons	Post monsoon and NE monsoon	Fair weather with low waves	Booms to contain the oil near the source, beyond 500 m from any installations	Delayed deployment may drive the spills towards coast when spills are to be diverted from critical areas
			Inclement weather due to depressions	Booms kept on standby while pursuing dispersant application/no action strategy for shore line clean up	Boom deployment not feasible, look for dispersants or prepare for shoreline clean up
		Monsoon and pre-monsoon	All weather conditions	No booms deployment unless the moving spills passing through any other fixed installation. Deploy booms for diversion in fair weather or disperse in rough weather	Deployment is not required as the spills move away from coast. However prepare for deployment in case of any other offshore facilities in the spill path
2	<1000 Tons	Post monsoon and NE monsoon	Fair weather with low waves	Deploy booms of all available capacities to contain before reaching coast	Boom deployment possible

Spill Tier	Quantity of spillage, tons	Season	Sea state	Equipment deployment strategy	Limitations
			Inclement weather due to depressions	Booms kept in readiness, engage dispersant application and/or prepare for shore line protection	Booms deployment not possible in this season, hence prepare for shore protection with containment and diversion
		Monsoon and pre-monsoon	All weather conditions	No booms deployment in this season as the spills move away from coast. Prepare to divert in case the spill path coincides with any fixed installations offshore	Boom deployment not required unless any threatened installations in offshore. Collate information of all available booms and plan the deployment
3	>1000 Tons	Post monsoon and NE monsoon	Fair weather with low waves	Coordinate deployment of all booms and skimmers with available logistics	Central coordination by Coast Guard for deployment of containment and reception facilities
			Inclement weather due to depressions	Priority response with dispersants or prepare for shoreline protection or diversion for slick dispersal at sea	Extensive oiling of beaches and shore facilities possible, be prepared for shore line cleanup and diversion booming near the coast
		Monsoon and pre-monsoon	All weather Conditions	Not required to deploy booms and skimmers, continue to monitor any diversion of slicks towards coast and prepare contingencies for dispersants	Boom deployment not possible in this phase and also not required as the spill move away from coast

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Response strategy for near shore and shallow regions:

For the oil spills emanating from near shore facilities of Vedanta Ltd (Cairn Oil & Gas) viz leaks from the trunk line and flow lines and any exploratory activities near the coast, the spills are to be managed in a quick and effective manner to prevent impact on the coast. As the spills reach the coast in less than a few hours, response time for such mitigation is very important. Following strategies shall be considered for spills in near shore and shallow regions off the Vedanta Ltd (Cairn Oil & Gas) facilities

Do Nothing: When the spills already enter the shallow regions and adequate facilities for diversion/containment are not available at site.

Dispersant application: Not permitted in less than 10 m water depth and also require Coast Guard approval for use even beyond this zone. Disperse oil after moving it seaward beyond 20 water depth using containment boom.

Divert spills: During Oct-Feb period when the general spill drift is towards the coast, deploy containment booms to move the oil away from the coast into deeper waters for dispersant application or recovery.

Recovery: Possible only in fair weather conditions with less than 1 knot current speed and 0.5-1 m surface waves. Either the offshore skimmer or sorbent mops/mop ropes can be used for faster pick up of oil from the sea. Facilities for waste collection should be available nearby.

Response vessels: The available production support vessel and the security boats operating in the Ravva offshore should have minimal facilities for deployment viz 200 m of near shore boom and one dispersant set with dispersant chemical for faster response. These are to be augmented by the additional supplies from S. Yanam base or Kakinada shore base.

Prepare for coastal protection/cleanup: Parallel arrangement for priority protection of the coastal facilities and prepare the shore line cleanup should be adequately addressed by the response team. Vessels of opportunity near the coast zone should be identified for support at sea.

Response strategy for river/creek inlets

The coast line along the vulnerable zone for spills from Ravva operations has several features like extended sandy beaches from north of Kakinada to south of Vasista Godavari river. This is also a deltaic area where the Godavari river system is branched into more than 6-7 major estuaries and small rivulets. Several drains also connect to the sea through salt water creeks, often extending to over 4-5 km hinterland. The Godavari estuaries have experience of tidal currents up to 20 km from the river mouth. The hinterland drains and estuaries are widely connected with several mangrove forests, marsh lands and exposed tidal flats.

These areas are also adjacent to salt pans and brackish water aquaculture ponds which depend on the salt water intake from rivers, rivulets and drains. Hence strategies of oil spill response in the rivers and inland drains are of paramount importance. Some of the major features of the coast line are given below:

Main estuaries of Godavari and Krishna rivers: There are four tributaries of Godavari river i.e Nilarevu, Vriddha Gowthami, Vainateyam and Vasista estuaries. Several small rivulets viz Gaderu Andnillarevu open into the Kakinada bay as a part of Godavari estuarine system. Krishna River also drains through two main channels open to the sea at Paleru and Munneru respectively.

Smaller drains: Agricultural drainage is through several drains from Kakinada to south of Nizampatnam bay. These are mostly open to the sea through narrow channel (not navigable) while the drain water carries all the wastes from agriculture from hinterland. The tidal influx into these drains is also used for brackish water aquaculture and salt pans in the region.

Mangroves: Mangroves are seen in the protected areas of river mouths or channels connected to the estuaries along the coast in the Godavari and Krishna river systems. There are no directly exposed mangroves from the open sea except a few small patches at the entrance to the river mouths. The protected mangroves are rich in biodiversity and of extensive ecological importance.

Response strategies: Oil spill response strategies for protection of river mouths and hinterland resources depend on the season of the year. While the monsoonal influx impacts movement of fresh water with a unilateral flow during June/July to Sept/October, the estuaries and creeks

experience tidal action even up to 10-20 km from the mouth of the rivers. The monsoon season also experiences movement of spills away from the coast, hence any risks of oil spills entering the river and drains is remote. Hence no protection or mitigation is required near the coast to protect the rivers and creeks during this period.

During October-February fair weather season, the tidal currents stir the estuaries and strong currents push the tidal water hinterland. Any slicks in the open ocean reaching the river mouth have chances of entering the creeks and rivers and needs to be controlled.
Deploy shore sealing booms of low draft and high buoyancy near exposed mangroves in the estuaries for protection of mangroves.
Deploy river protection boom at smaller creeks and drains in a diagonal manner (to minimize effect of tidal currents) and anchor on either side. Collect the oil from the pool into the barrels.

- Deploy low draft booms at the mouth of estuaries for deflection of spills to avoid reaching inside, try to direct to any sacrificial beach on either side of the estuary for clean-up.
- Don't apply any dispersants inside the river mouths as this area is rich in estuarine shrimp and fish larvae.
- Store adequate length of booms near the river mouths with occasional drills of deployment using local people.
- Make use of available fishing craft to seal the smaller creeks and drains using locally available materials like banana trunks, hay bundles and grass floaters when sufficient number of river booms is not available.
- Train the local people to use indigenous materials for prevention of entry of oil slicks into the fields/canals and creeks
- Train the salt pan operators on how to reduce ingress of oily patches into their canals with civil constructions for pumping channels.
- Don't enter into the mangroves and tidal flats for the purpose of deployment of spill control equipment as these would enhance further environmental damage.
- Take expert help while working around the creeks coated with oil.
- Involve locally available facilities and manpower for prevention of entry of oil into channels, creeks and mangroves.

Response strategy for intertidal region

The tidal amplitude in the region is less than one meter for most part of the year with semi diurnal tides moving with a resultant northward drift. Any entry of oil into the creeks is expected to move northwards towards Coringa sanctuary and Kakinada bay. The intertidal region in the creeks and estuaries is very small owing to the elevated banks in the forests and agriculture fields along the shoreline. However, the intertidal sandy stretch from Kakinada to northwards and southwards towards Vasista estuary is expected to be impacted in case of oil spill reaching the coast. The sandy beaches are used by the local villagers as landing points for fishing apart from drying their produce and living near the water front during dry seasons. There are several sand spits near the river mouths of Godavari and Krishna Rivers which are generally exposed during low tide are known to be habitats of Olive Ridley and other turtles in the region. Hence the intertidal region of the coast is very important both economically and environmental reasons.

- Prepare and engage communities living near the spill landing site for likely spillage based on simulations

- Drift the oil spills in the near shore region towards sacrificial beaches (low energy) for containment
- Deploy intertidal (shore sealing) booms at the creeks and water inlets to protect them
- Minimize entry into the mud flats and tidal marshes to avoid further damage
- Deploy manpower for cleanup along the high tide mark (using shovels, scrappers, combers and fill materials into polythene bags)
- Develop temporary storage pits beyond high tide line with HDPE liner and store all collected liquids/wastes
- Use low pressure jetting of the coarse grained sandy beach to release oil entered into deep if any
- Weathered residues settled on the beach (tar balls) can be collected in gunny bags for further disposal
- No mechanical collecting devices (JCBs etc.) should be deployed in the intertidal region which can damage beach fauna and flora.
- Animals if any impacted by oil spills should be collected and treated
- Any turtle nests seen along the coast should be protected with containment around the site

Response strategies for shore line clean-up

Type of equipment used for shoreline clean-up depends on the geomorphology of the coast and accessibility apart from the nature of crude and its weathering nature. Some of the strategies for shoreline clean-up of various types of coast lines are given below in ***Table 7.55***.

Table 7.55 Response Strategies for Shore Line Clean Up

Type of the shoreline	Locations along the coast	Nature of oil spill landed	Method and equipment required	Limitations
Sandy beach	Kakinada beach North of Uppada Hope island to mouth of Gowthami Godavari South of Sacramento to the north of S. Yanam S. Yanam to mouth of Vasista Godavari	Fresh oily patches	Scooping/scrapping of surface layer of oily sand with Shovels Low pressure wash on the beach to collect into pools with boom containment Low pressure flushing of oil if the oil is penetrated below. Use vacuum pumps to collect oil from intermediate lined storage pits. Keep trucks / tankers standby to pick up collected wastes. To be cleaned within 1-2 tidal cycles to avoid further spreading along the coast	Walking over the spilled areas or use of mechanical equipment further damage the sandy beaches with mixing and penetration. Delayed response will enhance lateral shift along the coast
	Do	Weathered oily residues and tar balls	Manual pick up usingcombers and collection in pits/gunny bags for further disposal	Requirement of manpower for collection and transport in remote locations

Type of the shoreline	Locations along the coast	Nature of oil spill landed	Method and equipment required	Limitations
Sand spits and tidal sand bars	Mouth of Gowthamiestuary at Bhairavapalem, Sacremento, Antarvedi and Krishna river mouth	All types	No interference manually on these sensitive locations, which are habitat for turtles and other sensitive species. Use of diversion/ containment boom for any released oil during high tide. Low pressure flushing using water jets during high tide to release and dislocate the oil from the surface	Extremely difficult task due to shallow nature of the locations. Reoiling of the locations to be controlled.
Jetties / wharf / rocky shores	Kakinada port, Bhairavapalem & Savitrinagar jetties Odalarevu jetty Yanam.	Freshly coated oily spills	Spray of neat concentrate of dispersant and leave for natural flushing. Contain the released oil with inshore booms and sorbents	Access to jetties and wharfs may be difficult due to interference by local fishing communities for compensation. Involve district admin and local contractors in operation
Exposed tidal flats	River mouth of Krishna extending from south of Vashista to Krishnapatnam bay	All kinds	Leave it alone with aerial surveillance as interference to tidal flats is more damaging. Look for any oil going into creeks/canals with access to the aqua ponds/agriculture and protect the channels	Site access to these areas is extremely difficult due to remote locations with no approach
Exposed mangroves along the coast	Kakinada bay River mouths of Gauthami, Vashista and Krishna rivers	All kinds	Before landing adopt diversion/containment approaches. Once landed in the mangroves, it is better to leave it alone with no or less interference. Areas of tourist and high environmental importance may be attempted for low pressure water spray on the plants/trees with no dispersant chemicals. Additives for enhanced microbial degradation (oleophilic fertilizers) may be attempted for faster recovery	Access to mangrove swamps with cleanup equipment difficult. Human interference to mangroves will cause more damage hence it is better to leave it alone and monitor recovery
Protected mangroves inside the creeks, rivers and estuaries	Kakinada bay, Coringa and other reserve forests of Godavari estuary and Krishna RF and other mangroves of Krishna river mouth	All kinds	As above	As above

Type of the shoreline	Locations along the coast	Nature of oil spill landed	Method and equipment required	Limitations
Salt pans and Aquaponds	Gadimoga and adjacent regions. Aqua ponds in the hinterland connected to creeks, drains and channels	All kinds	Chances of oil slicks reaching the salt pans and aqua ponds are remote as these channels are constantly monitored by the operators of these facilities. Salt brackish water is also pumped from the channels or passed through weir at the entrance of the channel. However protective booming with inshore booms or native arrangements like ropes, banana trunks and hay bundles can be placed on these channels to prevent entry of oil into the salt pans/ponds. Once entered, it has to be manually cleaned with sorbents and saw dust etc	Any entries of oil into these areas invite extensive criticism and social problems. Hence all out efforts to avoid entry into the channels to be done by deploying booms at the mouths ofchannels. No dispersants to be used in these locations.

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

7.3.9 Emergency Response

Oil spill response in Ravva operations are also dealt within the overall ambit of Emergency Management of Vedanta Ltd (Cairn Oil & Gas)'s operations in India. With the upstream oil and gas exploratory and production assets. Vedanta Ltd (Cairn Oil & Gas) established a broad framework of dealing with various types of emergencies typical of oil and gas industry operations. The intent of such framework is aimed at:

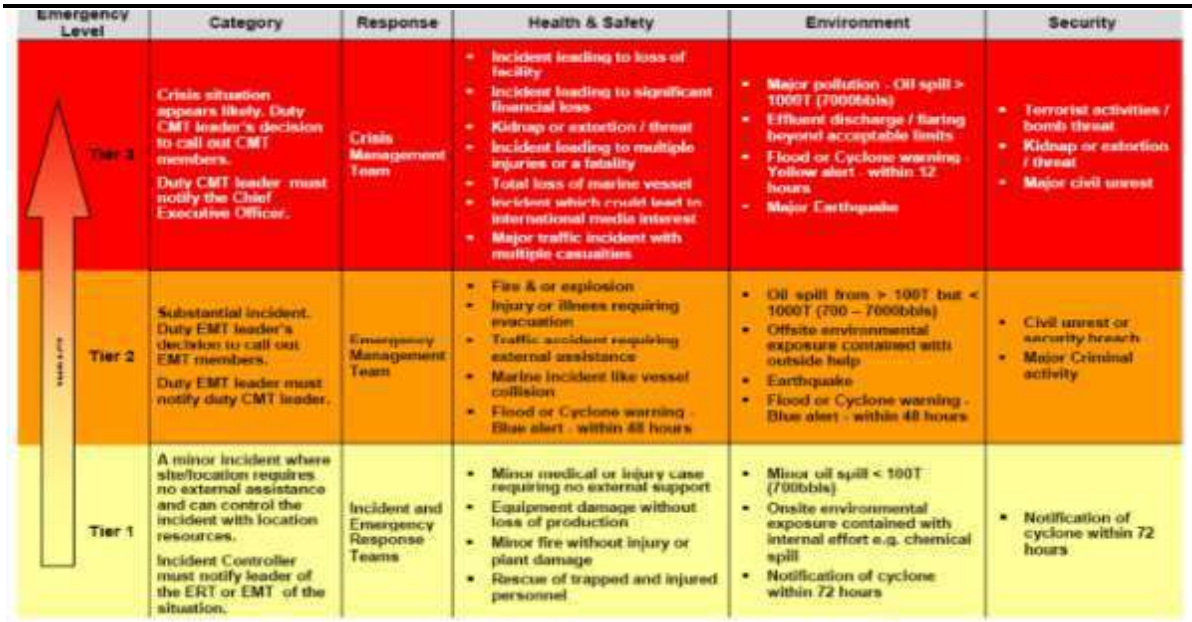
- Establishing plans applicable to various sites, Fields and locations with a uniform approach of minimizing losses to personnel, environment and assets after an incident of remarkable impact happened.
- Giving directions to the operating personnel with the strategies, roles and responsibilities and approaches for managing the situation without further escalation.
- Giving direction to the operational personnel with organizational arrangements for communication, reporting and strategies of response for different emergency scenarios
- Defining role clarity while escalation of emergencies, decision making at different levels of management for dealing with emergencies
- Identification of resources and arrangements for response and mitigation
- Vedanta Ltd (Cairn Oil & Gas) overall strategy is to segregate the actions at various levels commensurate with the magnitude of the emergency and required mitigation plans.

7.3.10 Emergency Management Structure of Cairn

Vedanta Ltd (Cairn Oil & Gas) follows a three level emergency management structure (called the tiers or levels). The tiered response structure is widely followed by the industry to identify the requirements at the site, strategic support and corporate decision making for minimizing the impacts of emergencies. The definition takes into account the magnitude of incidents, response time, response strategies required and the delegation of authority and responsibility

of decision making which are essential during emergency response. The categorization of emergency level for various categories of incidents is presented below in **Figure 7.41.**

Figure 7.41 Emergency Levels for Various Categories of Incident

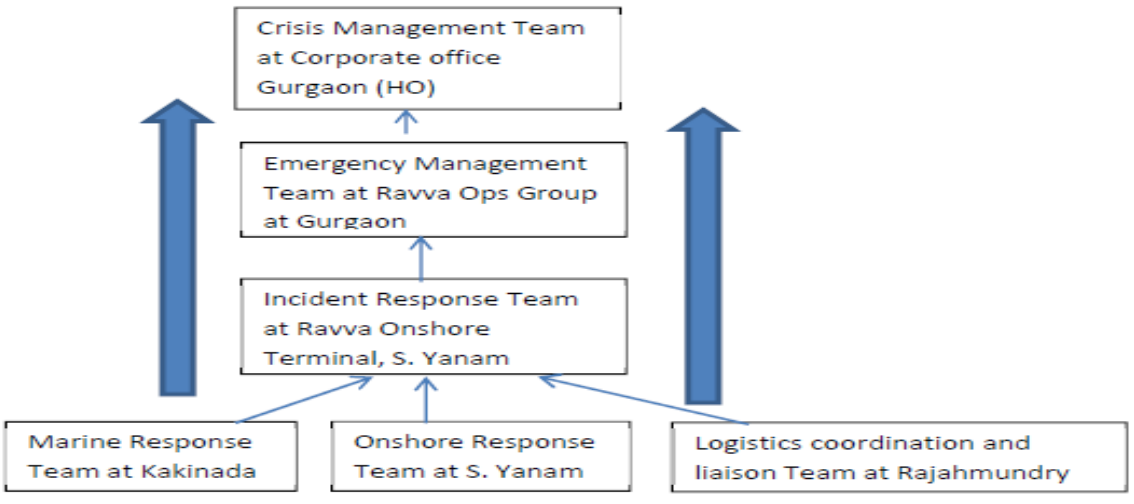


Emergency Level	Category	Response	Health & Safety	Environment	Security
Tier 3	Crisis situation appears likely. Duty CMT leader's decision to call out CMT members. Duty CMT leader must notify the Chief Executive Officer.	Crisis Management Team	• Incident leading to loss of facility • Incident leading to significant financial loss • Kidnap or extortion / threat • Incident leading to multiple injuries or a fatality • Total loss of marine vessel • Incident which could lead to international media interest • Major traffic incident with multiple casualties	• Major pollution - Oil spill > 1000T (7000bbls) • Effluent discharge / flaring beyond acceptable limits • Flood or Cyclone warning - Yellow alert - within 12 hours • Major Earthquake	• Terrorist activities / bomb threat • Kidnap or extortion / threat • Major civil unrest
Tier 2	Substantial incident. Duty EMT leader's decision to call out EMT members. Duty EMT leader must notify duty CMT leader.	Emergency Management Team	• Fire & or explosion • Injury or illness requiring evacuation • Traffic accident requiring external assistance • Marine incident like vessel collision • Flood or Cyclone warning - Blue alert - within 48 hours	• Oil spill from > 100T but < 1000T (700 – 7000bbls) • Offsite environmental exposure contained with outside help • Earthquake • Flood or Cyclone warning - Blue alert - within 48 hours	• Civil unrest or security breach • Major Criminal activity
Tier 1	A minor incident where site/location requires no external assistance and can control the incident with location resources. Incident Controller must notify leader of the ERT or EMT of the situation.	Incident and Emergency Response Teams	• Minor medical or injury case requiring no external support • Equipment damage without loss of production • Minor fire without injury or plant damage • Rescue of trapped and injured personnel	• Minor oil spill < 100T (700bbls) • Onsite environmental exposure contained with internal effort e.g. chemical spill • Notification of cyclone within 72 hours	• Notification of cyclone within 72 hours

Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Leadership for managing the response is very essential in emergency management. For each level of response the team leads are identified who are authorized with delegated powers of response. Broad structure of response in Vedanta Ltd (Cairn Oil & Gas) operations for dealing with Ravva emergencies is depicted in ***Figure 7.42.***

Figure 7.42 Emergency Response Structure for Ravva Operations



Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Incident Response Team (IRT) & Emergency Response Team (ERT) – Operational Response: It is the IRT and ERT's responsibility to deal with the respective location or asset's incidents / emergencies of minor nature requiring no external assistance and which can be controlled with local resources. For emergencies where external assistance is required the

Incident Controller at site/location must notify Emergency Management Team Leader at Gurgaon for action. The duty EMT Leader must be notified of all incidents within 30 minutes of the activation of the Incident Response Team.

Emergency Management Team (EMT) – Tactical Response: It is the Emergency Management Team's responsibility to respond and provide assistance to control major emergencies that occur within the Country (India). This document solely details the EMT's roles and responsibilities. This document is to provide guidance so that the EMT is able to address the varying range of strategic and tactical issues raised during a crisis. EMT in the Gurgaon office will provide support and assistance for emergencies at Ravva. EMT Leader must notify the Crisis Management Team duty Manager (Via the telephone) as soon as practically possible if the Emergency Management Team is mobilized.

Crisis Management Team (CMT) – Strategic Response: The Crisis Management Team in Gurgaon will coordinate the overall strategic response for major incidents involving any Vedanta Ltd (Cairn Oil & Gas) operations within India. A crisis is defined as a situation arising from single or multiple incidents or emergencies that escalate to a point beyond which significant damage to the Company's business could result, including commercial and reputation damage, significant financial loss, shareholder loss of confidence and damages resulting from litigation. When a potential crisis situation appears likely, the CMT will be mobilized to manage issues pertaining to the reputation and the continued commercial well-being of the Company. The CMT may however also be called upon to address some of the tactical roles that would normally be the responsibility of EMT.
Key Roles of response at various levels for Emergency Response

Prevention of accidental spillage is Vedanta Ltd (Cairn Oil & Gas)'s key priority. Offshore production and drilling facilities are designed, installed and operated to minimize possibility of oil spills. Facilities and resources supplied by third parties are also required to meet international pollution prevention design and operation standards. Vedanta Ltd (Cairn Oil & Gas) shares the community's concern for the protection of the natural environment from oil spills. The company is committed to integrating into its plans and operations to identify oil spill risks, prevent oil spills, and to implement appropriate spill response / clean-up strategies. To achieve this, Vedanta Ltd (Cairn Oil & Gas) will:

- Respond immediately to any incident with the objective of protecting human life and to minimize environmental impacts.
- Work and consult with appropriate government bodies, and the local community to address any
- Issues relating to oils spills in a timely manner.
- Provide adequate training and information to enable employees and contractors to adopt environmentally responsible work practices, and to be aware of their responsibilities in Prevention and clean -up of oil spills.
- Develop emergency plans and procedures so that incidents (accidental releases) can be - Responded in a timely manner.
- Develop and maintain management systems to identify, control and monitor risks and compliance with government regulations and industry guidelines.
- Where third party interests are involved, such as products or chartered vessels, drilling rigs, Vedanta Ltd (Cairn Oil & Gas) will assess the situation and take timely and appropriate action.

- Each employee is responsible for the implementation of these guidelines in association with their specific duties. This includes contractors and their employees.

Vedanta Ltd (Cairn Oil & Gas)'s approach to an oil spill is based on the following:

- Tactical response to a spill will be carried out by the operating unit where the emergency is Located.
- The incident controller is responsible for coordinating the on-site tactical response to an oil spill Emergency.
- The emergency Management Team located at Vedanta Ltd (Cairn Oil & Gas) Head Office, Gurgaon is responsible for coordinating the strategic response, and mobilization of equipment, materials, services and technical support as required in support of onsite spill response, and will manage follow-up actions.
- Action will be prompt and appropriate resources devoted to ensure most effective management of a spill.
- Communications will be timely and accurate in the event of an oil spill.

The broad functions and responsibilities of IRT, EMT and CMT of Vedanta Ltd (Cairn Oil & Gas) are depicted in the

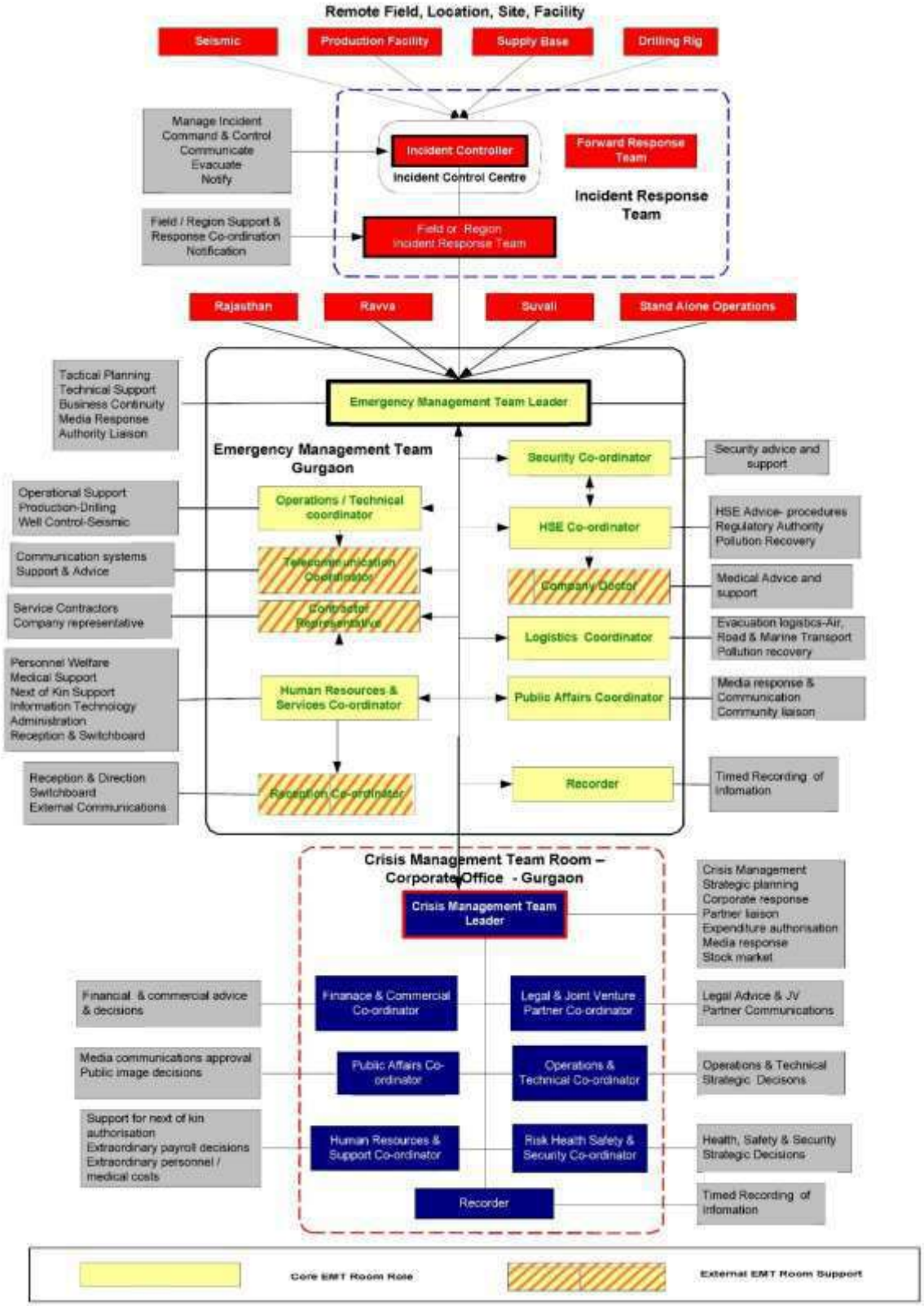
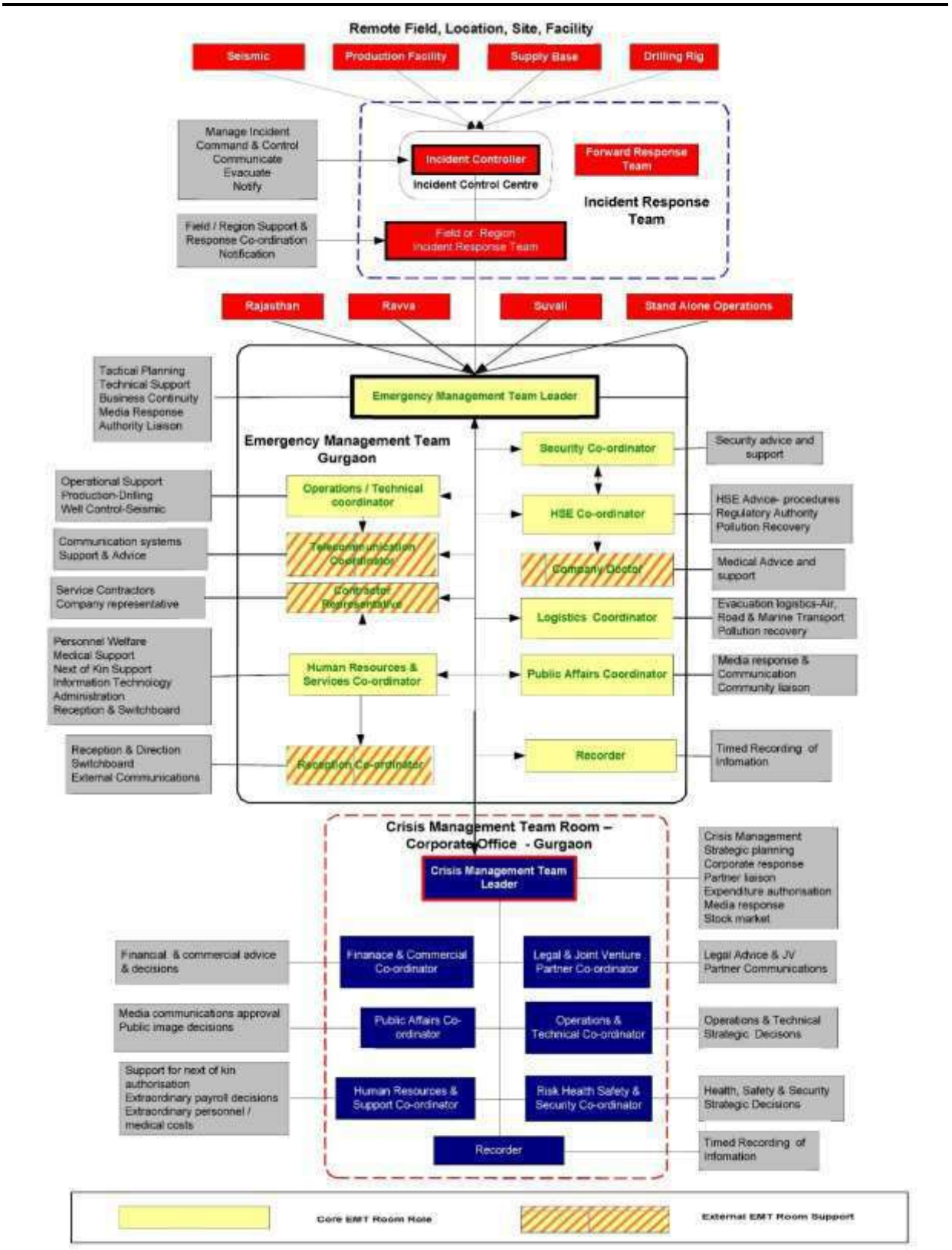


Figure 7.43.

Figure 7.43 Emergency Response Mechanism – Roles & Responsibilities



Source: Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva field, Vedanta Limited (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

7.3.11 Oil Spill Response Equipment

Vedanta Ltd (Cairn Oil & Gas) is having its own oil spill Response equipment. In addition to meet Tire-1 Preparedness a live mutual agreement with Oil and Natural gas Corporation Ltd, Reliance Industries Limited, Gujarat State Petroleum Corporation Oil India limited is in place, Vedanta Ltd (Cairn Oil & Gas) is having Associate member ship with M/s Oil spill Response Limited for Tire-II/III Emergencies. The list of equipment and copies of mentioned agreements are forming part of this plan (refer ***Annex 6 of*** **EIA Volume 2*).***

7.3.12 Support from other Operators under Mutual Cooperation agreement

Other than Vedanta Ltd (Cairn Oil & Gas), the following operators have upstream exploration and production activities around the KG Basin region:

- Oil and Natural Gas Corporation Ltd (both offshore and onshore)
- Gujarat State Petroleum Corporation Ltd (Offshore production and onshore terminal)
- Reliance Industries Ltd (Offshore production and onshore terminal)
- Oil India Ltd (Onshore exploration activities)

In addition to the oil companies, the region has other maritime activities like:

- Loading and unloading of vegetable oils, fertilizers, coal and other minerals from Kakinada Sea Ports Ltd (Kakinada port)
- Indian Coast Guard station in the Port limits
- Coastal Power Plants and Fertilizer units (Nagarjuna and Coromandal fertilizer plants) at Kakinada.
- Fishing harbor
- Kakinada old port in the Coringa channel of Godavari
- Fishing jetties at Bhairavapalem, Yanam, Vadalrevu and Antharvedi

As a part of mutual cooperation agreement with other operators, an understanding of support from three other oil companies (ONGC, RIL and GSPC) for the past 2 years. Equipment available with these companies is given in the Appendix-5, which is available on call on "no profit-no loss" basis. The primary objective of this agreement is support the oil companies in distress in case of any emergency resulting in oil spills with their available facilities on cost reimbursable basis. The agreement was effectively used in some incidents of this nature and considered to be an effective arrangement for attending to Tier-1 to Tier-2 spills (100-1000 tons).

7.3.13 Activation of OSRL Singapore

Oil Spill Response Ltd (M/S OSRL) is private consortium operated by the oil industry majors for attending to spills of higher magnitude (Tier-2 and above) with membership offered to various national and international oil companies with its HQ in UK. The M/S OSRL, Singapore is a regional unit located for assisting the members in the South and South-east Asia. Vedanta Ltd (Cairn Oil & Gas) is an associate member of M/S OSRL for the past 5 years and gained the services of M/S OSRL on several occasions in oil spill contingency planning, training and hands-on experience sharing with their competent personnel.

M/S OSRL has a stock of equipment available at their Singapore Base which is ready on round the clock basis for mobilization on an authorized call from the members. The stock of

equipment available with M/S OSRL is given at the **Annex 6 of EIA Volume 2**. A list of authorized personnel of Vedanta Ltd (Cairn Oil & Gas) for mobilization of equipment and services of M/S OSRL are also included in **Annex 6.**

Procedure for mobilization of equipment and services of M/s OSRL commences with notification by the authorized Vedanta Ltd (Cairn Oil & Gas) Representatives. M/s OSRL shall mobilize their equipment based on the request of the Vedanta Ltd (Cairn Oil & Gas) which may include specific equipment viz., booms, skimmers and dispersant chemicals. M/s OSRL has a dedicated aircraft which can fly to the nearest airport viz., Chennai or Vizag for delivering the material. Though there is an airport at Rajahmundry the operational suitability of the aircraft is not adequate for landing at Rajahmundry. Hence the response time of M/S OSRL for offloading their equipment in Indian airport is about 6-7 hours, there after Vedanta Ltd (Cairn Oil & Gas) is required to get the items cleared through Indian Customs, excise and other security formalities. M/s OSRL shall forward the material list along with required documents through email upon dispatch from Singapore.

7.4 ADDITIONAL STUDIES: OFFSHORE DISPERSAL OF DRILL CUTTINGS & DRILLING MUD

7.4.1 Drill Cutting & Spent Mud Generation & Disposal

Drilling Mud

For offshore drilling, Vedanta Ltd (Cairn Oil & Gas) is proposing use of water based mud (WBM) for the upper sections and use of synthetic base mud (SBM) for deeper and more difficult formations. WBM typically consists of water, bentonite, polymers and barite. Barite has higher density than other mud contents and helps in drilling and maintaining reservoir pressure. At the end of drilling of a well almost the entire amount of the SBM, if used will be collected for re-use in next drilling operation, while WBM will be discharged offshore.

Vedanta Ltd (Cairn Oil & Gas) is proposing drilling of 17 developmental (production) wells and 73 exploratory/ appraisal wells at the selected offshore locations, the total WBM generation is expected to be approximately 13,500 m^3 (i.e. 150 m^3 per well x 90 nos. of wells) for the whole offshore drilling programme which is expected to last for approximately 10 years.

It is proposed that approximately 150 m^3 (240 tonnes) per well of WBM of low toxicity will be disposed offshore. As per MoEFCC Guidelines, offshore discharge permitted is at a rate of 50 bbl $hour^{-1}$ (8 m^3 $hour^{-1}$ i.e. 12.8 tonnes $hour^{-1}$ @ 1.6 tonnes/m^3 density of drilling fluid), offshore discharge of drilling fluid of 240 tonnes will require approximately 20 hours per well.

All SBM generated will be recovered for reuse. There will be sufficient time between drilling of two wells, thus recovery of the water column to normal conditions is expected before drilling of next well at another location. The offshore discharge of cuttings and residual WBM will be designed to discourage the generation of suspended solids. This will be achieved by:

- maximising the cohesiveness of the solids; and
- encouraging the development and persistence of a density flow.

The cumulative drilling of offshore wells in a year will not exceed 8 to 9 nos. per year. The maximum period of disturbance for discharge of drill cuttings will be 30 hours x 9 = 270 hours per year on intermittent basis while for drilling mud it will be 20 hours x 9 = 180 hours per year on intermittent basis.

Drill Cuttings

Drill cutting consists of inert geological material. The amount of drill cuttings created is estimated at 220 m^3 (484 tonnes) per well. It is estimated that about 4% by weight of drilling mud will remain on the cuttings after treatment. Based on this estimate, 19.4 tonnes of drilling fluid will be lost on cuttings. In total it is therefore anticipated that a mass of 504 tonnes drilling cuttings will be discharged per well.

For 17 developmental and 73 exploratory/appraisal wells, the total quantity of drill cutting is expected to be 19,800 tonnes (220 m^3 per well x 90 nos of wells) for the whole drilling programme, which is expected to last for 10 years. Drill cutting generated out of the WBM/SBM of low toxicity will be washed, separated and disposed offshore. While in case of SBM usage is not of low toxicity it will be separated, washed and collected on-board and shipped for disposal to onshore at approved CHWTSDF.

As per MoEFCC Guidelines, offshore discharge permitted is at a rate of 50 bbl $hour^{-1}$ (8 m^3 $hour^{-1}$ i.e. 17.6 tonnes $hour^{-1}$), offshore discharge of drill cutting of 504 tonnes will require approximately 30 hours per well. Drill cuttings treated from shale shakers and centrifuges to separate mud from cuttings from the reservoir rock may have presence of hydrocarbon residues. Vedanta Ltd (Cairn Oil & Gas) will ensure that drill cutting associated with high oil content (oil content >10 g/kg) from hydrocarbon bearing formation are not disposed offshore.

7.4.2 Dispersion of Drill Cuttings

The coast in the study area is very exposed. It runs perpendicular to the wind directions that prevail during the Southwest and Northeast Monsoons and is open to the Indian Ocean to the south. The cuttings will settle on the seabed where they will initially accumulate. If the cuttings are not disturbed it will consolidate thus the resistance of the resulting pile to movement (shear resistance) will increase with time if the sediments are not disturbed by currents. For offshore discharge, two critical processes are:

- The effect of tidal and wave energies in constantly reworking the deposit. If this occurs the deposit will not be able to consolidate, and there will be incremental daily transport into adjacent seabed areas, so the likelihood of a cuttings pile accumulating will be low.
- The strength of peak tide and wave flows in relation to the consolidated strength of a cuttings pile.

In the relatively shallow depths in which the wells will be drilled a pile which does form in the short term, is predicted to be dispersed in the long term as a result of regular if infrequent high energy episodes.

The proposed drilling of wells will be in shallow water depths of 10 m to 15 m. Based on 15m depth tidal energy at the seabed can be characterised by U_{100} (strength of tidal flow at 1m above the seabed). This can be estimated from surface velocity using the method of Van Veen, where;

$$U_{100} = U_{surface} * (1/15)^{1/n}$$

where n can vary between 1 and 10 (Dyer 1986) (1)

The range of daily U_{100} values from this equation is 0.3 to 0.38 m s^{-1} (surface flow 0.5 m s^{-1}). The peak annual range of U_{100} values are 0.52 to 0.68 m s^{-1} (surface flow 0.9 ms^{-1}).

Wave energy at the seabed can be estimated using surface wave characteristics to estimate the peak oscillatory flow achieved under individual waves (Small man and Soulsby 1986)(2), annotated u_w. This relationship is summarised in ***Table 7.56***.

At 15m depth, this table gives the following critical values for u_w.

- daily peak flows (1m Hs, 5s period estimated) = 0.09 ms^{-1}
- annual peak flows (3m Hs, 10s period estimated) = 0.5 ms^{-1}

Mud and mud-sand mixtures have a threshold shear resistance (point at which the substrate will begin to move) of between 0.1 and 1.0 Nm^2, with resistance increasing with higher sand content and consolidation.

Assuming a smooth boundary layer, typical of muds with a small sand content, a salinity of 35% and temperature of 25°C, the U_{100} threshold values for the erosion of unconsolidated and consolidated cuttings under tidal currents can be calculated as 0.1 ms^{-1} and 0.4 ms^{-1} respectively. These values both lie below the respective daily and annual peak flows predicted for tidal currents in the area, therefore the probability is that tidal currents will effectively disperse the cuttings on a continuous basis. Based on the data available, calculations applied to the wave data give a similar result. Combined wave and tide effects will reinforce the dispersion process and are predicted to be more pronounced in shallower water.

Thus the indications are that a typical cuttings discharge will not accumulate to form a localised pile beneath the rig, but will become dispersed on a daily basis, reinforced by regular but infrequent episodes of high energy events (strong waves, equinoctial tides, storm surges, freshwater flooding) causing strong scour.

Dispersion of the cuttings pile so produced will be greatest during the monsoon period when storm waves are predicted to be largest. It is predicted that a small fraction of the discharge (estimated at a few percent) will escape from the plume of drilling waste during its descent, and some of the discharged material will be dispersed into the lower water column on initial impact with the seabed. The offshore discharge of WBM /SBM of low toxicity mainly comprise of solid, inert components of the drilling mud will settle to the seabed, while soluble low toxicity additives will dilute and disperse in the water column.

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(1)Dyer KR 1986 Coastal and Estuarine Sediment Dynamics. Wiley Interscience

(2)Soulsby RL and Smallman JV. 1986**. A direct method of calculating bottom orbital velocity under waves**. Report SR 76. HR Wallingford

Table 7.56 Bottom Orbital Velocity (Urms m/sec) Calculator

WATER DEPTH	15	m			BOTTOM ORBITAL VELOCITY CALCULATOR Urms (m/s)							
					(method of Soulsby & Smallman 1986)							
Hs	Tz		seconds									
m	3	4	5	6	7	8	9	10	11	12	13	14
0.5	0.01	0.03	0.05	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.09
1	0.02	0.06	0.09	0.12	0.14	0.15	0.16	0.17	0.17	0.18	0.18	0.18
1.5	0.03	0.08	0.14	0.18	0.21	0.22	0.24	0.25	0.26	0.26	0.27	0.27
2	0.04	0.11	0.18	0.24	0.27	0.30	0.32	0.33	0.34	0.35	0.36	0.37
2.5	0.05	0.14	0.23	0.30	0.34	0.37	0.40	0.42	0.43	0.44	0.45	0.46
3	0.06	0.17	0.28	0.36	0.41	0.45	0.48	0.50	0.52	0.53	0.54	0.55
3.5	0.07	0.20	0.32	0.41	0.48	0.52	0.56	0.58	0.60	0.62	0.63	0.64
4	0.08	0.22	0.37	0.47	0.55	0.60	0.64	0.67	0.69	0.71	0.72	0.73
4.5	0.09	0.25	0.41	0.53	0.62	0.67	0.72	0.75	0.78	0.79	0.81	0.82
5	0.10	0.28	0.46	0.59	0.68	0.75	0.80	0.83	0.86	0.88	0.90	0.92
5.5	0.11	0.31	0.51	0.65	0.75	0.82	0.88	0.92	0.95	0.97	0.99	1.01
6	0.11	0.34	0.55	0.71	0.82	0.90	0.96	1.00	1.03	1.06	1.08	1.10
6.5	0.12	0.36	0.60	0.77	0.89	0.97	1.04	1.08	1.12	1.15	1.17	1.19
7	0.13	0.39	0.64	0.83	0.96	1.05	1.12	1.17	1.21	1.24	1.26	1.28
7.5	0.14	0.42	0.69	0.89	1.03	1.12	1.20	1.25	1.29	1.32	1.35	1.37
8	0.15	0.45	0.74	0.95	1.09	1.20	1.28	1.33	1.38	1.41	1.44	1.46
8.5	0.16	0.48	0.78	1.01	1.16	1.27	1.36	1.42	1.46	1.50	1.53	1.56
9	0.17	0.50	0.83	1.07	1.23	1.35	1.44	1.50	1.55	1.59	1.62	1.65
9.5	0.18	0.53	0.88	1.13	1.30	1.42	1.51	1.58	1.64	1.68	1.71	1.74
10	0.19	0.56	0.92	1.19	1.37	1.50	1.59	1.67	1.72	1.77	1.80	1.83

The average background suspended solids as observed (in ***Section 3.13.1***) is up to 27 mg/l whilst drilling discharges may temporarily increase it to 100 mg/l at surface and 500 mg/l at bottom which will prevail in the immediate vicinity (10 to 20 m) during the intermittent discharge period of less than 45 days period per location. An analysis of the drill cuttings and drilling mud performed during the previous drilling in Ravva Field in September 2011 has been reproduced here in ***Table 7.57.***

Table 7.57 Composition Analysis of Drilling Mud & Drill Cuttings

SN	Parameters	Drill Cuttings		Drilling Mud	
		RC-2ST 8 ½" hole TD 2000 m	RC-2ST 6" hole TD 2144 m	RC-2ST 8 ½" hole TD 2000 m	RC-2ST 6" hole TD 2144 m
1	pH	9.29	9.44	7.21	8.61
2	Oil and Grease g/kg	3.48	0.23	0.9	0.6
3	Chromium (as Cr), mg/kg	48	26	31	19
4	Copper (as Cu), mg/kg	157	60.3	22.7	17.3
5	Lead (as Pb), mg/kg	19.7	15.4	22.2	24.4
6	Nickel (as Ni), mg/kg	329.3	423.2	211.8	231.7
7	Zinc (as Zn), mg/kg	210.1	127	104.6	93.1
8	Manganese (as Mn), mg/kg	348.2	161.6	91.7	67.7
9	Cadmium (as Cd), mg/kg	<0.01	<0.01	<0.01	<0.01
10	Mercury (as Hg), mg/kg	<0.01	<0.01	<0.01	<0.01
11	Cyanide (as CN), mg/kg	<0.1	<0.1	<0.1	<0.1
12	Total Petroleum Hydrocarbons, mg/kg	362	422	195	480

Source: Vedanta Limted (Cairn Oil & Gas), Analysis performed by MoEFCC recognized Lab - Universal Enviro Associates, Hyderabad for samples collected on 6 Sep 2011

Bioassay tests were also performed on drill cuttings and drilling mud sections from two depths as per ***Table 7.58.***

Table 7.58 Bio Assay of Drill Cuttings and Drilling Mud Samples

SN	Concentration % (V/V)	No. of Fish	Drill Cuttings										Drilling Mud									
			RC-2ST 8 ½" hole TD 2000 m					RC-2ST 6" hole TD 2144 m SBDIF					RC-2ST 8 ½" hole TD 2000 m					RC-2ST 6" hole TD 2144 m				
1	Sampling Receipt Date		06 Sep 2011					06 Sep 2011					06 Sep 2011					06 Sep 2011				
1	pH		9.29					9.44					7.21					8.61				
2	DO, mg/L		6.3					6.0					6.4					5.3				
3	Sea Fish Sizes		2.5 to 3.0 cm					2.5 to 3.0 cm					2.5 to 3.0 cm					2.5 to 3.0 cm				
4	Hours		24	48	72	96	Toxicity	24	48	72	96	Toxicity	24	48	72	96	Toxicity	24	48	72	96	Toxicity
5	Control	20	0	0	0	0	N	0	0	0	0	N	0	0	0	0	N	0	0	0	0	N
6	Test (10%)	20	0	0	0	0	N	0	0	0	0	N	0	0	0	0	N	0	0	0	0	N
7	Test (20%)	20	0	0	2	2	N	0	0	5	2	N	0	0	3	2	N	0	0	0	0	N
8	Test (40%)	20	2	2	4	1	N	4	6	7	2	Y	6	4	5	3	N	0	4	2	2	N
9	Test (50%)	20	5	4	8	0	Y	8	9	0	0	Y	7	9	4	0	Y	2	3	3	1	N
10	Test (60%)	20	9	4	4	4	Y		-	-	-	-	-	-	-	-	-	5	7	3	3	Y
	Test (70%)	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	9	1	0	Y

Source: Vedanta Ltd (Cairn Oil & Gas), Analysis performed by MoEFCC recognized Lab - Universal Enviro Associates, Hyderabad for samples collected on 6 Sep 2011. Note: LC – 50 at 50% concentration was found to be toxic to the fish; Y = Symptoms of toxicity observed; N = No symptoms of toxicity observed

The above table show that the toxicity of drill cuttings and drilling mud were within the acceptable norms of MoEFCC. The main impact on the benthic fauna will be from physical smothering and will be restricted to the areas where cuttings are deposited. Studies suggest that biological effects of drilling fluid of low toxicity contaminated cuttings will be confined to within 100m of the well site [(1)]. Re-colonisation of biota and recovery will be well established within a year after disposal has stopped [(2)].

7.4.3 Control Measures

To minimise impacts of disposal of drill cuttings and drilling fluid following mitigations will be adopted:

- Vedanta Ltd (Cairn Oil & Gas) will comply with MoEFCC Guidelines for Disposal of Drill Cuttings & Drilling Fluid for Offshore Installation notified as GSR 546(E) dtd 30 Aug 2005;
- Before offshore disposal of drill cuttings and unusable drilling mud (WBM only), Cairn will ensure prior laboratory composition testing as well as their low toxicity testing of 96 hour survival for LC-50 value >30,000 ppm), thereby ensuring use of low toxicity chemical additives for preparation of drilling fluids;
- Only WBM/SBM with low toxicity drilling mud additives shall be used in the programme. Vedanta Ltd (Cairn Oil & Gas) will ensure that toxicity of chemical additives used in the drilling fluid (WBM or SBM) should be biodegradable having bio assay test be conducted

(1) Gillmor, R. B., Menzie, C. A., Mariani, G. M., Levin, D. R., Ayers, R. C. and Sauer, T. C. (1985). **Effects of Exploratory Drilling Discharges on the Benthos.** Chapter In: **'Wastes in the Ocean: Volume 4. Energy Wastes in the Ocean'.** Duedall, I. W., Kester, D. R., Kilho Park, P. and Ketchum, B. H. (eds.) J. Wiley and Sons, New York.

(2) Daan, R. and Mulder, M. (1993b).

A Study on Possible Environmental Effects of a WBM Cutting Discharge in the North Sea, One Year After Termination of Drilling. NIOZ-Rapport 1993-16. Nederlands Instituut voor Onderzoek der Zee, Texel.

(of 96 hours LC50 value of > 30,000 mg/litre as per mysid toxicity or toxicity test conducted on locally available sensitive sea species) with Hg < 1 mg/kg and Cd < 3 mg/kg. Vedanta Ltd (Cairn Oil & Gas) will also ensure that no Cr^{+6} or chrome lignsulphonate additives are used. If otherwise, both drill cuttings and used drilling mud are to be brought onshore for disposal at a secured landfill;

- As required by MoEFCC Guidelines after laboratory reports showing safe for offshore disposal, used WBM/SBM and thoroughly washed drill cuttings can be discharged offshore intermittently (to avoid turbidity and reduction in transmittance) at a rate of 50 bbl/hour/well (i.e.8$m^3hr^{-1}well^{-1}$) for effective dispersion & dilution preferably at a location much beyond from shoreline and sufficiently away from any ecologically sensitive areas.
- Offshore discharges to be done at 3 to 5 m below the sea surface.
- For offshore disposal within 4.8 km from shore line, prior approval from APPCB will be obtained.
- Management of drilling fluid including its losses is routinely undertaken as part of the standard operational procedures of rig.
- The percentage of drilling fluids on cuttings will be reduced as far as is practical by correct operation and maintenance of the cuttings treatment equipment. The production of excess drilling fluid requiring disposal will also be reduced through recycling of mud;
- Drill cuttings treated from shale shakers and centrifuges to separate mud from cuttings from the reservoir rock may have presence of hydrocarbon residues. The project is to ensure drill cutting associated with high oil content (>10 g/kg) from hydrocarbon bearing formation should not be disposed offshore; and
- Vedanta Ltd (Cairn Oil & Gas) to ensure that well wise record of data on quantity and quality of drilling fluid and drill cuttings generation and disposal options used are offshore along with effluent quality is maintained and submitted to MoEFCC every six monthly as part of the compliance report.
- As per MoEFCC conditions, Vedanta (Cairn Oil & Gas) is required to monitor the petroleum hydrocarbon and heavy metal concentration in the marine fish species regularly and submit the report to MoEFCC regularly.

8 PROJECT BENEFITS

8.1 FINANCIAL BENEFITS

Following financial benefits are expected from the proposed oil & gas program:

(a) Majority of infrastructure for processing of production/well fluid are already available through the operating Ravva Terminal. Therefore, only new onshore well pads and the connecting pipelines are proposed to harness the hydrocarbon potential of the block.
(b) The regain in production of oil and gas within the already approved capacity will add to the energy independence of the nation and will reduce the import bills;
(c) Based on comparative cost benefit analysis, the project is found to be economically viable.
(d) Considering marginal field development, drilling of wells from onshore and offshore platforms and standalone locations proposed with no additional process facilities required.

8.2 SOCIAL BENEFITS

Following social benefits are expected:

(a) Limited interference with local community as the proposed project involves exploratory and development drilling from two onshore well pads located near shore sufficiently away from settlements and from offshore region sufficiently away from the villages;
(b) No interference with the fishing community since the project site is within the boundary limits of PSC block;
(c) Vedanta Limited (Cairn Oil & Gas) has been taking up of corporate social responsibility (CSR) actions in the region which will continued to be taken up as described in the following section.

8.3 CSR ACTIVITIES

CSR program encompasses various initiatives undertaken by a corporate entity in its business catchment in order to obtain a social license for operating in the area. These programs are aimed at developing the area as well as improve living standards of the stakeholders.

The Ravva JV onshore terminal operated by Vedanta Ltd (Cairn Oil & Gas) is the first and only tryst with industrialization for this remote village. Keeping this unique scenario in mind, Ravva JV for the past many years has initiated several CSR programmes aimed at improving infrastructure, economic development, health and educational facilities. The Ravva JV has also accelerated growth of micro enterprises through vendor development programme.

The implementation of the projects are carried out through partnership with the State Government's District Administration, community-based organizations, like minded corporate, NGOs (national as well as local) and specialized knowledge partners like NASSCOM Foundation, NIIT etc. There is a two pronged strategy for CSR that is based on the principles of inclusive growth and holistic development of the area. Two pathways of CSR implementation are given as under:

1. **Improvements in Physical Infrastructure development programs at Uppalaguptam and Amalapuram Mandals:** Since the year 2000, Ravva JV has been funding to the

development fund maintained with the District Collector with an understanding that 50% of the funds will be used for S.Yanam Village, 20% of the funds will be used for en-route villages from Amalapuram to S.Yanam, 20% of the funds will be utilized for Uppalaguptam Mandal and 10% of funds will be used for maintenance of old structures etc. Numerous infrastructure development works were undertaken in S.Yanam as well as neighbouring villages through these funds. These include construction of

- Village roads,
- Bus shelters,
- Water supply tanks & pipelines,
- Individual toilets etc..

2. **Direct Implementation of Social Infrastructure Programs at S'Yanam Village focused on Health, Education and Economic empowerment**
   a. **Education:** The most intensive CSR activities are conducted at this level. The major emphasis is on addressing the issue of unemployment by providing skills to the village youths and making them employable according to their qualifications and interests. Multiple options are given to the youths for career choices for a more inclusive decision making. For a long term sustainable development Vedanta Limited (Cairn Oil & Gas) has designed programs for the younger generation of the village through various educational projects tailor made for all levels starting from preschool to post graduate.
   b. **Health:** The Ravva JV is maintaining a Health clinic in the village, and provides free medicines. Vedanta Limited (Cairns Oil & Gas) has also sponsored construction of a hospital building in the village and has got approval from the government to initiate a Primary Health Centre in the village. The Company also supports the Village Panchayat to carryout quarterly fumigation to avoid the spread of mosquitoes and other vector borne diseases.

3. Economic Empowerment:

On this front, the Company is providing monthly pensions to physically handicapped persons and widows in S'Yanam Village. Also as a part of empowerment strategy Vedanta Ltd (Cairn Oil & Gas) is promoting Micro-Vendor Programme since the year 2004-05. The ideology of the Company is to include the villagers in the growth trajectory by providing them adequate opportunities, building their capacities and develop entrepreneurship qualities among them. Several contracts for support services like civil works, Painting works, Green belt development, vehicles etc. were given to the villagers. The aims of these initiatives were to provide more opportunity for vendors on the doorstep of Vedanta Ltd (Cairn Oil & Gas)'s Production activity. In addition to this Vedanta Ltd (Cairn Oil & Gas) is also promoting micro enterprise development for the women folks in the village leading to better quality of life and a larger participation of them in family decisions. In addition to this Vedanta Ltd (Cairn Oil & Gas) is also promoting micro enterprise development for the women folks in the village leading to better quality of life and a larger participation of them in family decisions.

8.4 CER INITIATIVES

Vedanta Ltd (Cairn Oil & Gas) will be taking up CER initiatives (refer to ***Table 9.5***) with commited budget of INR 20 Crores to be spent over next 10 years.

9 ENVIRONMENTAL MANAGEMENT PLAN

9.1 INTRODUCTION

This Section is revised to integrate baseline data generated in Chapter-3 i.e. 'Description of Environment' and response with action plan on issues raised during public hearing in the Environmental Management Plan (EMP) as communicated through minutes of 11th meeting of the Expert Appraisal Committee (EAC - Industry -2) of MoEFCC held from August 28 to 29, 2019 for the proposed expansion by M/s Vedanta Limited (Cairn Oil & Gas Division) in existing Ravva Field, PKGM-1 Block (of 331.26 km^2) located near Surasniyanam Village (S. Yanam) in Krishna-Godavari Basin, East Godavari District, Andhra Pradesh. Further recomendations communicated through 15th meeting of the Expert Appraisal Committee (EAC - Industry -2) of MoEFCC held from December 30-31, 2019 and January 1, 2020 in terms of the conditions imposed by APCZMA and a plan for achieving the same has been included in the EMP.

The objective of the EMP is to identify Project specific environmental actions that will be undertaken to mitigate and manage impacts associated with the proposed expansion of oil and gas development activities in PKGM-1 (Ravva) Block.

The EMP focuses on potential direct impacts and potential risks, as identified in the EIA under the sections on Impact Assessment (***Section 4*** of the EIA) and Risk Assessment (***Section 7*** of the EIA). The EMP also sets out response and action plan on issues raised during public consultation held on 11 October 2018 and a monitoring programme for key parameters to monitor environmental performance (***Section 6*** of the EIA).

9.2 ELEMENTS OF EMP

EMP includes four major elements:

- *Planning*: This includes identification of environmental impacts, legal requirements, commitments and policies, setting environmental objectives and HSE compliance;
- *Implementation*: This comprises of resources available for the Project, accountability of contractors, documentation of measures to be taken;
- *Checking - Measurement & Evaluation*: This includes monitoring, corrective actions and record keeping; and
- *Management Review*: Actions are taken to continually improve the HSE performance.

9.2.1 Planning

Various components of planning in respect of the proposed Project are specified in the following sub sections.

HSE and Corporate Sustainability policies of Vedanta Limited (Cairn Oil & Gas) are given in ***Figure 9.1*** while the Aviation and Marine Operation policies are presented in ***Figure 9.1.***

Figure 9.1 Vedanta Ltd (Cairn Oil & Gas)'s HSE and Corporate Sustainability Policies

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HSE Policy

At Vedanta Resources plc, we believe in sustainable development and are committed to effective management of health, safety and the environment as an integral part of our business. The health and safety of our employees and any other person who may be impacted by Vedanta's operations is of paramount importance and our aim is zero harm to people and minimal discharge to the environment.

Vedanta strives to:

- comply with applicable national, regional and local Health, Safety and Environment ('HSE') regulations and statutory obligations and other requirements as appropriate. We will develop, implement and maintain HSE management systems aligned with our commitments and beliefs and consistent with world-class standards. We will drive continuous improvement in HSE through setting and reviewing targets, assessing and reporting HSE performance, using appropriate best available practices and providing all employees with appropriate training;
- prevent injury and ill health to employees and contractors by providing a safe and healthy working environment and by minimising risks associated with occupational hazards;
- improve and enhance environmental conditions and avoid, reduce or mitigate the environmental impacts to neighbouring communities in areas that we operate including air and water emissions and noise;
- conserve natural resources, through adopting environmentally friendly and energy efficient technology and process improvements. We are committed to managing waste from our operations and we will adopt the principles of waste avoidance, reuse, recycling and beneficial utilisation to minimise discharge and disposal to the environment;
- promote a positive HSE culture within our organisation through effective communication, participation and consultation with employees in the workplace;
- implement regular health surveillance and risk based monitoring of employees;
- influence our contractors and suppliers to adopt principles and practices adopted by us and in accordance with our own policies;
- communicate with all our stakeholders on the progress and performance of HSE management.

Each Vedanta business shall sign up to this policy or develop an equivalent which shall be implemented throughout the business. We will measure and report progress against this policy and review performance on a periodic basis to ensure ongoing management of health, safety and the environment. The content and implementation of this policy will be reviewed periodically and actions taken accordingly including the sharing of good practices throughout the Vedanta organisation.

Signed by:

MS Mehta
CEO, Vedanta Resources plc

Date: 21st September 2011

CAIRN

WE FULL AMAZING

CORPORATE SUSTAINABILITY POLICY

Cairn India Limited is committed to implement sustainability practices that promote economic growth, social betterment and environmental stewardship by:

- maintaining the highest standards of ethical governance,
- upholding human rights,
- respecting the rights and dignity of every stakeholder,
- preserving the environment and
- promoting inclusive growth for the local communities in areas and regions where the Company operates

We acknowledge our responsibility towards all our stakeholders and commit to behave with honesty and integrity at all levels of engagement with them.

We will respect the rule of the law, adhere to the principles of sound corporate governance, respect and positively address human rights within our sphere of influence and activities, be proactive in our pursuit for social inclusiveness and behave responsibly to meet the challenges of Climate Change and Biodiversity loss.

The underlying principles of the Company's Sustainability goals are also embedded in our policies for Code of Business Ethics, Health, Safety and Environment and Corporate Social Responsibility. We shall design and implement a robust Sustainability Management System incorporating sustainability best practices as applicable to our industry.

We shall monitor our sustainability performance by conducting regular reviews so as to ensure that the controls established remain effective towards pursuance and achievement of sustainability goals. These reviews shall be the basis to reassess the relevance of such goals in the light of any changing circumstances. We shall remain transparent and accountable in reporting our sustainability achievements to our stakeholders through objective assessment mechanisms and endeavour to improve on a continual basis through stakeholder feedback.

Each and every employee, contractor, service provider and consultant of Cairn India Limited or its subsidiaries in India and abroad is obliged to comply with these principles.

Mayank Ashar
Managing Director and Chief Executive Officer

Effective Date: Nov 2014

Source: Vedanta Limited (Cairn Oil & Gas)

Figure 9.2 Vedanta Ltd (Cairn Oil & Gas)'s Aviation & Marine Operations Policies

AVIATION POLICY

Cairn is committed to the safe,economic and efficient use of aircraft in support of the Company's business activities. To meet this commitment, Cairn will adopt the latest International Association of Oil & Gas Producers (OGP) Aircraft management guidelines Report No. 390 as the the guiding aviation standard applicable to its operated activities and will:

- Comply with the requirements of local statutory aviation laws, as a minimum.
- Prefer to engage those airlines and operators that have better safety standards and lower accident rates.
- Utilise multi-engined aircraft and helicopters wherever practical when contracting aircraft for Cairn's Operations.
- Access a 'competent' Aviation Advisor to provide specialist support and advice on aviation matters.
- Engage for all aviation activities, other than scheduled airline travel, only aircraft operators and aircraft types approved for use by a competent aviation advisor / agency.
- Audit and/or review the performance of the aviation operatorsannually and conduct an operational aviation safety review on a country basis at least every two years, by an independent 'competent' Aviation advisor.
- Establish and implement an appropriate travel policy limiting the number of senior executive that travel together in the same aircraft.

Approval for deviation from this policy can only be given by an Exco member inconsultation with the Marine department on the basis of an approved business case which provides assurance that the levels of avaition risks are as low as reasonably practicable"(ALARP).

P. Elango

Chief Executive Officer

Effective Date: September 2012

MARINE OPERATIONS POLICY

Cairn is committed to the safe, efficient and cost effective use of marine vessels, equipment and/or contractors to support its business activities in India and abroad.

To meet this commitment, we shall:

- Comply with applicable local and international rules and regulations.
- Ensure safety at sea, prevent injury or loss of life, and avoid damage to the environment.
- Establish a management system to ensure that applicable codes, guidelines and standards recommended by the Organization, administrations, and relevant maritime industry organizations are taken into account.
- Ensure safe practices in marine operation establish safeguards against all identified risks, and continuously improve safety management including emergency preparedness.
- Establish and implement Cairn operating procedures with minimum Standards for Vessels / Marine equipment, competence and training for personnel.
- Develop and maintain in-house marine expertise and competencies supporting our marine activities.
- Give preference to operators who have implemented a Safety Management System to manage the Health, Safety and Environment aspects of their Marine operations in line with best International practice, with proven HSE performance.
- Audit the vessels and marine operators prior to deployment and monitor on a regular basis during operations.
- Conduct a marine management review annually on an asset basis.
- Monitor the performance of Marine operations through pre-defined marine oriented KPIs.

Responsibility for the compliance with Cairn's Marine Policy lies with the Director Operations, and Marine Department. Approval for deviation from this policy and standard can only be given by the head of Marine Department on the basis of an approved business case after ascertaining that the levels of Marine risk are "as low as reasonably practicable" (ALARP).

P Elango

Chief Executive Officer

Effective Date: Sept 2012

Source: Vedanta Limited (Cairn Oil & Gas)

Figure 9.3 Vedanta Ltd (Cairn Oil & Gas)'s Biodiversity and Water Management Policies

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Biodiversity Policy

Protecting and enhancing biodiversity is an integral part of Vedanta Resources plc's commitment to sustainable development. We are conscious of the potential impacts and dependencies of our business on the environment in general and on biodiversity in particular. Integrating the need for biodiversity conservation into operational decision making processes and taking all necessary measures to minimize impacts, is a commitment across the company. We are conscious that biodiversity is a complex phenomenon that needs to be identified, understood and valued from a biological and societal (i.e. in terms of ecosystem services) perspective. We believe that our performance on biodiversity conservation will create long term value for our business.

Vedanta strives to:

- prevent where possible, minimise and mitigate biodiversity risks throughout our businesses. We will manage and use land in our operations in a manner that allows biodiversity conservation needs to be integrated with business needs through the project lifecycle, including decommissioning, closure and rehabilitation;
- comply with, and exceed where possible, the local, regional and national legislative requirements on land management and biodiversity conservation and applicable international conventions where applicable in all jurisdictions in which it operates;
- identify and assess biodiversity status and value before the start of a new project and monitor impacts over the project lifecycle;
- we will consider the impacts on ecosystem services;
- work towards the conservation of threatened/rare and endemic species and high priority conservation areas, and support local, national and global conservation initiatives. We will provide information and raise awareness among our employees and other stakeholders to enhance knowledge and understanding of biodiversity and conservation issues, where applicable.

Each Vedanta business shall sign up to this policy which shall be implemented throughout the business. We will measure and report progress against this policy and review performance on a periodic basis to ensure ongoing management of biodiversity. The content and implementation of this policy will be reviewed periodically and actions taken accordingly including the sharing of good practices throughout the Vedanta organisation.

Signed by:

MS Mehta
CEO, Vedanta Resources plc

Date: *21st September 2011*

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Water Management Policy

At Vedanta Resources plc, we recognise the social, economic and environmental value of water and the increasing global concern of water scarcity. We understand that water is a key resource and needs to be used responsibly, balancing the needs of many different users.

Vedanta strives to:

- understand our water footprint at all our projects and operations, and will maintain a water balance that minimises the amount of freshwater consumed by re-using as much water as possible in our processes and encouraging rainwater harvesting where we can;
- comply with applicable national, regional and local regulations ; identify water conservation projects through reduction, recycling and reuse and monitor progress against water consumption reduction targets across our businesses. We will avoid pollution of surface water, ground water and other water resources arising from our operations;
- apply a zero discharge philosophy wherever possible;
- treat all wastewater to international best practice standards before discharging to the environment through the application of best available techniques (BAT) where possible and we will ensure that water/wastewater storage facilities are engineered and maintained;
- participate in local or regional water catchment planning activities to secure sustainable water resources for Vedanta operations and the activities of other users outside of the organisation;
- determine baselines and develop ongoing monitoring of water quality;
- work with communities and communicate with all our stakeholders on the progress and performance of water conservation and water management.

Each Vedanta business shall sign up to this policy which shall be implemented throughout the business. We will measure and report progress against this policy and review performance on a periodic basis to ensure ongoing management of water resources. The content and implementation of this policy will be reviewed periodically and actions taken accordingly including the sharing of good practices throughout the Vedanta organisation.

Signed by:

MS Mehta
CEO, Vedanta Resources plc

Date: *21st September 2011*

Source: Vedanta Limited (Cairn Oil & Gas)

Figure 9.4 Vedanta Ltd (Cairn Oil & Gas)'s Social Policy

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Social Policy

At Vedanta Resources plc, we are committed to the principles of sustainable development; protecting human life, health and environment, ensuring social well-being and adding value to the communities. We respect human dignity and that lies at the core of our business philosophy and business operations. We strive to manage our businesses in a fair and equitable manner meeting all our social responsibilities as a direct and indirect employer and respect the human rights of all our stakeholders.

Vedanta strives to:

- Comply with or exceed the legislative requirements in all jurisdictions in which it operates and develop systems to identify, manage, and mitigate risks and adverse impacts on communities and environment. We will also strive to uphold labour and human rights aligned with national and international regulations as applicable;
- Avoid involuntary resettlement where feasible and consider displacement only when business requirements make it unavoidable. We seek to adopt and implement best possible measures to improve or at least restore quality of lives and standards of living of displaced persons in particular and communities in general;
- Demand and foster leadership, learning and growth so as to deliver value to the organisation and society in a socially responsibility manner and train people and provide resources to meet social responsibility, objectives and targets;
- Respect the social, economic, cultural and human rights of communities and preserve the culture and heritage of the local communities and socially vulnerable groups and seek broad-based support for our operations;
- Consult and inform stakeholders in matters that affect them. We will regularly communicate social performance in an accurate, transparent and timely manner to stakeholders.
- Adopt Sustainable Development as an integral part of the business plan and put in place an appropriate institutional structure to plan and implement community development initiatives prioritizing local needs and ensuring long term sustainable benefits to communities.

Each Vedanta business shall sign up to this policy or develop an equivalent which shall be implemented throughout the business. We will measure and report progress against this policy and review performance on a periodic basis. The content and implementation of this policy will be reviewed periodically and actions taken accordingly including the sharing of good practices throughout the Vedanta organisation.

Signed by:

MS Mehta
CEO, Vedanta Resources plc

Date: 21st September 2011

Vedanta (Cairn's) Social Policy

Role of Vedanta Ltd (Cairn Oil & Gas)

Vedanta Ltd (Cairn Oil & Gas) has the ultimate responsibility for implementing the provisions of the EMP. This role includes management of environmental impacts, and measuring environmental performance through inspections/audits and monitoring. The EMP also includes implementation of action plan on issues raised during public hearing. The contractor performance as well as development of mechanisms for dealing with HSE is an integral part of environmental management. It is anticipated that the HSE requirements are made integral part of all relevant bidding / contract documents of this Project.

Role of Vedanta Ltd (Cairn Oil & Gas) Contractors

Vedanta Ltd (Cairn Oil & Gas)'s management is responsible for the performance of all its contractors /sub-contractors and ensuring that all Vedanta Ltd (Cairn Oil & Gas)'s commitments and policy requirements are translated into contractors' requirements and implemented to the full intent and extent of its commitment. Contractors and subcontractors are responsible for implementation and adherence to all the mitigation measures outlined in this EMP.

Organization, Roles and Responsibilities

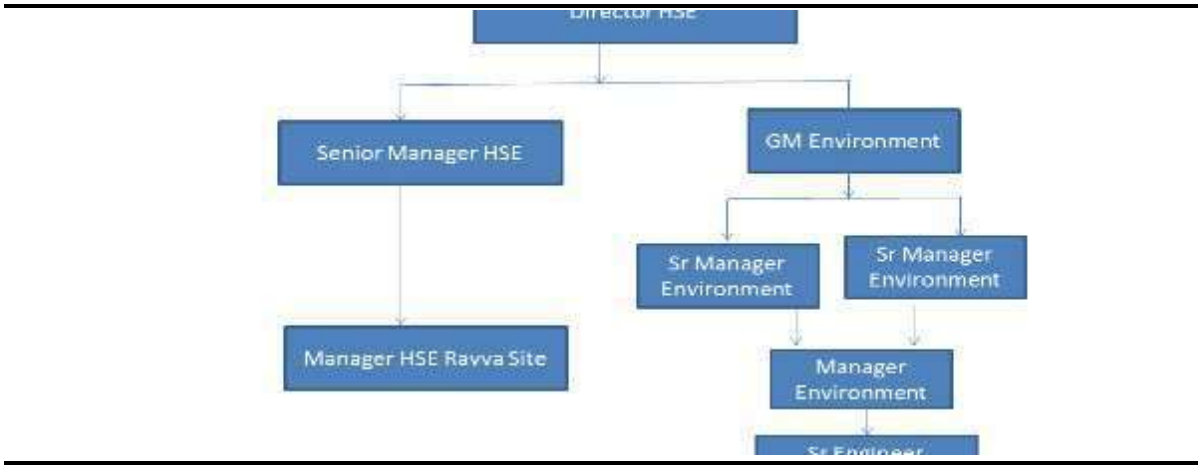
HSE Organizations

Vedanta Ltd (Cairn Oil & Gas)'s HSE Department has the overall responsibility for co-ordination of the actions required for environmental management and mitigation and for monitoring the progress of the proposed management plans and actions to be implemented for the Project. In general, the HSE department performs the following activities:

- Development of an Environmental Management System (EMS);
- Identifying legal requirement and preparation of required documents on environmental management;
- Ensuring availability of resources and appropriate institutional arrangements for implementation of EMP;
- Selection of appropriate MoEFCC approved monitoring agency for carrying out monitoring and analysis;
- Compliance of regulatory requirements;
- Reviewing and updating the EMP as and when required for its effective implementation at each stage of the Project.

Figure 9.5 Vedanta Ltd (Cairn Oil & Gas)'s HSE Organization Chart for Well Drilling

Figure 9.6 Vedanta Ltd (Cairn Oil&Gas)'s HSE Organization Chart for Ravva Operations



Source: Cairn (Oil & Gas)

A Grievance Redress process has been reportedly in place at Ravva Terminal/onshore Living Quarters to capture any grievance of community and local fishermen for disruption of livelihood. Grievance Redress responsibility has been allocated to the CSR Manager deputed at the Ravva Terminal.

Crises Management Organizations

Vedanta Ltd (Cairn Oil & Gas) has also established an organization set up for any crisis management. The Crisis Management Organization Teams have been included in Emergency Response Plan and Oil Spill Contingency Response Plan (OSCRP). Vedanta Ltd (Cairn Oil & Gas) is a member of Oil Spill Response Limited (OSRL), Singapore who will be available for any oil spill (Tier 2/3) related crisis management, while organization for Tier 1 spill is available at Ravva Terminal as defined in OSCRP.

Environmental Impacts & Mitigation Measures

Vedanta Ltd (Cairn Oil & Gas) will understand the requirement of environmental impacts and mitigation measures as worked out in this EIA (***Section 4***) as summarised in ***Table 9.1***, prior to start of each component of the Project covering:

- Construction of onshore well pads;
- Drilling of 10 exploratory/appraisal wells from onshore well pads;
- Drilling of 23 development wells from onshore well pads;
- Drilling of 14 exploratory/appraisal wells from existing offshore platforms;
- Drilling of 17 development wells from existing offshore platforms;
- Drilling of 59 exploratory/appraisal wells from stand alone offshore sites.
- Strengthening / upgradation of site access and approach roads
- Laying of 8 km of onshore pipelines corridor

The above mentioned **Project components** will be executed on a time horizon of approximately 8-10 years after obtaining required prior approvals. Prior to start the above mentioned components, Vedanta Ltd (Cairn Oil & Gas) will organize workshops to further understand regulatory/permit requirements, environmental impacts and required mitigations.

The EMP will be a "live" document. It will be reviewed by the Project team prior to start of activities related to development of well pads, setting up of offshore rig, laying of pipelines and drilling of wells. Vedanta Ltd (Cairn Oil & Gas) will review the required mitigation measures and ensure pollution control equipment or addition of capacity or modifications required are ensured by the contractors in consultation with its's HSE Manager. Vedanta Ltd (Cairn Oil & Gas) will ensure that where practical, equipment's on the rig and supply vessels/barges/tugs are adequate to achieve the levels of environmental performance outlined in this EIA. The EMP will be updated as needed to provide effective management of environmental issues associated with the Project.

9.2.2 *Implementation*

Management Control

Prior to start of proposed oil and gas development activities i.e. construction of onshore well pads, pipeline laying and prolonged programme of drilling of development and exploratory/appraisal wells, Vedanta Ltd (Cairn Oil & Gas) will ensure that equipment and procedures will be designed to achieve the levels of HSE and social performance by Vedanta Ltd (Cairn Oil & Gas) engaged personnel and its contractors and sub-contractors as per the required management system and applicable standards.

Implementation of the EMP will involve Vedanta Ltd (Cairn Oil & Gas) staff and its contractors, subcontractors and its logistics providers. This will involve the incorporation of the commitments contained in the EMP, including relevant mitigation and control measures, working practices and overall management procedures as appropriate.

Communication & Documentation - Internal & External Reporting

Communication and internal reporting will be maintained with the Contractors for Project related information dissemination. Contractors will play a key role in EMP implementation. This will include discussions and negotiations during the planning stage leading to the finalization of the contract with necessary allocation of responsibility for implementing of environmental mitigation measures.

External Reporting will be taken up with government agencies like the MoEFCC, APPCB, OISD, DGH, East Godavari District Administration, Coast Guard, Spill Response Agencies, etc. Necessary clearance / consents / permits for the Project are being pursued with the regulatory agencies. The same is expected to continue throughout the duration of the proposed Project.

9.2.3 *Checking*

Environmental monitoring and audits will be undertaken prior to start of the Project as well as during and after the oil and gas development programme to ensure that the environmental management measures are being satisfactorily implemented and that they are delivering the appropriate level of environmental performance.

Inspections & Auditing

The audit programme will include pre-commissioning audits of the facilities focusing on the compliance of equipment and procedures to deliver the specified level of performance to ensure that all environmental requirements are met. Regular audits will check:

- the integrity and function of physical systems;
- compliance with operating procedures;
- testing and review of emergency procedures;
- compliance with maintenance procedures and records; and
- Competence and training of operatives and rig and field management staff.

Audit results will be reported to management and field staff responsible for the process or equipment in question. Where audits reveal non-compliance with requirements, corrective actions will be implemented. These will be prioritised according to the significance of the environmental risks arising.

Monitoring

The inspections and audit process will be further supported by monitoring i.e. ensuring practical achievement of implementation of required actions. Sampling and analysis as per the identified monitoring plan will be implemented to check level of compliance of discharges, emissions and required environmental conditions.

Inspections and monitoring by regulators i.e. APPCB, MoEFCC and OISD, DGH, District Administration and other agencies will also help ensuring effective checking process of the implementation of the required actions.

Records of all of the monitoring activities will be maintained and will be available for review as required by the management representative. Environmental and pollution monitoring related requirement have been separately specified in ***Section 6***.

9.2.4 Management Review

Vedanta Ltd (Cairn Oil & Gas) management will review the performance against the required actions before, during and after completion of the proposed oil and gas developmental activities in Ravva Field. Prior to start of the Project components, required organization of Vedanta Ltd (Cairn Oil & Gas) and Contractor will be reviewed to ensure that responsible personnel are aware of their duties for effective implementation of required actions. Vedanta Ltd (Cairn Oil & Gas) will ensure the following:

1 Its representative (HSE Manager) will evaluate the contractor to review the contractor's management system and environment protection procedures to ensure compatibility with its HSE policies and Guidelines;
2 Its Commercial Manager and HSE Manager will ensure that the contract documents (with contractors) include environmental performance criteria to be maintained for the Project components;
3 Vedanta Ltd (Cairn Oil & Gas) will review all the conditions of environmental clearance, consent to establish, consent to operate and other permits and ensure their compliance is fully achieved;
4 Any specific environmental training needs will be identified for key personnel and training executed either directly by it or through expert agency/contractor;
5 A bridging document will be prepared to clearly define responsibilities and reporting requirements for contractors;
6 Prior to commencing operations all personnel will be briefed on the environmental sensitivities relevant to the operations and measures in place for the proposed Project;
7 All personnel will be encouraged to take an active part in meeting the environmental performance criteria;
8 Vedanta Ltd (Cairn Oil & Gas)'s representative (HSE Manager) will be in all key activities associated with ensuring compliance with agreed procedures to protect the environment;

9 Environmental performance will be discussed during regular review meetings between Vedanta Ltd (Cairn Oil & Gas) representative and the contractor representative. It will be the responsibility of company representative to ensure that appropriate action is taken to address any non-compliance. Senior management of Vedanta Ltd (Cairn Oil & Gas) will receive regular performance assessments or progress reports in implementing the EMP;

10 A review of the performance of the contractor will be undertaken on completion of Project components; and

11 In the event of non-compliance, Vedanta Ltd (Cairn Oil & Gas) will ensure that the deficiencies are rectified with a defined corrective action plan in a time bound manner.

9.3 MANAGEMENT ACTIONS

Table 9.1 sets out specific actions and monitoring requirements for the issues identified in ***Section 4.*** Vedanta Ltd (Cairn Oil & Gas) has also developed action plans to be available and communicated to all concerned during implementation of the proposed Project components. These include:

*a) Action Plan on issues raised during Public Hearing (refer to **Table 9.3**);*
*b) Action Plan on conditions imposed by APCZMA (refer to **Table 9.4**);*
c) CER Initiatives (Table 9.5);
*d) Waste Management Plan (refer to **Annex 5*** EIA Volume 2*);*
*e) Oil Spill Contingency Plan (refer to **Section 7.3** and **Annex 6*** EIA Volume 2*for relevant excerpts from OSCP);*
*f) Emergency Response Plan (refer to **Annex 7*** EIA Volume 2 *for relevant excerpts from ERP);*
*g) Occupational Health & Hygiene Procedure (refer to **Annex 8*** EIA Volume 2*)*
*h) Site Specific Conservation Plan & Wildlife Management Plan for Schedule I species (refer to **Annex 21*** EIA Volume 2*)*

Prior to start of Project components, Vedanta Ltd (Cairn Oil & Gas) will also ensure that the Safety Management Systems (SMSs) are in place as per the requirement of Schedule IV of the Petroleum and Natural Gas (Safety in Offshore Operations) Rules, 2008 to cover the following elements:

1) Hazard Identification Control of Hazards Establishing Barriers,
2) Contractor Safety,
3) Competency of Personnel,
4) Management of Change procedures,
5) Emergency Response Plan,
6) Maintenance Practices,
7) Operating Procedures on safety and other requirements,
8) Incident Reporting,
9) Performance Monitoring,
10) Regulatory Requirements, and
11) HSE Organisation and Risk Register

All the above mentioned documents will be updated from time to time prior to start of the Project activities.

9.4 BUDGET ALLOCATION FOR THE ENVIRONMENTAL MANAGEMENT PLAN

The EMP implementation and environment and pollution monitoring related indicative budget has been described in ***Table 9.2.***

- For mitigations of ongoing operations and contingency cost related to proposed Project components has been included as part of the ongoing operations as well as insurance covers. Approximately around 5% of the Project cost will be included as a budget for Pollution Control, Environmental, Health and Safety management, environmental monitoring and contingency cost for the proposed entire oil and gas development Project. This will also include the cost for implementation of the EMP, which has been highlighted in **Table 9.2.**

- Vedanta Ltd (Cairn Oill & Gas) has a budget for CSR activities, which is taken up and spent mostly through local administration on annual basis for CSR development in S. Yanam Village and surrounding area. For the year 2018-19, the CSR Budget approved is INR 5.9 Crores. The key CSR initiatives for implementation includes support for education and youth employment programs, provision of monthly pensions for physically handicapped people and widows, support to district administration for implementing infrastructure development works, construction of individual toilets, support for functioning of Primary Health Centers, etc as decided in consultation. The amount on CSR activities will be spent utilized by the district administration as per the needs of the local community.

- Vedanta Limited (Cairn Oil & Gas) is committed to spend INR 20 Crores for next 10 years under CER activities to comply with the concerns raised during the Public Hearing. This CER amount will be in addition to CSR and Environmental Pollution Control & Monitoring Related Budget. The CSR initiatives are included in Table 9.5.

- Vedanta Limited (Cairn Oil & Gas) has prepared a Site Specific Conservation Plan & Wildlife Management Plan for Schedule I species in the study area. The first phase of implementation will focus on habitat conservation for sea turtles and smooth coated otters. The Company is in the process of identifying specialist agencies who would work with them for implantation of such conservation plan and specific budget has also been allocated for the same.

The cost described in **Table 9.2** is indicative only and is subject to change depending upon economic conditions prevailing at the time of the Project components implementation.

Table 9.1 Environmental Management Plan: Onshore & Offshore Drilling Activity

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
A	*Environmental Issues Associated with Onshore Drilling Activity*						
A.1.1	Land Use	▪ Long term lease / procurement of land for onshore well; ▪ Restriction of land use along the pipeline corridor.	The two onshore well pads WP-7 (i.e. WP-A/RX-8) and WP-8 (i.e. WP-B/RX-9) are located in the existing well pad sites. Total land required for onshore well pads will be ~8ha. In addition, land of ~12 ha will be required for pipeline corridor of 8 km . The land use pattern of the study area shows sea area of 60.24% followed by agriculture land area of 12.73%, aquaculture land area of 13.14% and reserve forestland of 4.68%. The other major landuse types observed in the study include backwater (2.83%), Casuarina plantation (1.42%), settlements (0.99%) and sand dunes (0.86%)	Conversion of back-water, aquaculture fields into industrial land	Minor	▪ Immediate restoration of acquired land for pipeline to its best achievable original state after completion of the buried pipeline laying activity, thus to merge it with the best achievable surrounding land use. ▪ Remove all wastes from area surrounding onshore well pad sites and site approach road and pipeline corridor	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)
A.1.2	Physiography and Drainage	▪ Raising of well pad sites; ▪ Strengthening of site approach road ▪ Laying of onshore pipelines;	The onshore part of the PKGM-1 block lies in Godavari Delta. The drainage of the proposed well pad locations and surrounding areas is governed by the backwaters of the S. Yanam and	Site elevation may disturb drainage. Temporary disturbance of micro drainage channel due strengthening	Moderate	▪ Provide adequate drainage system for the well pads to maintain the micro-drainage of area; ▪ Reclaim and reinstate the land after completion of the pipeline laying; ▪ Maintain the cross drainage	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
		crossing of drainage channels/ nalas (minor drainage streams), etc.	Chirrayanam. (*Refer Section 3.3.1*).	of site approach road and laying of pipeline		structure along the pipeline route; ▪ Design site approach road with due consideration of micro drainage.	
A.1.3	Soil and Sediment Quality	▪ Disposal of construction waste/ MSW in non-designated area; ▪ Spillage of chemical, spent mud, hazardous waste, etc.; ▪ Surface runoff from material & waste storage areas and oil spillage area ▪ Disposal of decommissioning waste materials in open soil	Primary soil quality monitoring results indicated that texture of the soil varied from clayey, sandy loam and sandy. pH ranged from 6.1 to 7.5. The SAR varied from 3.8 to 13.2. There is no enrichment of heavy metals in soil (*Refer Section 3.11*). The sediment samples did not reveal presence of high concentration of metals. Concentration of TPH was also found to be low. The sediment samples did not reveal presence of any metallic or oil pollution in the area (*Refer Section 3.13.2*)	Soil contamination	Moderate	▪ Restricted project and related activities during monsoon season; ▪ Drainage system at site is to be provided with sedimentation tank and oily-water separator to prevent contaminants, especially oil and grease, from being carried off by surface runoff; ▪ Manage spills of contaminants on soil using spill kits; ▪ Storage of construction waste/ MSW in designated areas within well pad sites/ production facilities; ▪ Adopt best practices e.g. use pumps and dispensing nozzle for transfer of fuel, use drip trays etc. ▪ Testing of drill cutting to determine if they are hazardous in nature and accordingly planning for their disposal.	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)
A.1.4	Air Quality	▪ Site development and strengthening of	Particulate matters- PM_{10} and $PM_{2.5}$ were within the NAAQS. The gaseous pollutants like	Fugitive emission and emission of gasses with	Moderate	▪ Minimise movement of construction vehicles and enforce a speed limit around the construction site;	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
		site approach road; ▪ Operation of vehicles and construction machinery; ▪ Transportation, storage, handling of construction material, disposal of construction waste; ▪ Operation of DG sets; ▪ Flaring of hydrocarbon during well testing; ▪ Dust generation during loading of bulk solids; ▪ Transport of de-mobilised rigs and machineries	NOx, SO_2, CO, O_3 and NH_3 were observed well within the limits specified under NAAQS. HC at all locations were observed below the corresponding detection limit of 0.1 ppm whereas the total VOC levels varied from < 0.1 to 0.18 ppm. The heavy metal concentrations (As, Pb and Ni) were well within the NAAQS. H_2S varied from below the corresponding detection limit of 0.1 µg/m^3 to a maximum of 1.6 µg/m^3. Benzene and Benzo-a-pyrene (BAP) reported within NAAQS (*Refer Section 3.7*).	potential to degrade the ambient air quality; impacts are expected to be localised and over a short period.		▪ Regularly maintain all diesel-powered equipment and reduce idling time to avoid emissions of NOx, PM_{10} and SO_2; ▪ Vehicle / equipment exhausts observed to be emitting significant black smoke from their exhausts should be serviced/ replaced. ▪ Carry out regular water sprinkling at the site during dry season especially during the construction and decommissioning activities; ▪ Efforts would be made to maintain the stockpile against the wall or obstruction so that it works as a windbreak and the fugitive emissions by strong winds can be avoided; ▪ The trucks used for transport of fill material during the site preparation and debris transport during the decommissioning shall be provided with impervious sheeting; ▪ During construction, the approach road will be kept clean, free from mud and slurry to prevent any entrainment of dust; ▪ Maintenance of diesel power generators to achieve efficient	

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
						combustion, fuel efficiency and therefore reduce emissions; ▪ Use of low sulphur diesel oil; ▪ No cold venting to be resorted during well testing. Management of the well test programme by dedicated team for prevention of trips in product supply to the flare and flame out. Many of the above measures including checking of methane emissions, which may occur during well testing, are incorporated into management of the drilling operations. The well testing procedure involves the dedicated observation of the flare and radio communication to well test manager. In the event that product pressure drops in the well test flare, diesel can be injected to maintain combustion otherwise the feed line would be shut off; ▪ The vent boom shall be so located that any H_2S and HC gas concentration on the platform remains within acceptable limits for personnel safety, under worst operating & environmental	

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
						conditions. ▪ Other fugitive emissions from diesel fuel etc. will be reduced by appropriate storage and handling	
A.1.5	Noise	▪ Operation of machineries & equipment; ▪ Vehicular traffic; ▪ Operation of DG sets. ▪ Demobilization activity	The daytime noise level for residential areas varied from 50 to 53.5 dB(A) as against the corresponding standard of 55 dB(A) while night time noise level in residential areas varied from 40.1 to 43.5 dB(A) as against the corresponding standard 45 dB(A). The daytime noise levels recorded at the commercial location was 59.4 dB(A) and was within the prescribed limit of 65 dB(A). The night time noise levels recorded at the commercial location was 53.8 dB(A) which was within the prescribed limit of 55 dB(A) (*Refer Section 3.8*)	Increase in ambient noise levels	Moderate	▪ All vehicle and equipment involved in site development and drilling activity will be provided with noise control measures; ▪ Regular maintenance of equipment including lubricating moving parts, tightening loose parts and replacing worn out components should be conducted; ▪ Low noise equipment should be used as far as practicable; ▪ All DG/GG sets would be provided with acoustic enclosures; and ▪ Appropriate PPEs (e.g. earplugs) will be used for by workers while working near high noise generating equipment.	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)
A.1.6	Road and Traffic	▪ Transportation of construction materials and manpower; ▪ Transportation of drilling rig and machineries	Road traffic surveys were carried out at two at site access road near Chalapalli and Kunavaram village. Passenger car unit (PCU) equivalent vehicles recorded in Chalapalli village were 1741 during working day and	Damage of road and potential to impact community health & safety	Moderate	▪ Avoid the traffic movement during school hours and market times; ▪ Regular maintenance of the access roads; ▪ Deploying traffic marshals at important road junctions and near sensitive receptors (e.g.	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
		▪ Transportation of drilling chemical and fuel ▪ Transportation of manpower	1316 during non-working day whereas in Kunavaram village, the PCUs were observed as 2010 during working day and 1625 during nonworking day. (*Ref. Section 3.9*)			schools) for management of project traffic	
A.1.7	Surface Water Quality	▪ Surface runoff from construction sites, spill areas, well pad sites; ▪ Generation and disposal of domestic waste water from construction camp; ▪ Generation and disposal of domestic waste water from well pad sites; ▪ Hydrotest water during pipeline testing; ▪ Accidental discharge from waste pit	The surface water from the canals, creeks and backwater areas is used for domestic purposes (washing) and catching fish. The surface water quality revealed that the water conforms to CPCB Water Quality Criteria of Class "B "(Outdoor Bathing Organized) and Class "D" (propagation of wildlife and fisheries).	Increased sediment content of surface water; Contamination of surface water	Moderate	▪ Construction activities viz. stripping, excavation etc., during monsoon season will be restricted to the extent possible; ▪ Channelize all surface runoff from the construction site through storm water drainage system and provide adequate size double chambered sedimentation tank; ▪ Proper treatment of all wastewater and produced water to ensure that they comply with criteria set by the regulatory bodies (MoEFCC and SPCB) prior to discharge to sea / use of recharge of well; ▪ Hydrotest water will be taken to the ETP at Ravva Terminal for treatment. ▪ All chemical and fuel storage areas, process areas will have proper bunds so that contaminated run-off cannot escape into the storm-water	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
						drainage system; ▪ An oil-water separator will be provided at the storm water drainage outlet, to prevent discharge of contaminated run-off; ▪ Spill kits to be used for removal of any oil or chemical spillage on site; ▪ Additional storage area to be provided to store formation water within the well pad site. ▪ STP have been considered in the design of the well pad site camps for treatment of the domestic black water; ▪ Process wastewater would be treated in Effluent Treatment Plant (ETP) at well pad sites.	
A.1.8	Ground Water Resource	Sourcing of waterfor drilling (60 m^3/day/well)	Groundwater occurs under water table conditions and confined conditions. As per CSIR-NGRI (National Geophysical Research Institute, Hyderabad) study there is no change in groundwater water levels between 2006 to 2016	Reduction in piezo metric surface in pumping wells and possibility of land subsidence in the area	Minor	▪ Sourcing of water from Vedanta Ltd (Cairn Oil & Gas) existing bore well. No additional water will be withdrawal from the bore well; i.e. extraction within the permissible limit; ▪ ETP treated water will be utilised in mud preparation in the well pad sites. ▪ Regular monitoring of ground water levels and quality to ensure protection of the round water resources.	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
A.1.9	Ground Water Quality	Generation of sanitary effluent; Storage and handling of chemicals; Storage and handling of hazardous waste; Drilling and use of mud;	The pH of the groundwater varied from 7.1 to 7.4 which remained within acceptable limit of IS:10500. The turbidity ranged from 1 to 3 NTU which is also within acceptable limit. The groundwater samples collected from Challapalli and Samanthakur Villages showed higher levels of chlorides, The groundwater collected from Vedanta Ltd (Cairn Oil & Gas) Living Quarters and Uppalaguptam Village showed levels of chloride, TDS, alkalinity and hardness within the permissible limits. The groundwater samples did not reveal presence of any metallic or biological contaminants.	Contamination of groundwater	Minor	▪ The drill cutting along with spent mud will be stored in HDPE lined pit. ▪ After the drilling activity, this waste pit will be capped by HDPE liner and soil will be put over it. ▪ Impervious storage area to be provided especially for fuel & lubricant, chemical, hazardous waste etc. ▪ Prevent & mitigate spill of paint/fuel within the construction site; ▪ Conduct all the fuel transfer operations in paved areas; ▪ Regularly monitoring the ground water quality in the vicinity of the well sites.	Drilling Contractor/ Cairn
A.1.10	Ecology	▪ Construction of well pads; ▪ Strengthening of approach road to these well pad locations ; ▪ Construction of pipeline from these well pad locations to the Raava terminals; and	The beach habitat is represented by two shrub species, three climber species and two herb species. Casurina - shelter belt plantation was found along the coast with varied density. Vegetation in back waters/lagoons areas included mangrove species *Avacinia officianalis* and mangrove associate species	Habitat Loss and Habitat Disturbance	Minor	▪ The construction phase should avoid migratory season of birds (Oct-February) ▪ In case the migratory season cannot be avoided due to project schedules, early morning and evening activities should be avoided which is peak bird activity duration. ▪ Night activities to be avoided	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
		▪ Man and material movement to the well pad locations	such as *Sueda maritima*, *Salicornia brachiata* and *Sesuvium portulacastrum*			to the extent possible, if the same is unavoidable the low lights and illumination used should be used; ▪ Construction activities should be limited to 3.83 ha (225m X 170m) of well pad; ▪ Any areas for storage of construction material should be left scrap free post construction phase; ▪ Vedanta Ltd (Cairn Oil & Gas) has prepared a Site Specific Conservation Plan & Wildlife Management Plan for Schedule I species in the study area – refer to Annex 21 EIA Volume 2 for details.	
A.1.11	Land	▪ Land requirement for well pad sites, site approach road and onshore pipeline corridor	*Ref. A.1.1*	Permanent / temporary loss of land	Minor (with embedded controls)	▪ Vedanta Ltd (Cairn Oil & Gas) will compensate all affected landowners for any loss of land resulting out of the proposed onshore drilling program; ▪ Vedanta Ltd (Cairn Oil & Gas) should ensure that livelihood of local community, if any affected by the proposed land take are identified and compensated through adequate compensation and other livelihood restoration activities directly or indirectly through CSR activities	Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
A.1.12	Livelihood and Economic Opportunities	▪ Site development works	Agriculture (mostly paddy cultivation) and fishing (both culture and capture) are the mainstay of the economy of the study area. The farm sector employs ~70% of the active and productive work force whereas the non-farm sector (i.e. agriculture labour; labour in oil & gas operations or other small scale business / trading) employs ~30% of the workforce in study area. The overall work participation rate (WPR) is ~50%. The WPR was found to be higher among males as compared to the females.	Opportunities for semi-skilled and unskilled labour during the construction phase; Economic opportunities due to labour influx and income generation due to expenditure on supplies and equipment, which together with rentals etc. will provide minor inputs to the local economy.	Beneficial	▪ Vedanta Ltd (Cairn Oil & Gas)'s policy on local content will be implemented for this Project. As per Vedanta Ltd (Cairn Oil & Gas), wherever possible, engagement of local contractors and workers during the construction/ development phase will be preferred	Vedanta Ltd (Cairn Oil & Gas)
A.1.13	Occupational Health and Safety	▪ Construction of well pads; ▪ Drilling Activity ▪ Changes to/existing environmental conditions; ▪ Site decommissioning		Occupational Health and safety of construction workforce	Moderate	▪ The Contractor will prepare and implement a Health and Safety Plan prior to commencing work. This plan will include method statements for working methods, plant utilisation, construction sequence and safety arrangements; ▪ Measures will be implemented to reduce the likelihood and consequence of the following hazards: – falling from height;	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
						– entanglement with machinery; – tripping over permanent obstacles or temporary obstructions; – slipping on greasy oily walkways; – falling objects; – contact with dangerous substances; – electric shock; – variable weather conditions; – lifting excessive weights; – A Permit to Enter system will be established to ensure that only authorised persons gain entry to the site; ▪ All persons working on site will be provided information about risks on Site and arrangements will be made for workers to discuss health and safety with the Contractor; ▪ All workers will be properly informed, consulted and trained on health and safety issues; ▪ Personal Protective Equipment (PPE) shall be worn at all times on the Site.	

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
						▪ Before starting work all the appropriate safety equipment and the first-aid kit will be assembled and checked as being in working order; ▪ All lifting equipment and cranes will be tested and inspected regularly. All hoist ways will be guarded; ▪ Safety hoops or cages will be provided for ladders with a height in excess of two metres; ▪ When there is a risk of drowning lifejackets shall be provided and it shall be ensured that personnel wear adequate buoyancy equipment or harness and safety lines, and that rescue personnel are present when work is proceeding; ▪ The Contractor shall provide appropriate safety barriers with hazard warning signs attached around all exposed openings and excavations when the work is in progress.	
A.1.14	Community Health and Safety	▪ Road transportation ▪ Influx of construction workers; ▪ Potential exposure to	Consultation with health officials suggested that common form of ailment here are Viral Fever, Diarrhoea, Conjunctivitis, Mumps, Cold and Cough, Dengue, Malaria, Jaundice and Water borne diseases.	Accident in road; Communicable diseases	Moderate	▪ Water sprinkling at the access roads and construction sites would reduce dust emission; ▪ To reduce noise related impacts the vehicles should not blow horns near settlements and night time	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
		spills, fires and blowouts ▪ Exposure to air and noise pollution ▪ Changes to/existing environmental conditions;	Ambulance facility in case of medical emergency is also available there (*Ref. Section 3.15.6*).			movement of vehicle and construction activities will also be restricted; ▪ Introduce the traffic restriction along the traffic hotspots; ▪ Place traffic regulatory signage along the site access and approach roads; ▪ Develop mechanism for disposal of Bio-medical waste as per the best Industry practices; ▪ The grievance redressal process should be regularly tracked and monitored as part of the management function; ▪ A community emergency preparedness and response plan that considers the role of communities and community infrastructure as appropriate should be developed.	

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
A.1.15	Visual Quality	▪ Storage of construction materials; ▪ Storage and disposal of construction waste, municipal waste; ▪ Physical presence of rig and associate equipment; ▪ Dust deposition in the nearby property/ vegetation ▪ Unplanned disposal of decommissioning waste materials in the vicinity of the well sites;	Rural setting with back water and sea and villages with homestead plantation.	Visual and aesthetic impact on the nearby villages Disposal of MSW/ construction waste/ de-commissioning waste in open area around the village will create nuisance.	Minor	▪ All the construction activities will be restricted within the designated site; ▪ Fugitive dust will be supressed with periodic water sprinkling; ▪ On completion of work all temporary structures, surplus materials and wastes will be completely removed from site and disposed at a designated area; ▪ Construction wastes, decommissioning waste and municipal solid waste temporarily stored at the sites will be transported to the designated disposal site/facility at regular intervals; ▪ The pipelines once laid will be covered with burrowed soil and levelled as per the surrounding land.	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)
B	***Environmental Issues Associated with Offshore Drilling Activity***						
B.1.1	Air Quality	▪ Power generation on-board Rig through diesel generators resulting in air emissions due to combustion of diesel (hydrocarbons) during well	*Ref. A.1.4*	Air emission from DG Sets and potential to impact ambient air quality (localised and short period); Fugitive dust emissions during mud	Minor	▪ Maintenance of diesel power generators to achieve efficient combustion, fuel efficiency and therefore reduce emissions; ▪ Use of low sulphur diesel oil; ▪ No cold venting to be resorted during well testing. Management of the well test programme by dedicated	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
		drilling; ▪ Flaring of hydrocarbon during well testing; ▪ Dust generation during loading of bulk solids		preparation (related bentonite, barite etc. handling).		team for prevention of trips in product supply to the flare and flame out. Many of the above measures including checking of methane emissions, which may occur during well testing, are incorporated into management of the drilling operations. The well testing procedure involves the dedicated observation of the flare and radio communication to well test manager. In the event that product pressure drops in the well test flare, diesel can be injected to maintain combustion otherwise the feed line would be shut off; ▪ The vent boom shall be so located that any H_2S and HC gas concentration on the platform remains within acceptable limits for personnel safety, under worst operating & environmental conditions. ▪ Other fugitive emissions from diesel fuel etc. will be reduced by appropriate storage and handling; ▪ Loss of ozone depleting materials from the rig's systems will be kept to a	

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
						minimum by preventive maintenance of all relevant equipment. Refrigeration and air conditioning systems will be of closed circuit type.	
B.1.2	Noise	*Underwater Noise:* ▪ Drilling of development and exploratory wells ▪ Vessel movement *Ambient Noise Quality* ▪ Drilling rig and associate facilities ▪ Helicopter movement	*Ref. A.1.5*	Increase of underwater noise and potential to impact marine fish, mammals sea turtle and cetaceans; Increase noise levels in immediate vicinity of the source with potential to cause discomfort and health impact on workers.	Moderate	*For Drilling Activity* ▪ Diesel generators located at the rig are housed in an enclosure at the deck and the exhausts are provided with silencers. *For Transportation through Helicopters* ▪ Helicopters must maintain a minimum in-transit flying altitude of 500 m; ▪ Adhere to direct flight paths between Ravva Living Quarters (onshore) and rig and do not hover over or circle any marine fauna or coastal areas with birds; and ▪ All pilots and crew to be aware that deviations to flight paths are not permitted unless for technical or safety reasons. *For Transportation through Barge, Tugs, Support Vessels* ▪ Barges, Tugs and support vessels to maintain a distance of 350 m from any cetacean and to keep look out to avoid collision and to provide prior	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
						warning to enable detours at a safe distance; ▪ All crew and Master of the vessels must be briefed to understand that detouring to approach cetacean is not permitted.	
B.1.3	Seabed and Sediment Quality	▪ Positioning of drill rig; ▪ Discharge of drill cuttings and spent mud.	*Ref. A.1.3*	Potential to change the sediment quality	Moderate	▪ Drill cuttings treated from shale shakers and centrifuges to separate mud from cuttings from the reservoir rock may have presence of hydrocarbon residues. ▪ Vedanta Ltd (Cairn Oil & Gas) to ensure that drill cutting associated with high oil content (oil content >10 g/kg) from hydrocarbon bearing formation are not disposed offshore. ▪ Synthetic based mud will be disposed in TSDF at onshore facility	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)
B.1.4	Marine Water Quality	*Disposal of Drilling Waste:* ▪ Drill cuttings; ▪ Spent mud *Disposal of Liquid Waste from Support Services* ▪ Disposal of sanitary waste water from rig, barge, tugs, support vessel;	The marine water samples collected from different locations in the PKGM-1 Block revealed metal and oil and grease contents below detectable limits to very low levels of Cadmium, Copper, Lead and Total Chromium (*Ref. Section 3.13.1*).	Potential to change the marine water quality	Moderate	<u>For Drilling Waste</u>: Refer B1.3. <u>For Liquid Waste from Support Services</u> ▪ The treated wastewater discharge in accordance with Indian discharge requirements as well as MARPOL requirement; ▪ Black water will be released to the marine environment at the locations of the support vessels, tugs and barges after	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
		▪ Wash water and deck drainage runoff including WBM/SBM spills; ▪ Bilge water discharge; ▪ Cooling water; ▪ Discharge of drill cuttings and spent mud. *Disposal of solid & hazardous waste* ▪ Solid waste ▪ Kitchen waste ▪ Hazardous waste ▪ Bio-medical waste				treatment in accordance with Indian discharge requirement and MARPOL; ▪ The wash water will be treated to ensure oil and grease content of less than 15 ppm as per MARPOL requirement before offshore discharge at 0.6 m from sea surface; ▪ The bilge water will be treated on board and discharged offshore at 0.6 m from sea surface complying with MARPOL requirement of 15 ppm of oil and grease content. ▪ Oily water or bilge water containing more than 15 ppm of oil & grease content will not be discharged offshore and will be treated and oil will be collected in dirty oil tank and waste oil will be brought to shore for treatment and disposal. ▪ Cooling water will be discharged as per regulatory norms. <u>For Solid & Hazardous Waste</u> ▪ No garbage would be disposed of to the sea; ▪ Wastes are required to be segregated and stored on-board in appropriate	

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
						containers and transported back to shore for disposal; ▪ Organic waste will be disposed as per MARPOL standard; ▪ No plastic to be disposed to sea, as per MARPOL standard; ▪ Plastic, scrap metal and other non-combustibles should be segregated and disposed onshore; ▪ Biomedical waste is to be collected in specific collection bins provided with collection bags for onshore disposal; ▪ All hazardous waste (e.g. fluorescent tubes, batteries, oily rags and spent fuel etc.) will be collected and retained on-board for disposal at suitable onshore reception facilities	
B.1.5	Ecology	▪ Impacts due to sea bed disturbances ▪ Impacts due to underwater noise ▪ Impacts due to disposal of drilling waste	Meiobenthic community is represented by Copepods, Nematodes, Turbellarians, Nemertins, Foraminifera, Kinorynchs, Halacarids etc. Macrobenthic community is represented by Polychaetes, Molluscs, Cumceans Amphipods, Isopods, Cnidarians, Oligochaetes and Tanaidacea etc.	Disturbance to marine fauna Hearing loss to fish species; mortality of eggs and larve	Moderate	▪ Drilling contractor to visually inspect the area before start of activities; ▪ Avoid sudden loud noises, such as from the moving and putting down of heavy equipment, when cetaceans are observed in the region; ▪ Maintain the vessel and all noise generating equipment in good working order.	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

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			11 species of cartilaginous skeleton fishes without swim bladder and 37 species of fishes with boney skeleton and swim bladder were reported. Some solitarily nesting sites of Olive Ridley's Turtles have also been reported along the coast in the study area (*Ref. Section 3.14 and 3.15*).			▪ Use of Hydro Sound Damper (This technology consists of fishing nets with small balloon filled with gas and foam – tuned to resonant frequencies- fixed to it. It can be applied in different ways). The noise reduction thus achieved can be 4-14dB (SEL) to 8-13 dB (SEL) ▪ Noise emissions should begin at low power, increasing gradually until full power is reached. The soft start procedure should be of 20 min duration at least. ▪ Dedicated and independent Marine Mammal Observers (MMO) should watch the Exclusion Zone (EZ) for 30 min before the beginning the soft start procedure (120 min for highly sensitive species). ▪ The soft start procedure should be delayed if cetaceans enter the EZ Continuous watch should be kept for the entire duration of noise emission ▪ The activity should be stopped (or powered down) if cetaceans enter the EZ In case of a halt in noise, a new 30 min watch should be kept without animals in the EZ	

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
						before re-starting noise emissions (120 min for highly sensitive species)	
B.1.6	Livelihood and Economic Opportunities	Offshore drilling and vessel movement	*Ref. A.1.12*	Impact on livelihood of fishermen due to restricted movement through safety exclusion zones	Moderate	▪ Vedanta Ltd (Cairn Oil & Gas) should ensure that livelihood of fishermen, if any affected by the proposed development are identified and compensated through other livelihood restoration activities directly or indirectly through CSR activities. ▪ Issues of livelihood disruption due to restricted movement through the exclusion zone and proposed drilling of exploratory wells as well as damage of any equipment (including nets) /boat due to project activities should be captured through Grievance Redress process and regular stakeholder engagement.	Vedanta Ltd (Cairn Oil & Gas)
B.1.7	Community (Sea Users) Health & Safety	▪ Offshore Drilling ▪ Movement of Rig and Support Vessels	The fishing (both culture and capture) are the mainstay of the economy of the study area.	Potential exposure to spills, fires and blowouts; Accidents involving fishermen and fishing vessels; Hazards due to operational	Moderate	▪ Notification of the location of offshore facilities (including subsea hazards) and the timing of offshore activities should be provided to local and regional maritime authorities, including fishery groups. ▪ Position of fixed facilities and safety exclusion zones should	Drilling Contractor/ Vedanta Ltd (Cairn Oil & Gas)

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
				pipelines and abandoned infrastructure; Exposure to noise pollution; Improper waste management; Significant and long term impacts on community health and safety and socio-economically important resources in In the event of a serious oil spill		be marked on nautical charts. ▪ Clear instructions regarding access limitations to exclusion zones should be communicated to other sea users ▪ Subsea pipeline routes should be regularly monitored for integrity and if required should should be repaired in a timely manner. ▪ A spill response plan should be formulated. This plan should include arrangements for the Public training to warn of existing hazards, along with clear guidance on access and land use limitations in safety zones or pipeline rights of way. The plans thus formulated should be effectively communicated to the fishing community. ▪ The grievance redressal process should be regularly tracked and monitored as part of the management function.	
C	***Environmental Issues Associated with Operational Activity***						
C.1.1	Air quality	Flaring operation; Point sources; Power generation for operation of terminal	*Ref. A.1.4*	Ref. B.1.1	Minor	Ref. B.1.1	
C.1.2	Ground water resources	Souring of water required for operation	*Ref. A.1.8*	Ref. A.1.9	Minor	Ref. A.1.9	

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
		of terminal and injection water					
C.1.3	Ground water quality	▪ Injection of water in the reservoir; ▪ Spillage of fuel and chemical storage, hazardous waste storage.	*Ref. A.1.9*	Potential to contaminate the ground water resources	Minor	▪ The injection water is treated in injection water treatment system to meet the required water quality; ▪ All storage facilities have been provided with adequate containment system to prevent contamination of soil and subsurface aquifer; ▪ Vedanta Ltd (Cairn Oil & Gas) is to ensure periodic integrity testing of areas surrounding all process and storage tank and hazardous waste storage areas. ▪ Vedanta Ltd (Cairn Oil & Gas) will to ensure periodic integrity testing of well fulid transport pipeline; ▪ In case of any accidental spills at the onshore Ravva Terminal, CIL is to recover any spilled crude oil/chemical or fuel oil and adequately treat the area to prevent any subsurface contamination. ▪ Cairn is to periodically monitor the groundwater quality in the surrounding area to ascertain any impact	

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
						of groundwater quality	
C.1.4	Surface water quality and marine ecology	▪ Treatment and discharge of domestic waste water from Ravva Terminal; ▪ Effluent treatment & disposal; ▪ Treatment & disposal of produce water; ▪ Accidental discharge of well fulid from producing well and pipeline	*Ref. A.1.7 and A.1.10*	Potential to degrade the marine water quality and impact on marine ecology	Minor	▪ Provision of sewage treatment plant for sewage generated from Living Quarters and Ravva Terminal; ▪ Provision of Produced Water Injection System to effectively treat produced water before its discharge into confined hydrocarbon aquifers; ▪ Provision of API Separator for oil in water separation from produced water; ▪ Provision of ETP for treatment of produced water to ensure discharge standard. ▪ Staff to be suitably trained to ensure adequate treatment and monitoring of discharges from Ravva Terminal. ▪ Vedanta Ltd (Cairn Oil & Gas) will to ensure periodic integrity testing of well fulid transport pipeline. ▪ In case of any accidental spills at the onshore Ravva Terminal, Vedanta Ltd (Cairn Oil & Gas) is to recover any spilled crude oil/chemical or fuel oil and	

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
						adequately treat the area to prevent any subsurface contamination.	
D.	***Environmental Issues Associated with Decommissioning Activity***						
D.1.1	Air quality	▪ Fugitive emission ▪ Gaseous emission due burning of fuel	*Ref. A.1.4*	Impact on ambient air quality	Minor	▪ Prior to mobilisation, vessels for offshore and trucks and dumpers (onshore) will be audited to ensure that maintenance and efficiency of both generator and engine efficiency; ▪ Fuel used for mobilised vessels and onsore traffic will be monitored and comply with local regulat/MARPOL requirements, in particular with regard to low sulphur content; ▪ Decommissioning activities will be planned to minimise vessel and traffic use; ▪ Planned, preventative maintenance systems will be required for all vessels and traffic to ensure that all equipment (combustion and mechanical/ electrical) is maintained at peak operating efficiency.	Vedanta Ltd (Cairn Oil & Gas)/ Contractor
D.1.2	Noise quality	*Surface noise:* ▪ Propeller noise; ▪ Flow noise: the action of water passing the hull;	*Ref. A.1.5*	Impact of noise quality and marine fauna	Minor	▪ Machinery, tools and equipment will be in good working order and well-maintained (as required under the contract with the	Vedanta Ltd (Cairn Oil & Gas)/ Contractor

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
		▪ The use of thrusters for dynamic station-keeping; and, ▪ Machine noise: the operation of engines, generators, winches etc. *Underwater Noise:* Use of cutting tools and water-jetting				subcontractor); ▪ The vessels work programme will be carefully planned to optimise use; and, ▪ The number of required cuts will be minimised consistent with operational (including safety) considerations.	
D.1.3	Benthos and Benthic Habitat	Water jetting of sediments, the lifting of materials, and the temporary placement of objects on the seabed.	Meiobenthic community is represented by Copepods, Nematodes, Turbellarians, Nemertins, Foraminifera, Kinorynchs, Halacarids etc. Macrobenthic community is represented by Polychaetes, Molluscs, Cumceans Amphipods, Isopods, Cnidarians, Oligochaetes and Tanaidacea etc.	Potential to disturbed the benthic habitat and benthic community and marine fauna	Minor	▪ All activities which may lead to seabed disturbance will be planned, managed and implemented in such a way that disturbance is minimised; ▪ The careful planning, selection of equipment, and management and implementation of activities (especially water-jetting); and, ▪ A debris survey will be undertaken at the completion of the decommissioning programme. Any 'foreign' material, identified as resulting from decommissioning activities will be recovered from the seabed where possible	Vedanta Ltd (Cairn Oil & Gas)/ Contractor

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
D.1.4	Marine water quality and marine ecology	▪ Surface discharges and releases from specialised and support vessels; ▪ Seabed and water column discharges from unbolting and cutting, and lifting	*Ref. A.1.7 and A.1.10*	Impact on water quality and marine fauna	Minor	▪ Procedures and systems for the minimisation of waste and effluent generation ▪ (maintained as required under the contract with the subcontractor); ▪ Procedures and systems for the management of ballast and bilge water (maintained as required under the contract with the subcontractor); ▪ Accident prevention measures will be in place in order to minimise the potential for accidental spillages of hydrocarbons or other polluting materials; ▪ Vessels will be selected and audited to ensure that effective operational systems and onboard control measures are in place; and, ▪ Vessels' work programmes will be optimised to minimise use	Vedanta Ltd (Cairn Oil & Gas)/ Contractor
D.1.5	Soil and Sediment Quality	▪ Generation and disposal of decommissioning waste	*Ref. A.1.3*	Potential to contaminate soil and sediment	Minor	Wastes will be segregated according to characteristics and their disposal routes will be determined according to the waste hierarchy, taking account of the potential for recycle or recovery for reuse. Landfill disposal of waste will only be used as a last resort	Vedanta Ltd (Cairn Oil & Gas)/ Contractor

Ref No. (1)	Project Stage / Affected Aspect (2)	Project Activity (3)	Baseline Status (4)	Potential Impacts (5)	Impact Significance (6)	Proposed Mitigation Measures (7)	Responsibility for Implemen-tation (8)
D.1.6	Socio-economic impacts	▪ Denial of access and interference with navigation; ▪ Contribution to the economy:	*Ref. A.1.12*	Loss of economic activity and opportunity	Minor	▪ Complete the decommissioning activities within the planned timeframe; ▪ Inform the local fishermen community; ▪ Formulate grievance re-addressal system.	Vedanta Ltd (Cairn Oil & Gas)/ Contractor

Table 9.2 Budget for Environmental Actions

SN.	EMP Component / Particulars of Work	Budget (Per Well)	Cumulative Cost for Drilling Programme	Remarks
A	**During Onshore Drilling Activity**			
A.1	Suppression of fugitive dust with periodic water sprinkling;	-	**Rs. 1,37,25,000**	Cost of water sprinkling – One truck hiring charge (Rs. 1,00,000 per month X 9 months=Rs. 9,00,000); – Diesel charge (50 km travel per day @ Rs. 35/km X 270 days = Rs. 4,72,500); – Total cost for one year Rs.13,72,500; – Total cost for 10 years= Rs. 1,37,25,000
A.2	Drainage system at site is to be provided with double chambered sedimentation tank and oily-water separator;	-	-	Construction of sedimentation tank and oily-water separator- in built in project cost
A.3	Manage spills of contaminants on soil using spill kits;	**Rs. 60,000** (Rs 20,000 per kit X 3 spill kits per site)	**Rs. 19,80,000** (Rs.60,000 X 33 onshore wells)	Procurement of spill kits at well pad sites
A.4	Soil quality monitoring for nutrient status and contamination;	**Rs. 20,000** (Rs. 10,000 per sample X 2 samples)	**Rs. 6,60,000** (Rs. 20000 X 33 onshore wells)	Once before site works and once after decommissioning
A.5	Testing of drill cuttings and drilling mud	**Rs.60,000** (Rs. 5000 per sample X 1 sample per week X 12 weeks)	**Rs. 19,80,000** (Rs. 60,000X 33 onshore wells)	Testing of drill cuttings - weekly one sample at each well, drilling for approx. 12 weeks

SN.	EMP Component / Particulars of Work	Budget (Per Well)	Cumulative Cost for Drilling Programme	Remarks
		Rs.60,000 (Rs. 5000 per sample X 1 sample per week X 12 weeks)	**Rs. 19,80,000** (Rs. 60,000X 33 onshore wells)	Testing of waste drilling mud- weekly one sample at each well, drilling for approx. 12 weeks
A.6	Provide and maintain adequate drainage system for the well pads;	-	-	Drainage system in well pads-in built in Project cost
A.7	Provide and maintain the cross drainage structure along the pipeline route;	-	-	Cross drainage structure along pipeline route- in built in Project cost
A.8	DG stack emission monitoring	**Rs. 1,20, 000** (Rs 8000 per sample X 5 DGs X 3 months X 1 samples per month)	**Rs. 39,60,000** (Rs. 1,20,000 X 33 onshore wells)	DG stack emission monitoring monthly during onshore drilling
A.9	Ambient air quality monitoring	**Rs. 1,60,000** (Rs. 8000 per sample X 5 locations X 4 samples)	**Rs. 52,80,000** (Rs. 1,60,000 X 33 onshore wells)	Ambient air quality monitoring at 5 locations per well X 4 samples per location (once during site preparation; twice during drilling and once during decommissioning)
A.10	All DG sets would be provided with acoustic enclosures;	-	-	All DG sets will be procured with in-built acoustic enclosures
A.11	Personal Protective Equipment (PPE) shall be worn by workers at all times on the Site;	-	-	Procurement of PPEs- in built in Project cost
A.12	DG stack noise monitoring	**Rs. 30,000** (Rs. 2000 per sample X 5 DGs X 3 months X 1 sample per month)	**Rs. 9,90,000** (Rs. 30,000 X 33 onshore wells)	DG stack noise monitoring monthly during drilling
A.13	Ambient noise monitoring	**Rs. 60,000** (Rs. 3000 per sample X 5 locations X 4 samples)	**Rs. 19,80,000** (Rs. 60,000X 33 onshore wells)	Ambient noise monitoring at 5 locations per well X 4 samples per location (once during site works, twice during drilling and once during decommissioning)
A.14	Workplace noise monitoring	**Rs. 16,000** (Rs. 2000 per sample X 4 locations X 2 samples)	**Rs. 5,28,000** (Rs. 16000 X 33 onshore wells)	Workplace noise monitoring at 4 side boundaries within well pad site; twice during drilling
A.15	Regular maintenance of site access and approach roads;	-	-	Maintenance of site access and approach roads-in built in Project cost
A,16	Deploying traffic marshals at important road junctions and near sensitive receptors	-	-	Deploying traffic marshals at sensitive locations-in built in Project cost
A.17	Treatment of storm water runoff, drilling waste water and domestic waste water (sewage)	-	-	Cost of construction and maintenance of double chambered sedimentation tank and oily-water separator, ETP, STP - in built in Project cost

SN.	EMP Component / Particulars of Work	Budget (Per Well)	Cumulative Cost for Drilling Programme	Remarks
A.18	Bunding of chemical and fuel storage areas	-	-	Cost of bunding of fuel and chemical storage areas - in built in Project cost
A.19	Analysis of water from oily water separator prior to discharge	**Rs. 5000** (Rs. 5000 per sample X 1 sample)	**Rs. 1,65,000** (Rs. 5,000 X 33 onshore wells)	1 sample after drilling
A.20	Analysis of ETP and STP treated water	**Rs. 48000** (Rs. 8000 per sample X 2 samples X 3 months)	**Rs. 15,84,000** (Rs. 48,000 X 33 onshore wells)	1 sample each from ETP and STP per month from each operating well pad site
A.21	Surface water quality monitoring	**Rs.96,000** (Rs. 8000 per sample X 4 locations X 3 samples)	**Rs. 31,68,000** (Rs. 96,000 X 33 onshore wells)	Monitoring of physicochemical parameters of surface water quality at four locations
A.22	Monitoring of groundwater levels	-	-	Monitoring of groundwater levels quarterly at the nearby dug wells – time involvement of HSE
A.23	Drill cutting along with spent mud will be stored in HDPE lined pit in the well pad site	-	-	Construction of HDPE lined pits for storage of drill cuttings and waste mud- inbuilt in project cost
A.24	Ground water quality monitoring	**Rs.72,000** (Rs. 8000 per sample X 3 locations X 3 samples)	**Rs. 23,76,000** (Rs. 72,000 X 33 onshore wells)	Monitoring the ground water quality at 3 locations in the vicinity of the well pad sites X 3 samples per location (during site works, drilling and decommissioning)
A.25	All workers will be properly informed, consulted and trained on health and safety issues	-	**Rs. 20,00,000 (**Rs. 1,00,000 per training X 20 trainings)	2 training programmes per year for 10 years
A.26	Place traffic regulatory signage along site access and approach roads	-	-	Placing traffic signage-inbuilt in Project cost
A.27	Develop mechanism for disposal of Bio-medical waste			Biomedical waste collection and disposal- in built in Project cost
A.28	Implementation of Conservation Plan for Species and Habitats of Conservational Priority Species in the Study Area		**Rs. 88,00,000**	Details provided in Annex 21 EIA Volume 2
	Total Cost for 33 onshore wells **(A)**		**Rs.5,11,56,000**	
B	**Offshore Drilling Activity**			
B.1	DG sets attached with rig are housed in an enclosure at the deck and the exhausts are provided with silencers.	-	-	Diesel generators will be procured with acoustic enclosures

SN.	EMP Component / Particulars of Work	Budget (Per Well)	Cumulative Cost for Drilling Programme	Remarks
B.2	DG stack emission monitoring	**Rs. 1,20,000** (Rs 8000 per sample X 5 DGs X 3 months X 1 samples per month)	**Rs. 1,08,00,000** (Rs. 1,20,000 X 90 offshore wells)	DG stack emission monitoring monthly during offshore drilling
B.3	DG stack noise monitoring	**Rs. 30,000** (Rs. 2000 per sample X 5 DGs X 3 months X 1 sample per month)	**Rs. 27,00,000** (Rs. 30,000 X 90 offshore wells)	DG stack noise monitoring monthly during drilling
B.4	Training programme for pilot and crew on EMP, RFERP and OSCP provisions	-	**Rs. 20,00,000 (**Rs. 1,00,000 per training X 20 trainings)	2 training programmes per year for 10 years- =
B.5	Testing of drill cuttings and drilling mud	**Rs.20,000** (Rs. 5000 per sample X 4 samples)	**Rs. 18,00,000** (Rs. 20,000X 90 offshore wells)	Testing of drill cuttings - 4 samples prior to disposal
		Rs.20,000 (Rs. 5000 per sample X 4 samples)	**Rs. 18,00,000** (Rs. 20,000X 90 offshore wells)	Testing of waste drilling mud- 4 samples prior to disposal
B.6	Testing of water from oily water separator prior to discharge	**Rs. 20,000** (Rs. 10,000 per sample X 2 samples)	**Rs. 18,00,000** (Rs. 20,000 X 90 onshore wells)	2 samples from oily water separator during drilling and prior to discharge
B.7	Testing of treated drilling waste water	**Rs. 60,000** (Rs. 5000 per sample X 4 samples per month X 3 months)	**Rs. 54,00,000** (Rs. 60,000 X 90 offshore wells)	4 samples per month during the offshore drilling activity
B.8	Testing of treated bilge water	**Rs.60,000** (Rs 5000 per sample X 4 samples per month X 3 months)	**Rs. 54,00,000** (Rs. 60,000 X 90 offshore wells)	4 samples per month during the offshore drilling activity
B.9	Testing of marine water quality (physiochemical and biological parameters)	-	**Rs 160,00,000** (Rs 20,000 per sample X 40 samples per season X monitoring during 2 seasons per year X 10 Years)	Marine water quality monitoring at 40 locations in the PKGM-1 Block (including the marine outfall); monitoring during pre-monsoon and most monsoon season in a year.
B.10	Testing of marine sediment quality		**Rs 160,00,000** (Rs 20,000 per sample X 40 samples per season X monitoring during 2 seasons per year X 10 Years)	Marine sediment quality monitoring at 40 locations in the PKGM-1 Block (including the marine outfall); monitoring during pre-monsoon and post monsoon season in a year.
B.11	Marine biological sampling (benthos and plankton)	-	**Rs 240,00,000** (Rs 30,000 per sample X 40 samples per season	Marine biological sampling at 40 locations in the PKGM-1 Block (including the marine outfall);

SN.	EMP Component / Particulars of Work	Budget (Per Well)	Cumulative Cost for Drilling Programme	Remarks
			X monitoring during 2 seasons per year X 10 Years)	monitoring during pre-monsoon and post monsoon season in a year.
B.12	Management of Solid Waste (including organic wastes)	-	-	Solid waste including organic waste management and disposal- in built in Project cost
B.13	Management of Hazardous Waste	-	-	Hazardous waste management and disposal- in built in Project cost
B.14	Management of Biomedical Waste	-	-	Biomedical waste management and disposal- in built in Project cost
	Total cost for 90 offshore wells (B)		**Rs. 8,59,00,000**	
	Total (A + B)		**Rs. 13,70,56,000**	Cost is for completion of drilling of wells in 10 years. The average annual cost works out to be Rs. 137.06 Lakhs

Table 9.3 Action Plan on Issues Raised during Public Hearing held on 11 Oct 2018

Vedanta Limited (Cairn Oil & Gas) is committed to Spend INR 20 Crores for next 10 years under CER Activities to comply with the concerns raised during the Public Hearing. This CER amount will be in addition to CSR and Environmental Pollution Control & Monitoring Related Budget (refer to Table 9.5 on CER Intitiatives).

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
1	**Sri Nagini Nageswar Rao, ZPTC, Katrenikona**			
1 a)	Expressed concerns that promises made in the earlier public hearings by ONGC, GSPC, Reliance & Vedanta Limited had not been implemented.	The company has been implementing CSR activities since beginning of its operations. Till today, Vedanta has deposited INR 33.64 Crores with district administration.	Vedanta Limited (Cairn Oil & Gas) on behalf of Ravva Joint Venture (the Company) is committed to spend INR 2.0 Crores per annum on CER initiatives/projects in consultation with the District Collector, East Godavari District, Andhra Pradesh towards implementing the community development works as proposed during the public hearing held on 11th October 2018 at Surasaniyanam (S Yanam) Village, East Godavari District, Andhra Pradesh. The CER fund will be utilized towards implementing the following programs/ initiatives.	Annually Recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
			a) **Drinking water:** Setting up of community drinking water system for S. Yanam village. b) **Infrastructure:** Construction of roads, bridges/culverts, canal, stormwater & backwater drains, developing the parks with walking tracks, installation of the solar lights etc. c) **Tourism:** Promotion of the beach front tourism in the surrounding villages. d) **Health:** Supporting district medical department for expansion and effective operation and maintenance of public health center. e) **Solid waste and Sanitation:** Provision of Supporting the "Swatch Bharat" initiative for the effective waste management. f) **Education:** Supporting the Government schools and Anganwadis towards improving the educational standards, establishment of libraries, providing scholarships to the meritorious students etc. g) **Sports:** Supporting physical education in schools and youth such as providing sports kits, creating play area etc. h) **Skill development of the youth**: By developing training and competitive exam coaching centers in the villages and organizing skill development training programs. i) **Natural Resource Management (NRM):** Development of NRM related projects in the villages through plantation of the native species for increasing the green cover, providing fruit bearing saplings to the local villagers etc. j) **Fisheries and aqua culture development**: Development schemes for fishermen and aqua culture farmers including assistance for their livelihood development will be carried out in consultation with the Department of Fisheries, Andhra Pradesh, Central Marine Fisheries Research Institute etc. k) **Need based assessment study:** Carry out a need based (social) assessment study in the S.Yanam and	

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
			the surrounding villages through Smart Andhra Pradesh Foundation or through any reputed institutions. The outcome of the study will be discussed with the district administration and financial support will be based on the study outcome related program. In addition, the Company is also committed to contribute towards CSR projects by annually depositing INR 6.00 Crores to the State Government of Andhra Pradesh acting through Joint Collector, East Godavari District towards implementing community development works/projects. This fund will be utilized by the district administration for improving livelihood of the people residing in S. Yanam and surrounding villages. The amount to be spent and need of each program will be decided by the district administration based on the needs of the local community.	
1 b)	Expressed concerns that due to exploration of oil & gas in the area, soil subsidence witnessing in the entire coast, thereby causing earthquakes in the area.	A study was carried out by IIT (BHU) regarding land subsidence due to oil & gas exploration and it was reported that no land subsidence occurring due to oil & gas exploration in the block area.	The Company is ensuring continuous monitoring of land subsidence through installation of high precision geodetic grade GPS system to understand any adverse impact caused due to extraction of hydrocarbon resources from the reservoir. The data collected from this equipment will be processed and findings will be submitted to MoEFCC as part of six monthly compliance reporting. Annual Budget of INR ~10 Lakhs has been earmarked for the Land Subsidence Study.	Annually Recurring
1 c)	Opined that monthly allowance shall be provided to the entire fishermen communities and agriculturalists in this area.	The proposed developmental and operation phases activities do not likely to cause impact to the fishing and agriculture activities. Thus, there is no direct provision to give compensation/ money to the families.	As per the company policy, developmental activities are being taken up in consultation with the village representatives and district administration for improving the livelihood of the people of the nearby villages. The community development activities will continue to be taken up for S. Yanam and surrounding villages under CSR and CER programs/initiatives.	Annually recurring
1 d)	Fish death in this area due to pollution and the project authorities managed the higher officials and got a report	The Company has been carrying out its operations for past 25 years and all operations comply with the environmental regulatory requirements.	The study by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the	Annually Recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	stating that fish death in this area was not due to pollution from the plant.	The Company has given a contract to Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to carry out Marine Ecological Study annually to monitor any adverse impact caused due to the operation of the Company in PKGM-1 Block. The outcome of the recent study of 2018, showed TPH concentration observed in seawater and sediment samples at all the stations of the Company operational areas are very low and far below the standards prescribed by ATSDR (Agency for Toxic Substances and Disease Registry 1999) indicating no oil pollution or toxicity.	study will be submitted as part of six monthly compliance reporting to MoEFCC. Annual Budget of INR ~22 Lakhs has been earmarked for the Annual Marine Ecological Study.	
1 e)	Demanded monthly compensation, as they have been loosing their wealth, similarly given by Reliance Industries @ Rs.6700/- per month and also informed that GSPC announced monthly compensation to about 16000 families till the completion of drilling activities, but, they have given compensation for 6 months only instead of 23 months as per agreement.	The Company activities do not likely to cause impact to the livelihood of the people residing adjacent to the proposed operational activities. Thus, there is no likely issue of giving compensation/money to the families.	As per the Company policy, developmental activities are being taken up in consultation with the village representatives and district administration for improving the livelihood of the people of the nearby villages. Community development activities will continue to be taken up for S. Yanam and surrounding villages under CSR and CER programs/initiatives.	Annually recurring
1 f)	Pollution problems from the proposed project and questioned that why turtles, disappeared in this area. The project authorities drilled two wells in Gatchakayalapuram and Katrenikona, due to which the roads in this area are completely damaged. The Government sanctioned Rs.8.0 Crores for laying of roads in this area, and apprehended that if the project authorities re-start their activities, again roads would be damaged.	The proposed onshore drilling activities will be carried out ensuring that there is no impact on turtle species.	The Company will ensure no damage of public roads due to the movement of vehicles for the proposed activities. Recently, the Company has carried out a survey of the public roads to be used for this project, which is yet to start in the area and found them with pot-holes and damages, for which the Company has deposited INR 50 Lakhs as a first instalment to get the roads repaired by district administration. The Company proposes to have a MoU with Jawaharlal Nehru Technological University, Kakinada (JNTUK) for carrying out road damage assessment before and after the proposed project activities. As per the JNTUK	During the Project life cycle Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
			recommendation, if any road damage is occurred the estimated cost for its repair will be provided to district administration. During the project developmental and operational phases, periodic environmental monitoring will be carried out and report will be submitted to MoEFCC as part of six monthly compliance reporting.	
1 g)	Alleged that due to pollution from the drilling activities, the sea food productivity in this area completely damaged and due this, the youth from the villages are migrating to other areas for their livelihood. Alleged that earlier, they got about 5 kg of fish by each fisherman, and now they could not get even ½ kg due to pollution problem.	The Company has been carrying out its operations for past 25 years and all operations comply with the environmental regulatory requirements. The block remains in the less or no fishing zone area. The Company has given a contract to Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to carry out Marine Ecological Study annually to monitor any adverse impact caused due to its developmental and operation activities in the PKGM-1 Block. The outcome of the recent study of 2018, showed TPH concentration observed in seawater and sediment samples at all the stations of the Company operational areas are very low and far below the standards prescribed by ATSDR (Agency for Toxic Substances and Disease Registry 1999) indicating no oil pollution or toxicity. The study also showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers.	The Company will ensure that all the pollution control measures for developmental and operation phases will be in place as per the EMP, the environmental norms and conditions of APPCB and MoEFCC./ The Company will also take up environmental monitoring during the drilling campaign. Annual Budget of INR ~40 Lakhs has been earmarked for environmental monitoring during drilling program. The study by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC	During the Project life cycle Annually recurring for environmental monitoring Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
1 h)	Informed that the impact of drilling activity is not confined to this area only, the impact would be more up to 1000 of km in the underground and questioned the project authorities that how many tankers of oil they have been producing and re-injecting how many tankers of water into the well.	The Company will carry out drilling of wells as per the requirement of OISD, DGH and DGMS. The Company submits all the well production details together with well fluid production and water injection to DGH periodically. The DGH is the Indian regulatory body under the Ministry of Petroleum and Natural Gas (MoPNG). For the last 25 years of the Company's operations, no impact in terms of subsidence in and around the block area has been observed.	The Company will continue to inject the treated produced water co-mingling it with deep saline groundwater into the confined hydrocarbon reservoir zone to maintain the reservoir pressure. The Company is ensuring continuous monitoring of land subsidence through installation of high precision geodetic grade GPS system to understand any adverse impact caused due to extraction of hydrocarbon resources from the reservoir. Annual Budget of INR ~10 Lakhs has been earmarked for the Land Subsidence Study.	Ongoing Annually Recurring
1 i)	Demanded that a committee shall be constituted with members of Revenue, people representatives, village elders for obtaining concrete proposal for fixation of monthly compensation particularly to the fisherman community and agricultural farmers from the project authorities.	The proposed developmental and operation phases activities do not likely to cause adverse impact on livelihood of communities engaged in fishing and agriculture activities. Thus, there is no likely issue of giving compensation/money to the families.	As per the Company policy, developmental activities are being taken up in consultation with the village representatives and district administration for improving the livelihood of the people of the nearby villages. The Company will continue to spend on community initiatives/activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages.	Annually recurring
1 j)	Alleged that no employment was given to locals even for security guards by the existing plants and demanded for employment and livelihood for the locals.	Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh.	The Company will continue to engage with local communities and comply with the requirements specified in the AP Employment of Local Candidates in Industries and Factories, Bill 2019 that mandates requirement of at least 75% of the state candidates in the respective units.	During the Project life cycle
1 k)	Expressed concerns that due to exploration of oil & gas the sea food wealth was considerably decreased in the area. Reiterated that due to pollution from the drilling activities, sea food productivity, agricultural productivity completely damaged in this area and the farmers are	The drilling and completion of a well is carried out in average 45 days per well. After the completion of well drilling, no physical activity is required. The well fluid flowing from an offshore well is transported to onshore Ravva Terminal through subsea pipeline. The offshore well is remotely controlled from onshore Ravva Terminal.	The study by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC. The Company will undertake development schemes for fishermen and aqua culture farmers including assistance for their livelihood development will be carried out in consultation with the Department of	Annually recurring Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	converting the fertile agricultural lands into ponds, as no other way. Informed that the people of this area are not against establishment of oil companies. If any proposal established, it would be beneficial for development of this area citing the example of development of S.Yanam Village.	The export of crude oil from Ravva Terminal is carried out through offshore Single Point Mooring (SPM) facility into offshore vessel tankers with maximum 20 vessel trips per annum. Each vessel trip is completed in ~2 days. The recently conducted study in 2018 by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. Thus, there is no evidence of reduction of fish in the block area. The block remains in the less or no fishing zone area.	Fisheries, Andhra Pradesh, Central Marine Fisheries Research Institute etc.	
1 l)	Demanded again for compensation to the lands damaged due to drilling activities, and also suggested that the project authorities shall adopt the villages for development.	No onshore drilling activity has been carried out in past 10 years, thus no damage to the land has been caused due to onshore drilling activities. The Company has been implementing CSR - CER activities since beginning of its operations. Until March 2019, the Company has deposited INR 33.64 Crores with the district administration. Out of this, the predominant part of the budget was spent on improving the livelihood and infrastructure of S Yanam Village.	The Company will ensure that all the pollution control measures for developmental and operation phases will be in place for the proposed Project as per the EMP, the environmental norms and conditions of APPCB and MoEFCC. The Company will also take up environmental monitoring during the Project life cycle. In case any damage to the adjacent land is caused, the Company will provide adequate compensation as per the Land Acquisition Officer nominated by the government of Andhra Pradesh. The Company will continue to spend community initiatives/activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages.	Annually recurring As and when need arises. Annually recurring
1 m)	He also expressed his concerns that the project authorities had not been implementing the promises made during the public hearing, citing the example that earlier, during the Sri G.M.C. Balayogi period, CSR fund	The Company has been implementing CSR - CER activities since beginning of its operations. Until March 2019, the Company has deposited INR 33.64 Crores with the district administration. Out of this, the predominant part of the budget was spent on	The Company will continue to spend community initiatives/activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages. The Company will request the district administration to focus and spend more on community initiatives in and	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	was earmarked initially to S.Yanam Village only, latter allocation of funds extended to mandal level and further to constituency level.	improving the livelihood and infrastructure of S Yanam Village.	around the company operating villages including S. Yanam	
2	**M Sri Isukapatla Ravi Babu, resident of Challapalli,**			
2 a)	About 2% of the profits shall be earmarked for CSR activities and accordingly, the Ravva plant should earmark at-least Rs.10.0 Crores annually. CSR funds and CSR fund allocation started with Rs.1.0 Crore annually and gradually increased to Rs.5.0 – Rs.6.0 Crores at present.	The Company has been complying with the requirement as mentioned in the Companies Act, 2013 towards spent on CSR activities.	The Company will continue to take up CSR and CER activities as described in serial no. A1 a) above.	Annually Recurring
2 b)	No infrastructure facilities provided in S.Yanam including Challapalli village except laying of roads in S.Yanam Village.	The Company has established Mini Libraries, Public Health Centre, RO Plants, Community Health Centre, provided playing material/ equipment in nearby schools etc. besides laying of roads and other infrastructure facilities in S Yanam and Challapalli Villages.	The Company will continue to spend community initiatives/activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages	Annually Recurring
2 c)	No supply of drinking water in the villages. People in this villages facing water scarcity and during the summer it is more intensive.	Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up to provide clean and safe drinking water to ~ 6,000 people.	The Company will set up an additional (third) RO Plant in Cherriyanam Village.	June 2020
2 d)	Expressed concerns on chemical, water and noise pollution due to operations of Ravva Plant.	The Company has been carrying out its operations duly complying with environmental regulatory requirements for last 25 years. Periodical environmental monitoring reports are being submitted to regulatory agencies such as APPCB, MoEF&CC and APWALTA.	The Company will continue to carry out environmental monitoring through reputed third party agency. The Company will also continue to conduct internal and external environmental audits to ensure the Ravva Terminal operations comply with the environmental regulatory requirements. Annual budget of INR 10 Lakhs has been earmarked for the environmental audits.	Annually recurring Annually recurring
2 e)	People witnessing health problems such as hair fall, gastric, cancer and pregnancy problems and requested the Government authorities to enquire the people about the same.	The Company has been operating Cairn JV Charity Clinic for last 25 years. No such health issues have been reported due to Ravva operations.	The Company will continue to operate the Cairn JV Charity Clinic through tie up with Apollo Hospitals, Kakinada to provide health related services to the nearby communities. The Company will initiate a comprehensive secondary data study to understand community health issues, and	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
			decide suitable mitigation measures as applicable. Annual budget of INR 20 Lakhs has been earmarked for conduct of Community Health Assessment and Status of Health Interventions Study of the surrounding villages.	
2 f)	Facilities provided at newly constructed hospital are not fully adequate.	The Company has provided medical equipment, setting up of operation theatre, related infrastructure, ambulance and medicines in the Public Health Centre at S. Yanam at a cost of INR 20 lakhs.	The Company plans to support additional infrastructure, salary of additional support staff etc. to improve medical services of the existing Public Health Centre at S. Yanam.	One time – December 2020
2 g)	The Project authorities to give permanent employment to 36% local youths. Provided permanent employment to 8 nos. of local people only, out of 105 employees working. At present, recruited 333 local people as contract employees and about 200 people recruited non-local people engaged from about 2000 km of Chennai. Questioned the project authorities that why they engaged non-local people despite availability in the local area.	The statement provided is incorrect. Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh.	The Company will continue to engage with local communities and comply with the requirements specified in the AP Employment of Local Candidates in Industries and Factories, Bill 2019 that mandates requirement of at least 75% of the state candidates in the respective units.	During the Project life cycle
2 h)	Due to wells and drilling activities in offshore, due to discharge of sludge, oil wastes into sea, fish breeding capacity has been decreasing.	The drilling and completion of a well is carried out in average 45 days per well. After the completion of well drilling, no physical activity is required. During drilling activities, treated drill cuttings and drilling fluid is discharged offshore at the drilling location complying with the requirements laid down in the Environment (Protection) Rules, 1986 GSR546 E. Environmental monitoring of sea water and sediments is carried out before start, during drilling and post drilling activities carried out to monitor the environmental conditions and take up actions if any adverse impact is caused. The	The Company will continue to carry out environmental monitoring through reputed third party agency. The Company will also continue to conduct internal and external environmental audits to ensure the Ravva	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
		reports are being submitted to MoEFCC as part of six monthly compliance reporting. No sludge and oil wastes are discharged offshore at any stage of the Project implementation. The treated effluent from ETP at Ravva Terminal is discharged at marine outfall complying with the APPCB and MoEFCC discharge norms. The recently conducted study in 2018 by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. Thus, there is no evidence of reduction of fish in the block area.	Terminal operations comply with the environmental regulatory requirements. The study with Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC.	Annually recurring Annually recurring
2 i)	The project shall adopt sage culture and shall support the fisherman community providing latest technology. Provide mechanized boats, nets to the local fisherman community, as these people depends only on fishing activity. Because of oil & gas exploration in this area, local people loosing their livelihood and asked the project authorities are directly or indirectly reason for that. Always very co-operative for development of India, exploration, production and usage of Oil & Gas locally and also to decrease the imports of Oil & Gas. He re-iterated that the project authorities shall solve the local problems and shall give employment to the locals.	In the past 25 years, the livelihood opportunities have improved through infrastructure development, increased employment and overall socio-economic development of the area.	The Company will also consult Fisheries Department, East Godavari District, Kakinada to engage with fishing community in the area to improve their livelihood and also seek support in providing technology and fishing equipment. The Company will implement sage culture under CSR – CER activities as described with a budget as per serial no. A1 a) above.	Annually recurring Annually recurring
2 j)	Questioned where and how many acres of greenbelt developed for the	The Company has developed greenbelt in > 35% (83 acre) of Ravva Terminal area. The Company	The Company will develop greenbelt in the villages by planting minimum 5,000 saplings and where required	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	past 24 years. If land not available, the project authorities may take land from local farmers on lease basis for development of greenbelt.	has planted additional 3,000 fruit bearing plants in S Yanam Village through micro vendors in the community centre and public areas.	tree guards will also be provided. Greenbelt development in other villages will be taken-up periodically. Annual budget of INR 5.0 Lakhs has been earmarked for the promotion natural resource management in the surrounding area.	
2 k)	Questioned job mela conducted in the recent past, whom they have given the employment and requested for employment should be given to locals only, as people of this area are prone to accidents due to the exploration activity citing the example of Mamidikuduru accident. Out of thousand families in the village, about 600 families are getting benefitted by way of employment, small contracts and he demanded that the project authorities shall pay the current bills, shall provide daily commodities on monthly basis to the remaining 400 un-benefited poor families as monthly package.	A job mela was conducted for unemployed youths. About 2,500 youths participated, out of them 700 were employed by 40 different employers. The Company do not have provision to financially support unemployed youths.	The Company will continue to conduct job mela for local youths as on need basis. The Company will continue to conduct various skill development programs for the local youths to enable them for suitable employment.	As and when need arises
2 l)	He informed that they would support the project duly implementing the local issues pertaining to employment, pollution problems, compensation to the poor families raised in the public hearing.	The Company has been carrying out its operations for past 25 years and all operations comply with the environmental regulatory requirements. Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh. The Company has been complying with the requirement as mentioned in the Companies Act, 2013 towards spent on CSR activities.	The Company will continue to carry out environmental monitoring through reputed third party agency. The Company will also continue to conduct internal and external environmental audits to ensure the Ravva Terminal operations comply with the environmental regulatory requirements and on six monthly basis report to MoEFCC. The Company will continue to engage with local communities and comply with the requirements specified in the AP Employment of Local Candidates in Industries and Factories, Bill 2019 that mandates requirement of at least 75% of the state candidates in the respective units.	Annually recurring Throughout Project life cycle

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
			The Company will continue to take up CSR-CER activities as described in serial no. A1 a) above.	Annually recurring
2 m)	He informed that lot of unemployed youth with fully technical qualification available in this area and requested the project authorities not to engage people from other places and recruit the local people in contract employment, as thousands of crores of wealth from this area has been taken out by the project authorities.	Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh. The Company prefers to engage employment from local villages, however, for outside employees are engaged to meet the requirement of highly skilled oil and gas expertise.	The Company will continue to engage with local communities and comply with the requirements specified in the AP Employment of local candidates in Industries and Factories, Bill 2019 that mandates requirement of at least 75% of the state candidates in the respective units.	Throughout Project life cycle
2 n)	He also opined that the S.Yanam village was developed due to establishment of Cairn Energy and certain development activities is happening in this area but not up to the mark.	The Company is depositing INR 6.00 Crores to the State Government of Andhra Pradesh annually for community development works/projects. This fund will be utilized by the district administration for improving livelihood of the people. The amount to be spent and need of each program are being decided upon by the district administration based on the needs of the local community.	The Company is committed to spend INR 2.0 Crores per annum for CER initiatives/activities as per the need assessment done periodically. The Company will continue to spend community initiatives/activities in consultation with the district administration as part of CSR activities in and around the surrounding villages.	Annually recurring
2 o)	The Konaseema area is covered with sea mashes, rivers and Sea and hundreds of fisherman families depending on them, because of oil & gas exploration in this area, the local people loosing their livelihood and asked the project authorities are directly or indirectly reason for that.	The existing and proposed developmental activities do not likely to cause adverse impact on livelihood of communities engaged in fishing and agriculture activities. In the past 25 years of operations, there is no evidence of livelihood of people getting affected due the Vedanta Limited (Cairn Oil and Gas) operations. Rather there have been improvement in per capita income generation of S Yanam and Chirrayanam villages.	As per the Company policy, developmental activities are being taken up in consultation with the village representatives and district administration for improving the livelihood of the people of the nearby villages. The Company will continue to spend on community initiatives/activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages.	Annually recurring Annually recurring
2 p)	He suggested that if, requisite land is not available for development of greenbelt, and the project authorities may take land from local farmers on lease basis for development of greenbelt.	The Company has developed greenbelt in > 35% (83 acre) of Ravva Terminal area. The Company has planted additional 3,000 fruit bearing plants in S Yanam Village through micro vendors in the community centre and public areas.	The Company will develop greenbelt in the villages by planting minimum 5,000 saplings and where required tree guards will also be provided. Greenbelt development in other villages will be taken-up periodically.	Annually Recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
2 q)	The project authorities have not been giving employment to other villagers except S.Yanam, citing that the people of S.Yanam have not been willing to give employment to other villages. He also informed that while explaining the project detail by the authorities stated that about 50% of the employment has been giving to local people and requested the project authorities about 30% employment may be given to S.Yanm Village and 20% to other villages.	Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh.	The Company will discuss the local employment opportunity for surrounding villages with the District Administration.	FY 21
3	**Resident of S.Yanam**			
3 a)	Demanded monthly compensation of Rs.5000/- per family, employment and medical compensation to each family, only they would allow the proposed project, otherwise, people in this area will protest.	The Company activities do not likely to cause impact to the livelihood of the people residing adjacent to the proposed operational activities. Thus, there is no likely issue of giving compensation/money to the families.	As per the Company policy, developmental activities are being taken up in consultation with the village representatives and district administration for improving the livelihood of the people of the nearby villages. Community development activities will continue to be taken up for S. Yanam and surrounding villages.	Annually recurring
3 b)	Expressed concerns of facing health problems due to pollution problems from the plant and informed that earlier, 200-woman protest for medical compensation and all the 200 women arrested during the protest. Particularly fisherman community in this area has been losing their livelihood due to the plant operations and many people migrated for work.	The Company has been operating Cairn JV Charity Clinic for last 25 years. No such health issues have been reported due to Ravva operations. The recently conducted study in 2018 by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. Thus, there is no evidence of reduction of fish in the block area. The block remains in the less or no fishing zone area.	The Company will continue to operate the Cairn JV Charity Clinic through tie up with Apollo Hospitals, Kakinada to provide health related services to the nearby communities. The Company will initiate a comprehensive secondary data study to understand community health issues, and decide suitable mitigation measures as applicable. The study by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC. The Company will also consult Fisheries Department, East Godavari District, Kakinada to engage with fishing	Annually recurring Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
		The reported incident of arrest of 200 women has not happened during the tenure of the Company's operation in the Ravva Block and outside their sphere of influence. The Company is not directly and indirectly responsible for the same.	community in the area to improve their livelihood and also seek support in providing technology and fishing equipment.	
4	**Sri Lanke Bhimaraju, resident. of S.Yanam**			
4 a)	Fish productivity in this area has been gradually decreasing for the past 30 years due to operations of oil & gas exploration industries. Due to decrease in livelihood to fisherman community, many families migrated to other areas as casual labour and requested the environment department to study the issue in detail. Whether it is a misconception or real, the health problems of cancer and gastric increased in this area for the last 20 years and requested the environment department to study the issue in detail and reasons may be found out.	The Company has been carrying out its operations duly complying with all the pollution norms such as APPCB, MoEF&CC conditions and corrective actions would be initiated if any pollution caused. The Company has been operating Cairn JV Charity Clinic for last 25 years. No such health issues have been reported due to Ravva operations. The recently conducted study in 2018 by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. Thus, there is no evidence of reduction of fish in the block area. The block remains in the less or no fishing zone area.	The study with Andhra University will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC. The Company will continue to operate the Cairn JV Charity Clinic through tie up with Apollo Hospitals, Kakinada to provide health related services to the nearby communities. The Company will initiate a comprehensive secondary data study to understand community health issues, and decide suitable mitigation measures as applicable.	Annually recurring Annually recurring Annually recurring
4 b)	Vedanta Limited have been carrying out drilling activities in S.Yanam and Chirra Yanam villages and during operations excess gas would flared and the other wastes such as water, oil if releases in to local water sources and back waters, the lands would not be suit for agriculture and particularly the fisherman community would face inconvenience and if it happened, compensation shall be given to the land owners and fisherman community of the area and same	Drilling activities and related wastes management including flaring will comply with the regulatory requirement of the Environment (Protection) Rules, 1986 GR 546 E. There is no discharge of wastes outside the onshore well pads into any intertidal area and backwater, thus there is no likelihood of adverse impact caused to the fishing communities. No compensation due to pollution is applicable.	The Company will ensure that all the pollution control measures for developmental and operation phases will be in place for the proposed Project as per the EMP, the environmental norms and conditions of APPCB and MoEFCC. The Company will continue to carry out environmental monitoring through reputed third party agency. The Company will also continue to conduct internal and external environmental audits to ensure the Ravva Terminal operations comply with the environmental regulatory requirements and report to MoEFCC on six monthly basis.	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	should be incorporated in the activities proposed.			
4 c)	He also informed that earlier, the project authorities encouraged education benefits to the local fisherman community, same is slow down gradually in the recent past and suggested that the project authorities shall re-start, continue and increase educational benefits to children of fisherman community of this area under the chairmanship of the District Collector.	The Company will continue to support education benefits to local fishermen and other communities as has been carried out during the last 25 years.	Education benefits to local fishermen and other communities are included in the CSR – CER program.	Annually recurring
4 d)	He also informed that earlier, during the oil & gas exploration activity compensation was given in Yanam Village as well as in Gadimoga Village by the industries and in the same way the project authorities shall give compensation to all the affected villages. While welcoming the project, the project authorities shall take all the measures and shall carry their operations without causing any inconvenience to the local people.	For the proposed developmental and operational activities, the land cost will be duly compensated as per the norms laid by the Land Acquisition Officer nominated by the government of Andhra Pradesh. The Company has been carrying out its operations duly complying with environmental regulatory requirements for last 25 years.	Compensation of land cost will be done as per the norms to be specified by the Land Acquisition Officer nominated by the government of Andhra Pradesh. The Company commits to carry out all the operations in environmentally responsible manner.	During land acquisition Throughout the Project life cycle
5	**Sri A.Narasimha Murthy, Resident of Chirrayanam, Ex.Sarpanch**			
5 a)	He informed that due to activities of GSPC, fish productivity has been decreasing and turtle nesting grounds, which were existing earlier, were also disappeared due to activities of ONGC.	Not relevant to Vedanta Limited (Cairn Oil and Gas).	Not Applicable (NA)	NA

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
5 b)	He requested the project authorities to adopt their village i.e. Chirrayanam for solving water problem and shall carryout different development activities. While welcoming the project he requested the project authorities to carry their operations without causing any convenience to the local people.	Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up to provide clean and safe drinking water to ~ 6,000 people.	The Company will set up an additional (third) RO Plant in Chirrayanam Village. The Company commits to carry out all the operations in environmentally responsible manner.	June 2020 Throughout the Project life cycle
6	**Sri M.Annavaram, Resident of Chirrayanam, Ex.Sarpanch**			
6 a)	He informed that earlier, the ONGC carried out its operations and promised hospital and CC roads in the village, and completed its operations for 3 – 4 years and not even allocated Rs.1000/- to their village for development. He also informed that no development activities promoted in the village, for which they also staged protest.	Not relevant to Vedanta Limited (Cairn Oil and Gas).	The Company will continue to take up CSR-CER activities as described in serial no. A1 a) above.	Annually recurring
6 b)	He also informed that development by the industry confined to the S.Yanam village only, they could not have even transport facilities during the emergency for maternity, and it would take at least one hour time to reach nearest hospital.	The Company has provided medical equipment, setting up of operation theatre, related infrastructure, ambulance and medicines in the Public Health Centre at S. Yanam at a cost of INR 20 lakhs.	The Company plans to support additional infrastructure, salary of additional support staff etc. to improve medical services of the existing Public Health Centre at S. Yanam.	One time – December 2020
6 c)	He also informed that the roads in this area are completely damaged due to activities of oil & gas exploration industries and minimum three hours-time is taking to reach hospital at Amalapuram by auto in the emergency. While welcoming the project, he suggested that the Government authorities shall obtain a	The Company has supported through its CSR-CER programs for the development of infrastructure including construction of roads in and around the Company's operational areas.	The Company will continue to support by repairing of roads as part of the CSR-CER programs. As per the company policy, developmental activities will continue to be taken up in consultation with the village representatives and district administration for improving the livelihood of the people of the nearby villages. The Company ensures that no damage of the roads are caused due to its vehicular movements.	Annually recurring Throughout the Project life cycle

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	concrete proposal from the project authorities pertaining to implementation of CSR activities in the area.			
7	**Resident of Katrenikona**			
7 a)	He informed that the ONGC authorities have been carrying its activities in this area since long time. During the drilling activities, the project authorities have been giving very small amount of compensation to the adjacent land owners and there is no mention about the specific amount to be given. After completion of the drilling activity, the un-succeed bore wells are filling with soil of 3 – 4 tractors capacity only, which is in sufficient and the farmer could not carry agricultural activity immediately.	Not relevant to Vedanta Limited (Cairn Oil and Gas).	NA	NA
7 b)	Suggested that instead of giving small amount of compensation to the land owners, a fixed amount shall be given equal to the amount lost due to unfavourable condition for agriculture per year. He requested the project authorities that more CSR funds shall be allocated in this area towards education, establishment of playgrounds and laboratories, libraries and computers, as they would be help the people. Nobody can stop the activities of oil & gas exploration in this area and these would be explored either by the present management or some other	For the proposed developmental and operational activities, the land cost will be duly compensated as per the norms laid by the Land Acquisition Officer nominated by the government of Andhra Pradesh. The Company has been implementing CSR-CER activities since beginning of its operations. Until today, the Company has deposited INR 33.64 Crores with the district administration.	Compensation of land cost will be done as per the norms specified by the Land Acquisition Officer nominated by the government of Andhra Pradesh. The Company is committed to contribute towards CSR and CER projects by annually depositing INR 6.00 Crores to the State Government of Andhra Pradesh acting through Joint Collector, East Godavari District towards implementing community development works/projects including Drinking water, Infrastructure development, Health, solid waste and sanitation, Education, Sports: , Skill development of the youth, Natural Resource Management, Financial support etc.	During land acquisition Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	company. He also informed that a special package should be given to each family, besides allocation of more CSR funds for development of infrastructure in this area.			
7 c)	Suggested that monthly package shall be given to poor families in this area. More CSR funds shall be allocated and advised the project authorities that a residential school shall be established for the merit students of Katrenikona & Uppalaguptam mandals, so that all the engineering people required for ONGC would be produced here only.	The Company has been engaged in providing the following with respect to educational support in the surrounding villages: 200 mini libraries set up in Uppalaguptam Mandal; ~ 1500 students benefitted Supporting 14 additional teachers in Government Schools in S Yanam - wages for teachers of INR 30 lakhs per annum. Learning aids & playing material/ equipment provided in schools Competitive examination coaching provided to local youths.	The Company will provide scholarship to the meritorious students from affected villages (based on criteria as finalized with the coordination of district administration for scholarship amount and number of students). Establishment of libraries with weekly and monthly magazines to the surrounding villages. Develop IT training centres in the surrounding villages by providing computers for training. Develop parks with gravel walking tracks of 150 to 200 m length.	March 2021
7 d)	He also suggested that greenbelt shall be developed in these villages duly giving employment to the local people, so that the people in this area developed socio economically.	The Company has planted 3,000 well grown fruit bearing plants in S Yanam Village through micro vendors in the community centre and public areas. Greenbelt development in other villages will be taken-up periodically.	The Company will develop greenbelt in the villages by planting minimum 5,000 saplings and where required tree guards will also be provided.	Annually Recurring
8	**Sri B.Suri Babu, Resident of Chirrayanam – Gachikayalapuram MPTC**			
8 a)	He expressed his concerns that due to activities of ONGC, Cairn Energy, GSPC and Reliance sea fish productivity was decreased.	The Company has been carrying out its operations for past 25 years and all operations comply with the environmental regulatory requirements. The Company has given a contract to Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to carry out Marine Ecological Study annually to monitor any adverse impact caused due to the operation of the Company in PKGM-1 Block. The study has revealed no adverse impact on fish species has been observed in the block area.	The study to Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC.	Annually Recurring
8 b)	He and on behalf of his village opposed the proposed oil & gas	The recently conducted study in 2018 by Marine Biological Laboratory, Department of Zoology,	The study to Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will	Annually Recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	exploration activity. Earlier, they protest against the activities of oil & gas exploration due to which sea fish productivity decreased and the oil companies promised compensation for two years to each fisherman family, but, compensation was given for only 6 months to few people only.	Andhra University, Vishakhapatnam showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. Thus, there is no evidence of reduction of fish in the block area. The Company has given a contract to Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to carry out Marine Ecological Study annually to monitor any adverse impact caused due to the operation of the Company in PKGM-1 Block. The study has revealed no adverse impact on fish species has been observed in the block area.	continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC.	
8 c)	Expressed his concerns that they would allow the processing of public hearing only after obtaining concrete proposal from the project authorities.	The company has been carrying out its operations duly complying with all the pollution norms such as APPCB and MoEF&CC.	The Company has entered a MoU on 25 October 2018 with the State Government of Andhra Pradesh through Joint Collector East Godavari District on commitment of various community initiatives and programs with time line and budget.	Annually recurring
8 d)	Alleged that the Government has not been taken care about the endangering of fisherman community in the area and the Government has not showing the interest like protecting wild life to the fisherman community.	The Company has been carrying out its operations for past 25 years and all operations comply with the environmental regulatory requirements. No adverse impacts have been caused to the livelihood of the fishing community.	The Company will work together with the Wildlife Institute and District Forest Office for protecting endangered species in the Coringa Wildlife Sanctuary, East Godavari District. A budget of INR 70 Lakhs for three years period from FY19 to 21 has been earmarked.	For three FYs starting from 2019 - 22
8 e)	Suggested that the project authorities shall provide boats & nets to the local fisherman community.	In the past 25 years, the livelihood opportunities have improved through infrastructure development, increased employment and overall socio-economic development of the area.	The Company will also consult Fisheries Department, East Godavari District, Kakinada to engage with fishing community in the area to improve their livelihood and also seek support in providing technology and fishing equipment.	Annually recurring
8 f)	Drinking water infrastructure facilities shall also be provided to their fisherman society. 100 Nos. of additional solar lights shall be provided, as they have facing poor	Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up to provide clean and safe drinking water to ~ 6,000 people.	The Company agrees to provide the following additional support: Setting up of an additional RO Plant in Chirrayanam Providing 50 nos. of Solar lights at S Yanam, Chirrayanam and Gatchakayalapuram	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	visibility of roads particularly during the cyclones. Hospital facility shall also be provided each at Chirrayanam and Gatchakayalapuram panchayaths and shall provide efficient doctors		The review of existing medical facility available in Chirrayanam and Gatchakayalapuram Panchayats and plan for support as part CSR-CER initiatives and programs in the coming years.	
8 g)	Similarly, Reliance Industries, arrangements for corporate education to every 10th passed students of this area shall be provided. Employment opportunities to the un-employed youth shall be provided.	The Company will continue to support education through its CSR activities.	The Company will continue to take up CSR –CER activities as described in serial no. A1 a) above for improving education and job opportunities.	Annually recurring
8 h)	He also requested for employment to their youth at ONGC, S.Yanam. An amount of Rs.15,000/- shall be given as additional matching grant in addition to the Government's Rs.15,000/- grant for construction of toilets. Similarly by the Reliance Industries Limited, an amount of Rs.1.0 Lakh financial support shall be given to all the fisherman community brides in this area by the project authorities. Financial assistance for daily commodities shall also be given by the project authorities to fisherman community during the declaration of cyclone emergency by the Government. Preference should be given to locals for employment while drilling wells.	The Company has been implementing CSR activities since beginning of its operations. As on March 2019, the Company has deposited INR 33.64 Crores with the district administration.	The Company has entered a MoU on 25 October 2018 with the State Government of Andhra Pradesh through Joint Collector East Godavari District on commitment of various community initiatives and programs with time line and budget. The Company will continue to spend on community initiatives/activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages.	Annually recurring
8 i)	He also requested that an amount of Rs.1.0 Lakh shall be given by the project authorities as additional matching grant in addition to the			

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
	Government's Rs.2.0 Lakh for construction of houses for poor.			
8 j)	He also requested that the project authorities shall give compensation of Rs.5,000/- per month each fisherman family during the ban of fish catch from April to May every year by the Government. He also requested that project authorities shall give compensation of Rs.2.0 Lakhs to fisherman family, if loose their life due to any accident.	Not relevant to Vedanta Limited (Cairn Oil and Gas), as the operating block is in no fishing or less fishing zone.	NA	NA
8 k)	He also requested the project authorities that CSR funds of minimum Rs.1.0 Crore shall be allocated every year to Chirrayanam and Katrenikona Villages, until completion of the proposed project.	The Company has been complying with the requirement as mentioned in the Companies Act, 2013 towards spent on CSR activities.	The Company will continue to take up CSR and CER activities as described in serial no. A1 a) above.	Annually Recurring
9	**Sri Jogi Arjuna Rao, Resident of S.Yanam, Ex. MPP, Uppalaguptam**			
9 a)	He informed that the canals which were damaged by ONGC earlier shall be repaired by the present management. He also informed that the people in the S.Yanam village are very poor and they lost a lot of employment opportunities.	Not relevant for Vedanta Limited (Cairn Oil & Gas)	NA	NA
9 b)	He expressed his concerns that the Vedanta Limited has been releasing gas during the night time, due to which they have been facing heart problems. They have also been facing lot of health problems due to the nearby plant.	There is no cold vent release of natural gas from Ravva operations. All emergency releases of natural gas are routed through flare. The company has been carrying out its operations duly complying with all the pollution norms such as APPCB and MoEF&CC. The Company has been operating Cairn JV Charity Clinic for last 25 years. No such health issues have been reported due to Ravva operations.	The Company will continue to operate the Cairn JV Charity Clinic through tie up with Apollo Hospitals, Kakinada to provide health related services to the nearby communities. The Company will initiate a comprehensive secondary data study to understand community health issues, and decide suitable mitigation measures as applicable.	Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
9 c)	He also informed that they have not even getting sufficient drinking water. The canal bund which was damaged by the ONGC authorities shall also be repaired by the present management. The present management has been carrying its operations for the past 20 – 25 years and about 90% of the people in the S.Yanam village are poor and the management has not taken any concrete proposals for development of the village. Rs.50,000/- shall be given by the project authorities to each poor families for construction of houses.	Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up to provide clean and safe drinking water to ~ 6,000 people. The Company has been implementing CSR activities since beginning of its operations. As on March 2019, the Company has deposited INR 33.64 Crores with the district administration. The Company is depositing INR 6.00 Crores annually to the State Government of Andhra Pradesh annually for community development works/projects. This fund will be utilized by the district administration for improving livelihood of the people. The amount to be spent and need of each program is being decided upon by the district administration based on the needs of the local community. The district administration will duly consider about repair of the canal bund and may accordingly take up the work.	The Company has entered a MoU on 25 October 2018 with the State Government of Andhra Pradesh through Joint Collector East Godavari District on commitment of various community initiatives and programs with time line and budget. The Company will continue to spend on community initiatives/activities in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages. The Company will follow up with the district administration on the canal bund issue.	Annually recurring
9 d)	He also requested that employment to the local people in any form shall be given.	Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh.	The Company will continue to engage with local communities and comply with the requirements specified in the AP Employment of Local Candidates in Industries and Factories, Bill 2019 that mandates requirement of at least 75% of the state candidates in the respective units.	During the Project life cycle
10	**A Woman, Resident of S.Yanam**			
10 a)	She expressed her concerns that the project authorities have not been implementing any development activity for the poor in the village. She also informed that they would not allow the proposed project until implementing any developmental activity to them.	The Company has been complying with the requirement as mentioned in the Companies Act, 2013 towards spent on CSR activities.	The Company will continue to take up CSR and CER activities as described in serial no. A1 a) above.	Annually Recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
11	**Smt. Satyavathi, Resident of S.Yanam**			
11 a)	While welcoming the project she requested the project authorities that developmental activities such as education to their children, and other facilities shall be provided. No employment opportunities given to them till date.	The Company has been complying with the requirement as mentioned in the Companies Act, 2013 towards spent on CSR activities.	The Company will continue to take up CSR and CER activities as described in serial no. A1 a) above.	Annually Recurring
11 b)	She also informed that they do not have even drinking water facilities. In spite of the promises made by the project authorities, they have not taking up any development activities.	Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up to provide clean and safe drinking water to ~ 6,000 people.	The Company will set up an additional (third) RO Plant in Cherriyanam Village.	June 2020
12	**Sri R.Tirupathi Rao, Resident of S.Yanam**			
12 a)	Informed that it is the responsibility of industries for development of local area as per re-habilitation and re-settlement act. But, the management has not taken any steps for development of local area, even though it has been operating for the past 30 years, citing the example that the management has not even supplying drinking water to the villages till today. He also demanded for release of white paper on the funds released for S.Yanam Village development year wise for the past 30 years, as people of this village have lot of doubts in this regard. He also alleged that due to drilling of deep wells in this area, the entire agriculture land contaminated with salt water intrusion, thereby people of this area lost their livelihood.	The proposed onshore well pad locations only small parcel of land, thus there is no resettlement and rehabilitation involved. The Company has been complying with the requirement as mentioned in the Companies Act, 2013 towards spent on CSR activities. The Company has been implementing CSR activities since beginning of its operations. As on March 2019, the Company has deposited INR 33.64 Crores with the district administration. As the Company's CSR funds are being spent by the district administration, the expense records may be obtained by the complainant directly from the district administration officer. A study was carried out by IIT (BHU) regarding land subsidence due to oil & gas exploration and it was reported that no land subsidence occurring due to oil & gas exploration. The Company carries out aquifer monitoring through dedicated monitoring wells located within Ravva Terminal and Piezo wells outside	The Company will continue to take up CSR and CER activities as described in serial no. A1 a) above. The Company is ensuring continuous monitoring of land subsidence through installation of high precision geodetic grade GPS system to understand any adverse impact caused due to extraction of hydrocarbon resources from the reservoir. The data collected from this equipment will be processed and findings will be submitted to MoEFCC as part of six monthly compliance reporting.	Annually Recurring Annually recurring

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
		the Ravva Terminal to monitor the water quality and levels. There is no change in the baseline data. The compliance reports are being periodically submitted to APWALTA, Government of Andhra Pradesh.		
12 b)	Expressed his concerns that due to release of oily water into sea by the industry, fish productivity completely decreased in the area, thereby fisherman community lost their livelihood. The company management has not provided employment except giving lower grade employment.	The treated effluent from ETP at Ravva Terminal is discharged at marine outfall complying with the APPCB and MoEFCC discharge norms. The recently conducted study in 2018 by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. Thus, there is no evidence of reduction of fish in the block area. Of the total 500 employees working at Ravva Terminal, 430 employees (i.e. more than 85%) including 414 employed from S Yanam & surrounding villages and 16 from other areas of Andhra Pradesh. The employment provided is based on skill set requirements.	The Company will continue to carry out environmental monitoring through reputed third party agency. The Company will also continue to conduct internal and external environmental audits to ensure the Ravva Terminal operations comply with the environmental regulatory requirements. The study by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEFCC. The Company will continue to engage with local communities and comply with the requirements specified in the AP Employment of Local Candidates in Industries and Factories, Bill 2019 that mandates requirement of at least 75% of the state candidates in the respective units.	Annually recurring Annually recurring During the Project life cycle
12 c)	Alleged that the PHC constructed by the project authorities handed over to Government instead of maintaining the same.	The PHC was handed over to the Government as per the requirement of local administration. The Company does not have technical capability to operate PHC. The Company has provided medical equipment, setting up of operation theatre, related infrastructure, ambulance and medicines in the Public Health Centre at S. Yanam at a cost of INR 20 lakhs.	The Company plans to support additional infrastructure, salary of additional support staff etc. to improve medical services of the existing Public Health Centre at S. Yanam.	One time – December 2020

SN	Public Hearing Representation - Issue Raised	Vedanta Limited (Cairn Oil & Gas)'s Response to the Representation	Action Plan	Target Date
12 d)	Informed that only 14 nos. of teachers appointed and demanded for education facilities to all the villages to be provided by the project authorities from KG to PG. He suggested that the Government authorities and project authorities shall consider the issues raised by the general public and then only start the expansion proposal. Similar type of public hearing presided by the Joint Collector earlier, but, no action taken against the industry on the issues raised by the public.	The Company has been implementing CSR activities since beginning of its operations. As on March 2019, the Company has deposited INR 33.64 Crores with the district administration. The Company has been supporting the Government schools and Anganwadis towards improving the educational standards by supporting additional teachers, establishment of libraries, providing bus passes for the students, providing scholarships to the meritorious students etc.	The Company has entered a MoU on 25 October 2018 with the State Government of Andhra Pradesh through Joint Collector East Godavari District on commitment of various community initiatives and programs with time line and budget. The Company will continue to spend on community initiatives/activities including education for students in the surrounding villages in consultation with the district administration as part of CSR and CER activities in and around the surrounding villages.	Annually recurring
12 e)	The people in S.Yanam village could not even get drinking water till date, though the ONGC operating unit for the past 30years.	Through CSR initiatives, two Reverse Osmosis (RO) plants have already been set up by the Company to provide clean and safe drinking water to ~ 6,000 people.	The Company will set up an additional (third) RO Plant in Cherriyanam Village.	June 2020
12 f)	They could not even breathe fresh air, due to air, water pollution from the plant and every family in the village has been suffering with different type of diseases. The plant has not been taking any steps for control of pollution and the concerned authorities have not taken any action.	The Company has been carrying out its operations for past 25 years and all operations comply with the environmental regulatory requirements. No health issues have been reported due to Ravva operations.	The Company will ensure that all the pollution control measures for developmental and operation phases will be in place as per the EMP, the environmental norms and conditions of APPCB and MoEFCC. The Company will initiate a comprehensive secondary data study to understand community health issues, and decide suitable mitigation measures as applicable.	During the Project life cycle

Table 9.4 Action Plan on Conditions Imposed by APCZMA in NOC dated 3 April 2019

S.N.	Ameliorative and Restorative Measures Recommended by APCZMA	Compliance
1.	The proposed constructions shall conform to the norms prescribed in CRZ Notification S. O. No.19 (E), dated 06-01-2011 issued by the Ministry of Environment and Forests, Government of India.	The proposed construction activity will conform the prescribed norms of CRZ Notification S. O. No.19 (E), dated 06-01-2011 issued by the Ministry of Environment and Forests, Government of India. As per the requirement, CRZ maps were prepared by MoEFCC approved agency National Centre for Sustainable Coastal Management, Chennai. Appraisal of the Project was held by APCZMA following which NOC was issued on 07 April 2019.
2.	No activity on ground shall be undertaken without obtaining Environmental Clearance from the Ministry of Environment and Forests, Government of India.	All activities on ground will commence after obtaining Environmental Clearance from Ministry of Environment and Forests, Government of India.
3.	Regular monitoring of sea water of the sea shall be taken up to study the impact on marine organism.	Vedanta Limited (Cairn Oil & Gas Division) has engaged the Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to annually carry out Marine Ecological Study to monitor any adverse impact caused due to its developmental and operation activities in the PKGM-1 Block. The outcome of the marine monitoring study of 2018 has confirmed no adverse impact caused due to existing operations in PKGM-1 Block. The results of seawater and sediment samples at all the stations of the Company operational areas are very low and far below the standards prescribed by ATSDR (Agency for Toxic Substances and Disease Registry 1999) indicating no oil pollution or toxicity. The study also showed encountering of 13 taxa of finfish from the offshore block area. Among the 13 taxa, Stolephorus sp. (Anchovy) and Opisthopterus sp. dominated in very large numbers. The study report will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEF&CC.
4.	The monitoring of hydrocarbons & other relevant parameters shall be entrusted to an independent agency like Andhra University and any other accredited institutions in addition to in-house monitoring.	
5.	Marker buoy and light indicators shall be established close to the route of the pipeline to avoid fishing net damage.	All the existing and proposed pipelines are laid below the seabed, thus there is no exposure of any pipeline above the seabed. Marker buoys and light indicators are not applicable for any offshore route of pipeline, hence there will no damage to fishing nets.
6.	The nearby coastal waters are known to support rich and diverse biotic communities where some of the best fishing grounds for the east coast exist.	Vedanta Limited (Cairn Oil & Gas Division) will ensure that its existing and proposed activities do not cause impact on biotic communities and fishing grounds are well maintained. The Company has engaged the Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to annually carry out Marine Ecological Study to monitor any adverse impact caused due to its developmental and operation activities in the PKGM-1 Block. The study report will continue to be carried out annually and outcome of the study will be submitted as part of six monthly compliance reporting to MoEF&CC.
7.	The industry shall undertake post-project monitoring of estuarine and coastal waters and the	In normal operations no adverse impact is caused.

	industry is advised to follow internationally acceptable protocols while dealing with marine biological aspects.	During offshore drilling a well, drill cuttings and drilling fluids are discharged complying with the requirements of the GSR 546 (E) of Environment (Protection) Rules, 1986. Environmental and biological aspects monitoring will be carried out a) prior to start of drilling; b) during drilling; and c) post drilling. All the monitoring reports will be submitted to MoEFCC as part of six monthly compliance reporting. In addition to the environmental and biological aspects monitoring during drilling, there will also be annual marine study of the PKGM-1 Block area by Andhra University. During offshore drilling activities, best practices will be followed for environmental controls. Discharges from the rig and vessels engaged will follow the Indian and international (e.g. MARPOL) Standards.
8.	The industry shall follow international codes and standards for laying the submarine pipelines.	Vedanta Limited continues to follow submarine pipeline system for acceptance criterial and procedures for pipeline design, fabrication and installation as per DNV-GL-ST-F101. This Standard applies modern limit-state-design principles with "Safety Classes" linked to Consequences of Failure.
9.	All safety measures shall be incorporated to avoid any possible accidents due to structural failures and adequate safety measures shall be provided to prevent blow outs of Natural Gas / Hydrocarbons.	All necessary safety measures such as corrosion control, physical damage and instrumentation controls are incorporated during the initial design life and operation phase of the installations. In addition, periodic monitoring are carried out such as corrosion study, free span survey of pipelines, physical inspection of structures by engaging divers, artificial intelligent pipeline pigging etc. Vedanta Limited will continue to evaluate through competent agencies once in five years the complete risk of operating the pipelines and other structures beyond its design life and submit "fitness-for-service certificate" to OISD specifying the allowable future operations period and conditions implying safe operations. The safe practices for work over operations, well stimulation operations, and blow out prevention equipment systems for drilling wells are carried out in accordance with requirement of Oil Industry Safety Directorate Guidelines i.e. OISD-GDN-182 and Oil Industry Safety Directorate recommended practices OISD-RP-174.
10.	There shall not be any obstruction to fishing activity beyond 500m exclusive drilling zone.	Vedanta Limited (Cairn Oil & Gas) shall ensure that their activities do not cause any obstruction to fishing practices beyond 500m of exclusive drilling zone.
11.	Fish tissue analysis of local fish species shall be conducted to evaluate the bio-accumulation of hydrocarbons and heavy metals.	Fish tissues analysis of local fish species to evaluate the bio-accumulation of hydrocarbons and heavy metals are being carried out annually by Marine Biological Laboratory, Department of Zoology, Andhra University, Vishakhapatnam to monitor any adverse impact caused due to its developmental and operation activities in the PKGM-1 Block.
12.	Bio-assay analysis shall be conducted periodically to establish the toxicity levels.	Vedanta Limited (Cairn Oil and Gas) shall be carried out periodically to establish the toxicity levels for marine discharges.
13.	The guidelines issued by the CPCB for extraction of oil and gas shall be followed. The drill cuttings and drilling fluids for offshore installations should confine to the guidelines issued by CPCB.	Vedanta Limited (Cairn Oil and Gas) will continue to follow "Guidelines for disposal of solid wastes, drill cuttings and drilling fluids for offshore and onshore drilling operation" as notified under the Environment (Protection) Rules, 1986. The environmental monitoring will be carried out prior to, during and post drilling of a well.
14.	The industry shall extend necessary assistance to the Forest and Wildlife Department towards	Vedanta Limited (Cairn Oil and Gas) has agreed to support the Wildlife Institute of India and District Forest Office for protecting endangered species in the Coringa Wildlife Sanctuary, East Godavari

	conservation and preservation of Coringa Wildlife Sanctuary, which is an Ecologically Sensitive Area.	District. A Project titled "Ecological and Conservation for Perspectives of Fishing Cat (*Prionailurus viverrinus*)" is being carried out for three FYs starting from 2019-22 with grant of INR 74.03 Lakhs.
15.	Full cooperation shall be extended to all inspecting authorities/ organizations such as APPCB, MoEF&CC, CPCB and local Environment Protection Organizations.	Vedanta Limited (Cairn Oil and Gas) shall extend full cooperation as required to all inspecting authorities/ organizations such as APPCB, MoEF&CC, CPCB and local Environment Protection Organizations.

Source: Vedanta Ltd (Cairn Oil & Gas)

Actions on CER

Ravva JV commits to contribute in total INR 20.0 (Rupees Twenty Crores) towards implementing CER projects, over ten years (considering the project period). This amount will be used for the CER initiatives/projects in consultation with the District Collector, East Godavari District, Andhra Pradesh towards implementing the community development works as proposed during the public hearing held on 11th October 2018 at Surasaniyanam Village, East Godavari District, Andhra Pradesh. The CER fund will be utilized towards implementing the following programs/initiatives.

Table 9.5 Action Items on Corporate Environment Responsibility (CER) Fund of INR 20 Crores to be spent over next 10 years

S.N.	Heading	Description
a	Drinking water	Setting up of community drinking water system for S. Yanam village.
b.	Infrastructure	Construction of roads, bridges/culverts, canal, stormwater & backwater drains, developing the parks with walking tracks, installation of the solar lights etc
c.	Tourism	Promotion of the beach front tourism in the surrounding villages.
d.	Health	Supporting district medical department for expansion and effective operation and maintenance of public health center.
e.	Solid waste and Sanitation	Provision of Supporting the "Swatch Bharat" initiative for the effective waste management.
f.	Education	Supporting the Government schools and Anganwadi's towards improving the educational standards, establishment of libraries, providing scholarships to the meritorious students etc.
g.	Sports:	Supporting physical education in schools and youth such as providing sports kits, creating play area etc.
h.	Skill development of the youth	By developing training and competitive exam coaching centers in the villages and organizing skill development training programs.
i.	Natural Resource Management (NRM)	Development of NRM related projects in the villages through plantation of the native species for increasing the green cover, providing fruit bearing saplings to the local villagers etc.
j.	Fisheries and aqua culture development:	Development schemes for fishermen and aqua culture farmers including assistance for their livelihood development will be carried out in consultation with the Department of Fisheries, Andhra Pradesh, Central Marine Fisheries Research Institute etc.
k.	Need based assessment study	Carry out a need based (social) assessment study in the S.Yanam and the surrounding villages through Smart Andhra Pradesh Foundation or through any reputed institutions. The outcome of the study will be discussed with the district administration and financial support will be based on the study outcome related program

10 SUMMARY AND CONCLUSION

10.1 PROJECT DESCRIPTION

The proposed expansion of oil and gas exploration, development and production has been planned in the existing Ravva field (PKGM-1 Block) to enhance production, which has declined over the years due to ageing of the field. No additional platform or facility has been planned in the onshore region. The proposed oil and gas development will result in maintaining production well within already approved capacity of APPCB and MoEFCC i.e. 50,000 BOPD of crude oil and 2.32 MMSCMD of natural gas. Vedanta Ltd (Cairn Oil & Gas) has identified contingent hydrocarbon resources available within Ravva Field and has therefore proposed the onshore and offshore oil and gas development.

In order to maintain hydrocarbon production at already approved production capacities, Vedanta Ltd (Cairn Oil & Gas) now proposes the following:

1) Drilling of a total of 123 exploratory and development wells covering 83 nos. exploratory wells and 40 nos. development (production) wells. Of the 83 exploratory wells, 59 are proposed to be drilled from standalone offshore locations, 14 nos. from existing offshore platforms and 10 nos. from onshore well pads to assess presence of hydrocarbons in prospects identified. Of the 40 development (production) wells, 17 will be drilled from the existing offshore platforms and 23 nos. from onshore well pads]
2) Establishing of 2 nos. of onshore well pads (as against 8 onshore well pads proposed during ToR stage) located within the PKGM-1 Block#; and
3) Laying of ~8 km of pipeline corridor (for three pipelines) connecting onshore well pads with the existing onshore oil & gas processing Ravva Terminal.

 # Note: Vedanta Ltd (Cairn Oil & Gas) has dropped drilling of wells from five onshore well pads (wellpads #1 to 5) that were located outside the PKGM-1 Block from the Project proposal, and no well will be drilled from such locations. Wellpad #6 will also not be developed to minimise environmental impacts.

10.2 DESCRIPTION OF THE ENVIRONMENT

The baseline information obtained by primary monitoring/survey and review of secondary information has been summarized below:

Table 10.1 Summary of Baseline Environment in the Study Area

Project setting	PKGM-1 Block lies mostly in offshore and partly onshore region of Central Godavari Delta between eastern branch of Gautami and western branch of Vasishta of the Godavari River
Climatic conditions	Climate of the region is tropical, maritime and seasonal
Ambient air quality	Studied at 8 locations within the study area during Jan to Mar 2018. AAQ was observed to be well within National AAQ Standards
Noise	Noise monitored at 8 locations during Jan to Mar 2018. Noise levels were observed to be within the prescribed norms.
Soil quality	Studied at 6 locations; soil texture varied from clayey to sandy loam and sandy; soil quality was typically representative of rural coastal areas; no enrichment of heavy metals in soil.

Groundwater quality	Studied at 4 locations. Two of the groundwater samples showed high TDS and alkalinity, therefore are not fit for consumption without treatment. None of the groundwater samples showed presence of any metallic or biological contaminants
Surface water quality	Studied at 4 locations. The surface water from the canals, creeks and backwater areas is used for washing and catching fish. The surface water quality revealed that the water conforms to CPCB Water Quality Criteria of Class "B "(Outdoor Bathing Organized) and Class "D" (propagation of wildlife and fisheries).
Marine water and sediment quality	Marine water quality was studied at 8 locations at 3 water depths (surface, middle & bottom) while bottom sediments were studied from 8 locations. All the monitored parameters were observed in the acceptable range for marine environment.
Marine ecology	▪ 15 genera of phytoplankton, 6 genera of zooplankton identified in the study area. Benthic community represented by meiobenthos and macrobenthos communities ▪ 11 species of cartilaginous fish and 37 species of bony fish enumerated from the study area. ▪ Olive Ridley's Turtles (*Lepidochelys olivacea*) nesting is known to occur mainly in Sacramento Shoal and beyond 10 km from nearest well site; sporadic nesting reported along the coast in the study area.
Terrestrial ecology	▪ No National Park or Wildlife Sanctuary is located within 10 km from PKGM-1 Block. Reserve Forest patches are found in the study area; Coringa Wildlife Sanctuary (WLS) is located at 18 km from the PKGM-1 Block. ▪ Major habitats in study area include Beach habitat, Shelter belt plantation, Vegetation in back waters/lagoons ▪ Tree diversity generally is low in coastal areas, along aquaculture ponds and in agricultural fields. Moderate diversity of shrubs and high diversity of herbs in agricultural areas observed ▪ Faunal groups in the study area represented by 3 species of amphibians; 14 species of reptiles; 96 species of birds and 23 species of mammals ▪ Schedule I species in the study area represented by Olive Ridley Turtle, Indian flap shell turtle, Monitor lizard, Osprey (Pandion haliaetus i.e. Gadda in Telugu), Fishing cat, Smooth coated otter and Indian Pangolin.
Socioeconomics	**Demography**: (within the Study Area as per 2011 census) include population of: ▪ Within 2 km : 5,614 (2 villages) ▪ Within 2 to 10 km: 181,764 (32 villages) **Literacy**: ▪ Study area villages have an average literacy of 63.42% and female literacy of 58.98%. **Occupation**: ▪ Agriculture – mostly paddy cultivation engaging 70% of active work force ▪ Fishing – both culture and capture. ▪ Non-farm activities (i.e. working as labour) **Education** ▪ All villages within 5 km radius from Ravva terminal have access to middle schools. Two villages have high schools **Health infrastructure –** All Mandalas have operational public health centres (PHCs) with district hospital in Rajahmundry **Amenities** ▪ Electricity supply is there across all villages ▪ Postal, telecom and banking services are well established in the region

10.3 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The EIA study has been undertaken to assess the potential significant adverse environmental impacts due to the proposed expansion activities. Mitigation measures have been proposed as part of EMP to minimize adverse environmental impacts, if any.

Table 10.2 Summary of Anticipated Environmental Impacts and Mitigation Measures

Source	Impact	Mitigation Measures
Underwater noise from support vessels, rotation of rig drilling bit	▪ Unlikely impact to marine mammals ▪ All activities are short term temporary in nature, hence there will be natural restoration ▪ Marine fauna tend to move away from the noise source	▪ Avoid sudden loud noises ▪ Maintain the vessel and all noise generating equipment in good working order
Noise from helicopter, vessels	▪ Noise mainly during take-off and landing ▪ Vessels movement in mainly in shallow water - unlikely impact to marine mammals	▪ Helicopters to maintain a minimum in-transit flying altitude. ▪ Adhere to flight paths and not hover over any marine fauna or areas with birds ▪ Vessels to maintain a distance of 350 m from any cetacean if sighted ▪ No hunting or fishing by Cairn permitted
Noise generated during: ▪ Operation of machineries, equipment, DG sets; ▪ Vehicular traffic;	▪ Increase in ambient noise levels	▪ Equipment involved in site development and drilling activity will be provided with noise control measures; ▪ Regular maintenance of equipment ▪ DG/ GG sets would be provided with acoustic enclosures; ▪ Appropriate PPEs to be used by workers
Disposal of treated drill cuttings, residual water based drilling mud Other solid wastes e.g. packaging waste, food waste	▪ Increased localised turbidity in water column ▪ Change in sediment particle size distribution ▪ Smothering of seabed invertebrates ▪ Insignificant impacts on marine environment from other wastes as these will be collected, segregated and disposed onshore ▪ Insignificant impact on soil and ground/ surface water environment as all wastes generated from onshore activities will be collected, segregated and disposed	▪ Compliance to MoEF&CC Guidelines for Disposal of Drill Cuttings and Drilling Fluid for onshore & offshore oil & gas exploration and production ▪ Only WBM/ SBM with low toxicity drilling mud to be used ▪ Unused SBM will be collected for reuse in next drilling ▪ All other wastes e.g. packaging will be disposed off at port facility. ▪ Food waste will be macerated < 25 mm before discharge to sea.
Liquid discharges (from rig, vessels) to marine environment	▪ Insignificant impact to marine environment with mitigations in place	▪ All discharges to offshore will be treated as per Indian discharge requirements and also international standards (MARPOL) ▪ Wash water and deck drainage will be directed to bilge tanks and will be discharged only after treatment in oil-water separator ▪ On-board STP will treat all sanitary wastewater.
Air emission during onshore well pad site development and strengthening of approach road ▪ Construction machinery operation;	▪ Fugitive dust emission and diesel combustion gases to degrade ambient air quality - potential impacts on humans and other biological receptors;	▪ Minimise movement of construction vehicles and enforce speed limit ▪ Regular water sprinkling at the site during dry season; ▪ Maintain the stockpile against the wall or obstruction so to work as a windbreaker and covering of the stockpiles with tarpaulin sheets;

Source	Impact	Mitigation Measures
▪ Transportation, storage, handling of construction material, waste; ▪ Operation of DG sets;	▪ Impacts are expected to be localised and over a short period.	▪ Periodical maintenance of diesel-generators & equipment engaged
Air Emissions during well drilling ▪ Diesel generators on-board vessels ▪ Test flaring Fugitive air emissions from unloading of materials	▪ Potential impacts on humans and other biological receptors are low due to large distance from offshore ▪ Dispersion modelling shows resultant PM_{10}, NOx, SO_2 and CO values within NAAQS	▪ Periodical preventive maintenance of diesel generators for efficient combustion ▪ No cold venting during well testing ▪ Fugitive emissions reduction by appropriate storage and handling
Air emission during operation: ▪ Transportation, storage, handling of hydrocarbon, waste; ▪ Operation of DG sets; ▪ Flaring in emergency situation.	▪ Fugitive emission and emission of gasses with potential to degrade the ambient air quality; ▪ Impacts are expected to be localised and over a short period.	▪ Minimise movement of vehicles and enforce speed limit; ▪ Regular maintenance of diesel-generators and equipment; ▪ Use of low sulphur diesel oil ▪ No cold venting to be resorted ▪ Flaring through elevated height (30m) only in emergency situation
Air Emissions from Ravva Terminal – processing and power generation	▪ No additional process equipment or power generation proposed - no additional impact	▪ Existing mitigation measures will be continued for prevention and control of air emissions within the prescribed limits.
Impacts on surface water due to: ▪ Surface runoff from construction sites, well pad sites; ▪ Generation and disposal of domestic waste water from construction, well pad sites; ▪ Hydro test water during pipeline testing; ▪ Accidental discharge from waste pit	▪ Increased sediment content of surface water; ▪ Potential contamination of surface water.	▪ Construction activities during monsoon season to be restricted to the extent possible; ▪ Surface runoff from the construction site to be channelized through storm water drainage system along with double chambered silt and oil & grease trap; ▪ Hydro test water to be taken to the ETP at Ravva Terminal for treatment; ▪ All chemical and fuel storage areas, process areas to be provided with bunds; ▪ Mobile STP to be provided at well pad site camps for treatment at Ravva Terminal
Sourcing of water from Cairn's existing bore wells at Ravva Terminal	▪ Impact on groundwater resources due to usage of water for proposed activities	▪ Water for mud preparation will be effectively utilised at well pad sites.
Hazardous wastes generated from the well pad sites and Ravva Terminal i.e. waste oil, ETP sludge, tank bottom sludge, oil filters, oil soaked rags and other drilling wastes	▪ Potential land and water contamination	▪ Waste management plan for storage, transport and disposal as per the HW Rules and authorization conditions ▪ HDPE lined pits will be provided for storage of drill cuttings, spent mud, drilling waste water, formation water, etc. ▪ After completion of the drilling activity, all drilling wastes will be disposed off to nearby CHWTSDF
Impacts on Community Health and Safety due to: ▪ Road transportation ▪ Influx of construction workers; ▪ Potential exposure to spills, fires ▪ Exposure to air and noise pollution	▪ No significant disturbance to community health & safety	▪ Water sprinkling at access roads and construction sites to reduce dust emission; ▪ Restriction on blow of horns near settlements; ▪ Minimal movement of vehicles in night time; ▪ Introduce traffic restriction along the traffic hotspots; ▪ Place traffic regulatory signage along the site access and approach roads; ▪ Grievance re-dressal process will be in place; ▪ Emergency preparedness and response plan in place

Source	Impact	Mitigation Measures
Impacts on Landuse due to: ▪ Long term lease/ procurement of land for onshore well pads and site approach road;	▪ Conversion of back-water, aquaculture fields into industrial land use	▪ Immediate restoration of acquired land for pipeline to its best achievable original state after completion of the buried pipeline laying activity ▪ Removal of all wastes from area surrounding onshore well pad sites and site approach road and pipeline corridor
Impacts on Ecology due to ▪ Construction of well pads, approach road, ▪ Laying of pipeline ▪ Man and material movement to the well pad locations	▪ Habitat loss and disturbance	▪ Activities during early morning and evening which is the duration of peak bird activity should be avoided ▪ Night activities to be avoided to the extent possible, if the same is unavoidable then low lights and illumination should be used; ▪ Construction activities should be limited to area within the well pad; ▪ Any areas for storage of construction material should be left scrap free post construction phase;
Risks due operations in PKGM-1 Block	▪ Accidents resulting in impact on surrounding communities and environmental media. ▪ Oil spills impacting environmental media and marine communities.	▪ Risk Assessments for activities have been undertaken as part of the EIA; provision of preventive and mitigation control measures.

10.4 ENVIRONMENTAL MONITORING PROGRAMME

Cairn will also ensure that the environmental performances of all the activities are monitored throughout execution of various Project components. Monitoring will include aspects and activities, such as emissions, quantities of different wastes generated, characteristic of un-treated and treated effluent; environmental quality (air, noise, surface and ground water, marine water and ecology, etc.) and verified that they meet the prescribed standards. Hazard and consequence monitoring will also be included to cover health and safety related aspects, incidents of accidental spills and effective health and safety management before, during and post drilling of wells. Cairn will continue to report environmental performance and submit monitoring reports regularly to statutory authorities.

10.5 ADDITIONAL STUDIES

Risk Assessments for activities have been undertaken as part of the EIA. Oil spill risks have been evaluate and appropriate preventive and mitigation measures have been designed. Compliance to applicable statutory requirements and guidelines will be ensured. The Ravva Field Emergency Response Plan (RFERP) has been specifically developed by Cairn for Ravva operations. The Oil Spill Contingency Plan is also in place to deal with any accidental oil spillage. Prior provisions of shore protection boom, sorbent booms, sorbent pads and other necessary equipment ready for drilling activities at onshore well pads will be ensured. Cairn is also a member of OSRL, Singapore for necessary support in the event of an oil spill. Cairn will ensure availability of adequate infrastructural facilities near the offshore installations so that booms, skimmer and chemical dispersants that could be deployed immediately in case of oil leakage from the rig.

10.6 PROJECT BENEFITS

The benefits due to the existing operations and proposed expansion project is as follows:

- Majority of the infrastructure for processing of production/well fluid are already available through the operating Ravva Terminal. Therefore, only onshore well pads and the connecting pipelines are proposed to harness the hydrocarbon potential of the block. The increase in production of oil and gas within the already approved capacity will add to the energy independence of the nation and will reduce the import bills
- Implementation of CER and CSR program encompasses various initiatives undertaken by a corporate entity in its business catchment in order to obtain a social license for operating in the area. These programs are aimed at developing the area as well as improve living standards of the stakeholders.
- Direct and indirect employment and business opportunity during drilling and operational phase

10.7 ENVIRONMENTAL MANAGEMENT PLAN

An Environmental Management Plan (EMP) has been developed based on established requirements of an environmental management system covering Planning, Implementation, Checking and Review phase to overall ensure continual improvement. The EMP defines Vedanta Ltd (Cairn Oil & Gas)'s EHS Policy, EHS Management System (EHSMS), and relevant applicable Indian environmental regulatory and MARPOL requirements. The EMP summarises potential impacts associated with the proposed oil and gas development in the onshore and offshore region of Ravva Field and clearly set out the corresponding control/mitigating measures that need to be implemented. The EMP also set out the organization structure and the environmental monitoring programme for key environmental parameters to be monitored in respect of environmental performance and management review process.

Action Plan on issues raised during Public Hearing and Action Plan on conditions imposed by APCZMA have also been integrated in the EMP.

The EMP will be a "live" document. It will be reviewed by the Project team prior to start of any activity related to proposed oil and gas development in consultation with Cairn's HSE department. Periodic review and audits will be done for effective management of environment system and accordingly, where required during the Project life cycle, the EMP will be updated as needed to provide effective management of environmental issues.

Implementation of the EMP will involve Cairn, its contractors and its logistics providers. The overall responsibility of compliance of the requirement lies with Cairn.

10.8 CONCLUSION

The impact assessment study indicates that the overall impact from the proposed expansion project will be short to medium term, reversible, localised and are not expected to contribute significantly to the surrounding environment.

To minimize adverse impact of backwater flow in to Chirrayanam Creek, Vedanta Ltd (Cairn Oil & Gas) has decided not to develop well pad 6. Also there will be no development of well pads # 1 to 5 located outside the PKGM-1 Block for want of approval from DGH.

Mitigation measures have been suggested to minimize adverse significant environmental impacts. A Wildlife Conservation Plan for Schedule 1 species observed/reported in the study area has been prepared for its implementation Risk assessment including oil spill analysis has been included as part of the study. Cairn has developed an Oil Spill Contingency Response Plan, which will be implemented in the event of any oil spill. An EMP has been developed to cover implementation mechanism for recommended mitigation measures to counter likely adverse environmental impacts arising due to drilling of offshore and onshore wells, strengthening of site access roads and laying of 8 km of onshore pipelines corridor along with the on-going operations in the Ravva Field. So with the implementation of the pollution control mechanisms and strengthen the existing environment and risk management measures, the anticipated impacts from the proposed drilling project will be mitigated.

Vedanta Ltd (Cairn Oil & Gas) will also ensure that the environmental performances of all the activities are monitored throughout execution of various Project components and will continue to report environmental performance and submit monitoring reports regularly to statutory authorities.

The effective management system coupled with monitoring of environmental components and efforts for continual improvements will result in satisfactory environmental performance for the proposed expansion of oil and gas exploration, development and production has been planned in the exiting Ravva field (PKGM-1 Block).

11 DISCLOSURE OF CONSULTANTS

Environmental Resources Management (ERM) is the world's leading provider of environmental, health, safety, risk, social consulting and sustainability related services. With a history that spans more than four decades, ERM today has a global footprint of 160 offices in 40 counties, employing more than 5000 best-in-class professionals. In the last three years, ERM has worked with more than 50% of the Global Fortune 500 Companies.

ERM India Private Limited (ERM India) was formally established in 1995 with its headquarters in Delhi and regional office in Mumbai (Maharashtra), Bangalore (Karnataka), Ahmadabad (Gujarat) and Kolkata (West Bengal). The contact address of ERM India is as follows:

ERM India Private Limited
Building No.10, Tower A, 4th Floor
DLF Cyber City, Gurgaon -122002 India
Tel:+91-124-4170300;

11.1 ERM'S ACCREDITATION AS EIA CONSULTANT

ERM has been accredited as EIA consultant for various sectors including Offshore and Onshore Oil and Gas Exploration Development and Production from National Accreditation Board for Education and Training (NABET) of Quality Council of India (QCI) under the Accreditation Scheme for EIA Consultant Organisation as per the requirement of MoEFCC. ERM's Accreditation Certificate from National Accreditation Board for Education and Training (NABET) is presented as ***Figure 11.1.***

Figure 11.1 ERM's Accreditation from NABET

Quality Council of India

National Accreditation Board for Education & Training

CERTIFICATE OF ACCREDITATION

ERM India Private Limited

Building 10, Tower A, 4th Floor, DLF Cyber City, Gurgaon- 122 002

are accredited as Category - A organization under the QCI-NABET Scheme for Accreditation of EIA Consultant Organizations: Version 3 for preparing EIA/EMP reports in the following sectors:

Sl.No.	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1	Mining of minerals including opencast / underground mining	1	1 (a) (i)	A
2	Offshore and onshore oil and gas exploration, development & production	2	1 (b)	A
4	River Valley	3	1(c)	A
4	Thermal power plants	4	1 (d)	A
5	Secondary Steel only	8	3 (a)	B
6	Cement plants	9	3 (b)	A
7	Chlor-alkali industry	13	4 (d)	A
8	Chemical fertilizers	16	5 (a)	A
9	Pesticides industry and pesticide specific intermediates	17	5 (b)	A
10	Petro-chemical complexes	18	5(c)	A
11	Petrochemical based processing	20	5 (e)	A
12	Synthetic organic chemicals industry	21	5 (f)	A
13	Oil & gas transportation pipeline	27	6 (a)	A
14	Isolated storage & handling of Hazardous chemicals	28	6 (b)	B
15	Airports	29	7(a)	A
16	Industrial estates (EPZs), (SEZs), Biotech Parks, Leather Complexes	31	7 (c)	A
17	Common hazardous waste treatment, storage and disposal facilities	32	7(d)	A
18	Highways	34	7(f)	A
19	Common Municipal Solid Waste Management Facility (CMSWMF)	37	7 (i)	B
20	Building and construction projects	38	8 (a)	B
21	Townships and Area development projects	39	8 (b)	B
22	Automobile and Auto Components	40(i)	-	-

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RA AC minutes dated Apr. 21, 2017 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/17/0345 dated 21 June 2017. The accreditation needs to be renewed before the expiry date by ERM India Private Limited following due process of assessment.

C.E.O NABET
Dated: Jun.21, 2017

Certificate No.
NABET/ EIA/1619/ RA 0055

Valid till Date
Oct. 31, 2019

For the updated List of Accredited Consultants with approved sectors please refer QCI-NABET website.

National Accreditation Board for Education and Training
(Member - International Accreditation Forum & Pacific Accreditation Cooperation)

QCI/NABET/ENV/ACO/20/1301 April 30, 2020

To

ERM India Private Limited
Building No. 10, Tower A, 4rth Floor,
Gurugram, Haryana-122002

Sub.: Extension of Validity of Accreditation till 31st July, 2020 - regarding

Dear Sir/Madam

In view of the outbreak of Corona Virus (COVID-19) and subsequent lockdown declared for its control vide order dated 24th March 2020, issued by Ministry of Home Affairs, Govt. of India, NABET hereby extends the Validity of your Accreditation till 31st July 2020.

As soon as, NABET office opens/resumes its operation necessary action regarding issuance of certificate/extension of validity letters / other may be initiated, therefore, ACO to ensure their complete application with NABET, if applicable.

Meanwhile, you may enclose this with your EIA reports along with the certificate/validity letter. The EAC/SEIAA/SEAC/Other are hereby requested to consider the same as a valid document for the preparation of EIA/EMP report.

With best regards.

Sd/-
(A K Jha)
Sr. Director, NABET

No.IA-J-11011/41/2018-IA-II(I)
Goverment of India
Minister of Enviroment,Forest and Climate Change
Impact Assessment Division
***

Indira Paryavaran Bhavan,
Vayu Wing,3rd Floor,Aliganj,
Jor Bagh Road,New Delhi-110003
24 Mar 2018

To,

M/s Cairn India Limited
Cairn Oil & Gas, Vedanta Limited, DLF Atria, DLF Phase-2, DLF City, Gurgaon, Haryana - 122002Gurgaon,
Gurgaon-122002
Haryana

Tel.No.124-4594176; Email:dilipkumar.bera@cairnindia.com

Sir/Madam,

This has reference to the proposal submitted in the Ministry of Environment, Forest and Climate Change to prescribe the Terms of Reference (TOR) for undertaking detailed EIA study for the purpose of obtaining Environmental Clearance in accordance with the provisions of the EIA Notification, 2006. For this purpose, the proponent had submitted online information in the prescribed format (Form-1) along with a Pre-feasibility Report. The details of the proposal are given below:

1. Proposal No.:	IA/AP/IND2/72440/2018
2. Name of the Proposal:	Oil and Gas Exploration and Development in Existing Ravva Field, PKGM-1 Block (of 331.26 km2) located near Surasniyanam Village (S. Yanam) in Krishna-Godavari Basin, East Godavari District, Andhra Pradesh by Vedanta Limited - Cairn Oil & Gas on behalf of the Ravva Joint Venture
3. Category of the Proposal:	Industrial Projects - 2
4. Project/Activity applied for:	1(b) Offshore and onshore oil and gas exploration, development & production
5. Date of submission for TOR:	24 Jan 2018

In this regard, under the provisions of the EIA Notification 2006 as amended, the Standard TOR for the purpose of preparing environment impact assessment report and environment management plan for obtaining prior environment clearance is prescribed with public consultation as follows:

1(b):STANDARD TERMS OF REFERENCE FOR CONDUCTING ENVIRONMENT IMPACT ASSESSMENT STUDY FOR OFFSHORE AND ONSHORE OIL AND GAS EXPLORATION, DEVELOPMENT AND PRODUCTION PROJECTS AND INFORMATION TO BE INCLUDED IN EIA/EMP REPORT

A. STANDARD TOR FOR OFFSHORE OIL & GAS EXPLORATION, DEVELOPMENT & PRODUCTION

1) Executive summary of the project.

2) No. of exploratory wells for which environmental clearance is accorded and No. of new wells proposed during expansion. Status and No. of the wells which are completed and closed.

3) Project Description and Project Benefits;

4) Cost of project and period of completion.

5) Employment to be generated.

6) Distance from coast line.

7) Details of sensitive areas such as coral reef, marine water park, sanctuary and any other eco-sensitive area.

8) Recommendation of SCZMA/CRZ clearance as per CRZ Notification dated 6th January, 2011 (if applicable).

9) Details on support infrastructure and vessel in the study area.

10) Climatology and meteorology including wind speed, wave and currents, rainfall etc.

11) Details on establishment of baseline on the air quality of the areas immediately affected by the exploratory drilling and also particularly with reference to hydrogen sulphide, sulphurdioxide, NOx and background levels of hydrocarbons and VOCs.

12) Details on estimation and computation of air emissions (such as nitrogen oxides*, sulphur oxides*, carbon monoxide*, hydrocarbons*, VOCs*, etc.) resulting from flaring, DG sets, combustion, etc. duringallprojectphases

13) Base line data collection for surface water for one season leaving the monsoon season within 1 km for each exploratory wells, particularly in respect of oil content in the water sample and sediments sample.

14) Fisheries study w.r.t. benthos and marine organic material and coastal fisheries.

15) Source of fresh water. Detailed water balance, waste water generation and discharge.

16) Noise abatement measures and measures to minimize disturbance due to light and visual intrusions in case of project site closed to the coast.

17) Procedure for handling oily water discharges from deck washing, drainage systems, bilges etc.

18) Procedure for preventing spills and spill contingency plans.

19) Procedure for treatment and disposal of produced water.

20) Procedure for sewage treatment and disposal and also for kitchen waste disposal.

21) Details on solid waste management for drill cuttings, drilling mud and oil sludge, produced sand, radioactive materials, other hazardous materials, etc. including its handling and disposal options during all project phases.

22) Storage of chemicals on site.

23) Commitment for the use of water based mud (WBM) and synthetic oil based mud in special case.

24) Details of blowout preventer Installation.

25) Risk assessment and mitigation measures including whether any independent reviews of well design, construction and proper cementing and casing practices will be followed.

26) Handling of spent oils and oil from well test operations.

27) H2S emissions control plans, if required.

28) Details of all environment and safety related documentation within the company in the form of guidelines, manuals, monitoring programmes including Occupational Health Surveillance Programme etc.

29) Restoration plans and measures to be taken for decommissioning of the rig and restoration of on-shore support facilities on land.

30) Documentary proof for membership of common disposal facilities, if required.

31) Any litigation pending against the project or any directions/order passed by any Court of Law against the project. If so, details thereof.

32) Total capital and recurring cost for environmental pollution control measures.

***

Vedanta Limited
(Cairn Oil & Gas)

Environment Clearance and CRZ Clearance for Expansion of Offshore & Onshore Oil & Gas Exploration, Development & Production in existing Ravva Field, PKGM-1 Block (of 331.26 km^2) located near Surasaniyanam Village (S.Yanam) in Krishna Godavari Basin, East Godavari District, Andhra Pradesh

EIA Report – Volume 2 (Annexes to EIA) Revised

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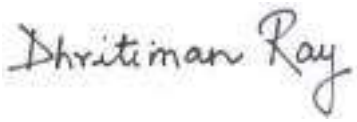
Vedanta Limited (Cairn Oil & Gas)

Environment Clearance and CRZ Clearance for Expansion of Offshore & Onshore Oil & Gas Exploration, Development & Production in existing Ravva Field, PKGM-1 Block (of 331.26 km^2) located near Surasaniyanam Village (S.Yanam) in Krishna Godavari Basin, East Godavari District, Andhra Pradesh

30 April 2020

Reference # 0440174

Project Manager	**Dhritiman Ray** *Principal Consultant*	
NABET Approved EIA Co-ordinator for Oil & Gas Sector	**Sushil Kumar Handa** *Technical Director*	

LIST OF ANNEXES

Annex 1	Report on Environmental Monitoring around Offshore Installations of Ravva Field (Phase III) Conducted by Marine Biological, Andhra University for Vedanta Ltd (Cairn Oil & Gas) during Nov 2017
Annex 2	Ship Collisions Risk Assessment
Annex 3	Transport & Occupational Risks
Annex 4	Dropped Object Hazards and Risk Assessment
Annex 5	Waste Management Plan
Annex 6	Relevant Excerpts from Oil Spill Contingency Plan
Annex 7	Relevant Excerpts from Emergency Response Plan
Annex 8	Occupational Health & Hygiene Procedure
Annex 9	Overview of the national and international regulatory and policy framework applicable to this project
Annex 10	Trends in Environmental Monitoring Results (Submitted to MoEFCC on 25 April, 2018 as part of the Report against compliance to the conditions stated in the environmental clearances)
Annex 11	Certified Copy of EC Compliance Report, Andhra Pradesh Pollution Control Board, Regional Office, Kakinada, 31.01.2019
Annex 12	Report against compliance to the conditions stated in the CFO and the HW Authorisation Order submitted to APPCB on 25 Jan, 2018
Annex 13	Membership Certificate of Vedanta Ltd (Cairn Oil & Gas) with Coastal Waste Management Project (TSDF), Vishakhapatnam
Annex 14	NOC from APWALTA for Ground Water Extraction
Annex 15	Results of Micro-Meteorological Monitoring, Conducted by Vimta Labs during Jan–Mar, 2018
Annex 16	Results of Ambient Air Quality Monitoring, Conducted by Vimta Labs during Jan–Mar, 2018
Annex 17	Hourly Equivalent Noise Levels, Based on Ambient Noise Monitoring Conducted by Vimta Labs during Mar, 2018
Annex 18	Results of Traffic Survey, Conducted by Vimta Labs during Mar, 2018
Annex 19	Phytosociology of Different Vegetation Types
Annex 20	Faunal Species Observed / Reported from Study Area
Annex 21	Site Specific Conservation Plan & Wildlife Management Plan for Schedule I species
Annex 22	Proceedings of the Environmental Public Consultation
Annex 23	▪ NOC from Andhra Pradesh Coastal Zone Management Authority; ▪ Summary Report on CRZ mapping by National Centre for Sustainable Coastal Management (NCSCM), Chennai.
Annex 24	Copy of Agreement with OSRL

Annex 1

Report on Environmental Monitoring around Offshore Installations of Ravva Field (Phase III) Conducted by Marine Biological Laboratory, Andhra University for Vedanta Ltd (Cairn Oil & Gas) during Nov 2017

For Annex-1 to EIA Volume 2 on

Report on Environmental Monitoring around Offshore Installations of Ravva Field (Phase III) Conducted by Marine Biological, Andhra University for Vedanta Ltd (Cairn Oil & Gas) during Nov 2017

Access the document through link below

https://drive.google.com/file/d/1Q_bfWlp4_P-3xFe07TI3SZ4unYHTNCW_/view?usp=sharing

Annex 2

Ship Collision Risk Assessment

1 SHIP COLLISIONS

Although the international regulations stipulate that all merchant and fishing vessels are to keep a minimum distance of 500 metres from an offshore oil and gas installation, sea-farers are known to use offshore platforms as navigational aids. Also, for various reasons vessels are known to travel along an errant route, i.e. outside a designated "shipping lane".

1.1 PERSONNEL CONSIDERED

In case of a collision, both the platform and the colliding vessel will potentially be damaged. Both the platform personnel and the crew of the colliding vessel are exposed and could be injured. In this assessment only the personnel on board of the RF Platform are considered, i.e. the fatality risk of the colliding vessel crew is outside the scope of the analysis.

1.2 TYPE OF VESSELS

A variety of ships and mobile installations may be in the vicinity of the RF Platform, with the potential to collide with it. Generally, potential colliding vessels are classified as follows:

- Visiting vessels, which approach the platform on legitimate business under their own power, including supply vessels, multipurpose service vessel, stand-by vessels and diving support vessels;
- Passing merchant vessels, which pass close to the platform because it lies near to their route between ports. Some offshore support vessels may also pass close to the platform on their way to or from another installation;
- Fishing vessels, which may pass close to the platform repeatedly if it lies within or on route to the fishing grounds;
- Naval vessels, which may conduct exercises near to platforms;
- Offshore (shuttle) tankers, which may load at offshore moorings near to the platforms.

Naval vessels cause relatively low risks of ship-platform collisions due to their high standards of operation, which make errant movement and breakdown relatively unlikely. However, naval vessels may approach platforms in military exercises or for intelligence gathering and collisions may then occur due to navigational misjudgements. Naval vessels are usually omitted from collision frequency predictions. Theoretical models are difficult to apply due to the lack of public-domain information on their movements.

Hence the types of vessels considered for the collision risk assessment for the RF Platform are:

- Visiting vessels, in particular supply vessels and multipurpose service vessels;
- Passing merchant vessels;
- Fishing vessels.

1.3 TYPE OF COLLISIONS

Several types of collision may be distinguished:

- Powered passing collisions – where a vessel is passing close to an installation and suffers a watch-keeping failure. If the vessel happened to be heading directly for the platform and was not warned off by its stand-by vessel, it might collide with the platform at close to its service speed.
- Drifting collision – where a vessel suffers a breakdown (propulsion or steering failure), and drifts under the action of wind and waves into the platform. Such collisions are most likely in severe weather. The vessel drift speeds are relatively low, making precautionary evacuation of the platform possible.
- Collision on approach – where a visiting vessel approaching the platform suffers a watch-keeping or mechanical failure, and fails to stop on arrival. It may then collide with the platform at full-speed, similar to a powered passing collision.
- Collision while alongside – where a visiting vessel collides with the platform while maneuvering or conducting transfer operations alongside. This is the most common type of ship-platform collision, and platform sub-structures are designed to withstand it, so that damage is usually minimal.

1.4 SHIPPING DATA

The following ***Table 1.1*** represents shipping data assumed for the ship collision study

Table 1.1 Shipping Data (Assumption)

Vessel	Displacement (tons)	Speed (knot)	Impact Energy (MJ)
Stand by Vessel(SBV)	800	8	7.9E-03
Supply Vessel	1250	12	2.6E-02
Naval Vessel	1000	12	2.0E-02
Fishing Vessel	600	10	8.7E-03

1.5 CONSEQUENCES ANALYSIS

Collision Types

In analysing collision consequences, collisions are split into two types:

- Glancing Blows – where the ship brushes against the platform and retains most of its kinetic energy. Accident experience shows that, for most platforms, this causes negligible damage.
- Full-on collisions – where the ship is stopped by the platform and has no residual kinetic energy.

1.5.1 Consequence Analysis for Powered Collision

Energy Absorption for Powered Collision

The vessel that can hit the installation has different weights and velocities, giving different hit energies. A small powered vessel may have as much kinetic energy as a large drifting vessel.

Therefore, a division into different kinetic energies and vessel types is therefore relevant. For a direct hit or impact, the kinetic energy is given by the following equation:

$$E = \frac{1}{2} \cdot \frac{M}{1000} \cdot (1+k) \cdot V^2$$

Where:

E = impact energy (MJ),
M = vessel mass (tonnes),
k = hydrodynamic added mass (0.1 for bow and stern impact),
V = vessel speed (m/s) = 0.514 x knots.

Below ***Table 1.2*** presents the results for impact energy for a powered collision of typical third party vessels:

Table 1.2 Impact Energy for a Powered Collision

Vessel	Displacement (tons)	Speed (knot)	Impact Energy (MJ)
Stand by Vessel(SBV)	850	8	7.9E-03
Supply Vessel	1250	12	2.6E-02
Naval Vessel	1000	12	2.0E-02
Fishing Vessel	600	10	8.7E-03

Collision Frequencies:

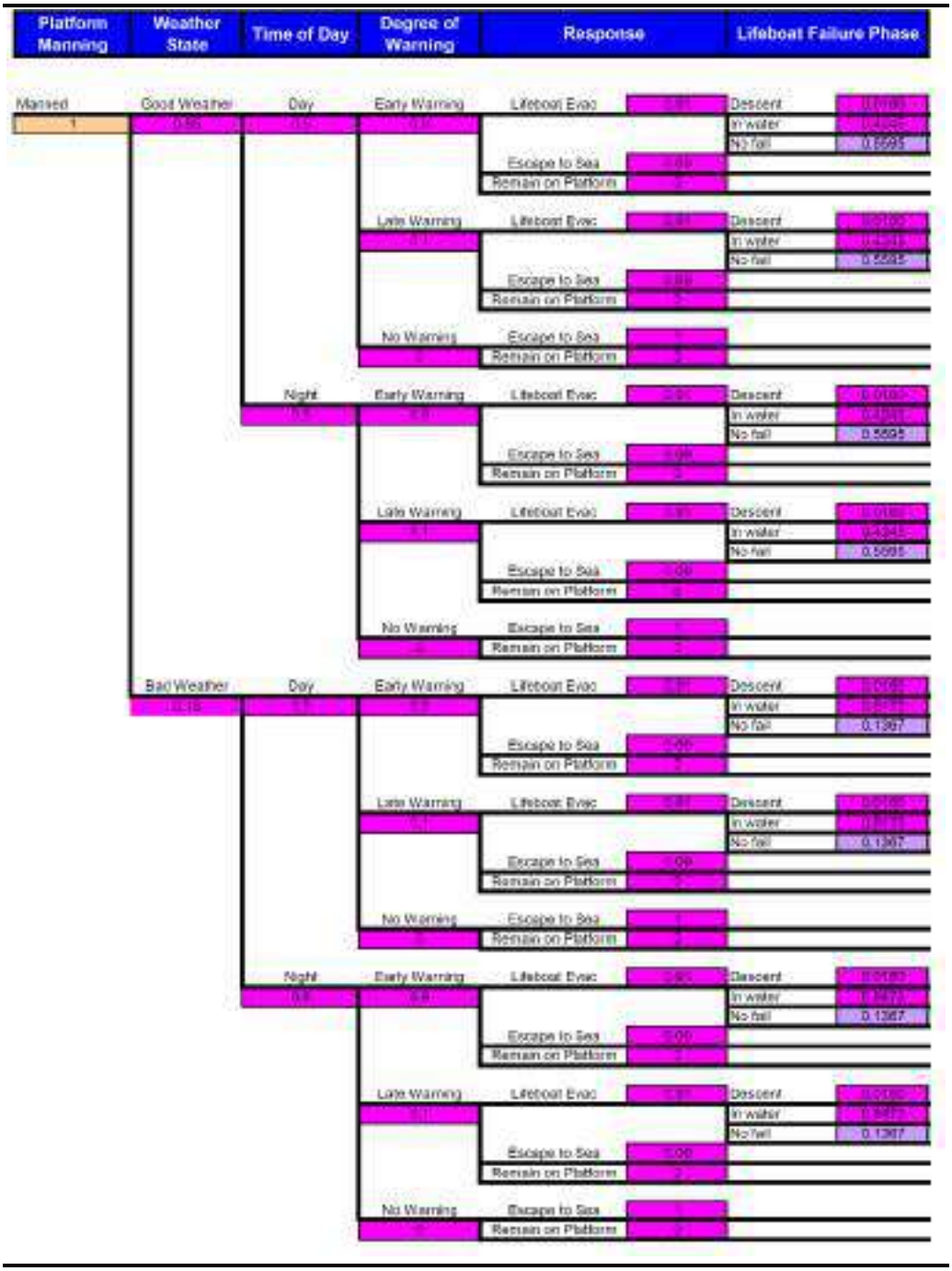
Based on the data provided in the previous sections, the collision frequency for a supply vessel leading to moderate or severe damage can be calculated as the product of:

Collision frequency of visiting vessel for fixed platform: 7.6 E-05 per year
Collision frequency of visiting supply vessel for fixed platform: 5.4 E-04 per year

Supply vessel collisions are relatively common: these are usually very low energy collisions.

The risk associated with ship collision is assessed using an event tree model, shown in ***Figure 1.1.***

Figure 1.1 Ship Collision Event Tree



The estimated Individual Risks associated with a ship collision with the RF Platform is 9.78 x 10-7. The estimated PLL associated with a ship collision with the RF Platform is 1.97 x 10-6. The assessment of whether or not the personnel risk is acceptable depends on the risk contribution of ship collisions to the overall risk, and is not part of the scope of this appendix. The IRPA is in the order of 9.78E-07, which in implies that the risk is within acceptable limits.

Annex 3

Transport and Occupational Risks

1 INTRODUCTION

1.1 INTRODUCTION

Transportation hazards (by helicopter) & Occupational hazards are discussed in the following sections. The principal source of the data presented is the data published by OGP Risk Assessment Data Directory, March 2010.

1.2 TRANSPORT RISK

Helicopter transport risks consider the risk to personnel whilst travelling to and from RF/RG platforms. The risk to an individual for any given trip is calculated as Helicopter Transport i.e. the sum of the risk of fatality during the cruise phase of a flight and the risk of fatality during the take-off / landing phase of a flight. The helicopter flight duration is 10 minutes and number of return flights is based on 2 helicopter visits per week, i.e. 104 per year. Number of crew visit to the platform via helicopter is 3. They are assumed to be accompanied by 2 pilots.

Table 1.1 Helicopter Transport Risk Summary

Worker Category	No. of Trips per year	No. of Crew per trip	Flight Duration (min)	IRPA	PLL
Maintenance Crew	104	3	10	3.98E-05	4.1E-04

1.3 OCCUPATIONAL RISK

Occupational accidents include all non-major accident hazards with the potential to cause serious injuries or fatality, and typically include categories such as “struck by”, “falls”, “caught between”, “electrical”, “burn”, drowning and others. The calculation of occupational risks is based on historical levels of fatalities taken from OGP Risk Assessment Data Directory, March 2010, which provides a base Occupational Fatal Accident Rates (FAR) of 3.56×10^{-8} hours covering fatalities from all causes and a multiplication factor of 0.56 for Asian offshore activities.

Air transport and vehicle incidents were discounted for FAR values for the three main job functions are presented in ***Table 1.2*** below. However, as the data is not available about the job functions of the 3 member crew the calculations have been carried out with average value of all the job functions.

Table 1.2 Occupational Fatal Accident Rates per Cause (OGP)

Cause	% Excluding Major Accidents & Transport	Drilling	Production	Stewards
Struck by Vehicle	25%	0.8	0.51	0.07
Other	15%	0.48	0.31	0.04
Fall	10%	0.32	0.2	0.03
Caught between Air Transport	7%	0.22	0.14	0.02
Electrical	6%	0.19	0.12	0.02
Drowning	4%	0.13	0.08	0.01
Unknown	4%	0.13	0.08	0.01
Total	71%	2.27	1.44	0.21

1.4 OCCUPATIONAL RISK FOR NORMAL OPERATIONS

PLL for the hazard equates to 4.74E-06 per year. The IRPA with occupational events on RF platforms is 4.5E-07.

Annex 4

Dropped Object Hazards and Risk Assessment

1 INTRODUCTION

1.1 BACKGROUND

This report details the results and findings of the Dropped Object Hazard Risk Analysis (DOHRA) Study performed for example RF Platform.

Report explain the dropped object frequency for RF Platform and the contribution of dropped object frequency in total leak frequency estimated in RA.

1.2 OBJECTIVES

The objectives of the dropped objects assessment are:

- Identify the number and types of crane lifting operations carried out on the RF Platform.
- Review the likelihood and consequences of dropped and swung load impacts on topsides process equipment and structures, bearing in mind the risk reduction steps already in place.
- Estimate risk associated with dropped objects, swinging loads, loads overboard, etc.
- Assess whether further protection steps are considered necessary to reduce the risks to personnel to ALARP. This will be based on engineering judgment, supported, as necessary, with risk data from the RA.

1.3 SCOPE OF ASSESSMENT

The study includes dropped and swung loads from the platform crane and their effects on topsides process equipment and structures.

Exclusions:
The study excludes, however, consideration of dropped/swung loads on the platform during installation and hook-up activities.

The study also does not consider in detail the effects of dropped and swung loads directly onto personnel, or the hazards of personnel basket transfers (if any). These are significant but are considered occupational type hazards, which should be addressed as part of the Vedanta Ltd (Cairn Oil & Gas) for RF platform.

2 *CRANE DETAILS*

The platform is provided with one diesel driven platform crane. This is supposed to have sufficient reach to cover all the necessary deck handling requirements with the boom length of 10m.

The following main details on the crane have been considered.

- Deck crane shall be used for handling of equipment, materials, drums and personnel baskets from barges and supply vessels etc. and for loading and unloading of materials between boat landing area and lay down area/ main deck of the platform.
- One 5 Ton capacity Deck Crane is located on the main deck of RF platform

3 LIFT OPERATION DETAILS

3.1 INTRODUCTION

To assess the effects of dropped objects on the topsides facilities it is necessary to identify the frequency and type of the lifts carried out on the facility by the platform crane. There will be two main types of lifting operations to be carried out:

- **Routine.** These will be carried out very regularly and consist of transfer of supplies to and from the supply vessel and then within the platform.
- **Maintenance.** These will be carried out much less frequently. They include platform lifts of equipment requiring repair. The objects lifted may well be heavier that the routine lifts.

3.2 LIFTING OPERATION DETAILS

The main lifting activities will be material transfer between supply vessel and the designated laydown areas of the platform. In addition, it is assumed that strict crane lifting procedures and regular safe job assessments are enforced at RF Platform in order to regulate lifting of heavy load above live process equipment during normal operation. The anticipated lifting activity at RF platform is given in ***Table 3.1.***

Table 3.1 Lifting Activities at RF Platform

Description	Lifts/year
Utility/Chemical supplies/Maintenance	52

4 CAUSES AND CONSEQUENCES OF DROPPED OBJECTS

4.1 CAUSES OF DROPPED/SWUNG LOADS

The main causes of dropped objects are outlined below:

4.1.1 Human Error

This is the most common cause of dropped objects incidents. This can be caused by inadequate fastening of the load by riggers, mis-judgment by the crane operator, rigger miscalculation of load weights, incorrect shipping manifests or failure to follow proper lifting procedures.

Crane operators and riggers both on the platform and on the supply vessel will be given complete and thorough initial training to a recognized offshore marine standard.

This will be reinforced by regular refreshers and safety awareness campaigns. Sound, clearly documented and enforced procedures will be put in place to further assist in the reduction of these risks.

It is also noted that a significant cause of dropped objects is poor slinging and rigging practices. For example, bundles of scaffold poles being lifted only using wire or webbing slings. Slings have been known to move along a bundle, resulting in tubulars falling onto the platform or sea. Therefore, it is good practice to lift tubulars and such loose items in certified baskets/containers.

4.1.2 Mechanical Failure

These are the result of mechanical or structural failures within the slings, wires, swivels or pedestal bolts.

Compliance with design codes, quality assurance during construction and regular testing and maintenance by competent personnel will reduce these risks.

4.1.3 Weather Conditions

Supply vessel motions, wind loading on lifted objects and poor visibility can also lead to dropped/swung loads.

This will be controlled by the setting and enforcement of environmental weather restrictions for lifting operations. These weather restrictions will include general visibility parameters.

5 DROPPED OBJECTS FREQUENCY ANALYSIS

5.1 CLASSIFICATION OF OBJECTS

The potential dropped objects (i.e. the objects that are lifted) are defined and classified. Details required are:

- The type of lifting operations (which cranes are used)
- The type of lifted objects (weights and shape)
- The number of lifted objects per year

5.1.1 Type of Lifted Objects

The various lifted objects have been further classified based on typical shapes and weight groups, as presented in ***Table 5.1.*** Reference source not found. Deck crane shall be used for handling of equipment, materials, drums and personnel baskets from barges and supply vessels etc. and for loading and unloading of materials between boat landing area and lay down area/ main deck of the platform.

Table 5.1 ***Object Classification, Typical Load Data***

SN	Description	Weight (tonnes)
1	Flat/Long shaped	<2
		2-5
2	Box/round shaped	<2
		2-5

5.2 DROP FREQUENCY

The generic drop frequencies used are based on the accident database from UK Continental Shelf covering the period 1991-99 for fixed offshore units.

During this period, 323 incidents with dropped objects and 21948501 lifts reported. This gives a dropped object probability of 1.47E-05 per lift. Examination of the World Offshore Accident Database 1998 for Falling Load Accidents on Fixed Units from 1980-97 shows that a total of 89 accidents occurred worldwide. Of the 89 accidents, 68 occurred in the North Sea, while 20 occurred in the Gulf of Mexico. The number of installation in the Gulf of Mexico is 10 times that of North Sea. The higher number of reported accidents in North Sea is due to the high level of reporting required by authorities such as UK HSE. Thus, use of UK data, in lieu of local data, will conservatively estimate the dropped object frequencies on RF Platform although it is not clear whether operating standards between the two is comparable.

Based on the accident database from UK Continental Shelf covering the period 1991-99 for fixed offshore units, approximately 71% of the loads dropped by the main cranes impact the installation, 9% fall in sea with the remaining 20% falls onto the supply vessel. The frequency for dropped objects is therefore taken to be 1.05E-05 per lift for impact on the platform (i.e. 1.47E-05 × 0.71),

1.28E-06 per lift for dropped into sea and 2.96E-06 per lift for dropped onto supply vessel.Based on the number of lifts to each location on the platform, the frequencies of dropped loads (Dropped Frequency x No. of Lifts) are calculated and summarised in ***Table 5.2.***

Table 5.2 Frequencies for Dropped Objects at on the RF Platform

Location	Number of Lifts / year	Dropped Object Frequencies		
		On Platform	In sea	On Supply vessel
Crane on Platform	52	5.43E-04	6.88E-05	1.53E-04

5.2.1 Impact Energies

In lieu of accurate information, ***Table 5.3*** may be used for impact energy estimates, giving a suggested split of the object's energy into energy bands with a conservative conditional probability of occurrence.

Table 5.3 Conditional probabilities of Impact Energies

Cat	Description	Weight	Energy Category					
			<50	50-100	100-200	200-400	400-800	>800
1	Flat/Long Shaped	<2	30%	18%	14%	12%	11%	15%
2		2-5	5%	8%	15%	19%	25%	28%
3	Box/round shaped	<2	50%	30%	20%	-	-	-
4		2-5	15%	20%	30%	40%	10%	-

In order to estimate whether a swung load or dropped object will significantly damage an equipment item, it is important to define the damage classification according to impact energies absorbed during the accident. ***Table 5.4*** tabulates the damage classification for steel pipelines according to impact energies and the amount of damage (dent) caused. Damage classification of bare steel pipes is used to conservatively estimate the damage on the exposed equipment items.

Table 5.4 Impact Capacity and Damage Classification for Steel Pipelines

Dent/Diameter (%)	Impact Energy (kJ)	Damage Description
<5	0-50	Minor Damages
5-10	50-75	Major Damages, Leak anticipated
10-15	75-105	Major Damages, Leak & rupture anticipated
15-20	105-145	Major Damages, Leak & rupture anticipated
>20	145-	Rupture

Based on the above table, it is assumed that impact energies above 50 kJ will cause significant damage and leak on equipment items on board RF Platform in dropped objects accidents.

6 CONSEQUENCE ANALYSIS

6.1 INTRODUCTION

Objects dropped on the topsides have to potential to impact on a number of process equipment of the rooftop, Main Deck. Besides objects being dropped from the crane, there is possibility of them being swung sideways onto equipment. Depending on the crane slew speed, the sideways impact could dent and damage unprotected process equipment.

6.2 DROPPED OBJECTS IMPACTING TOPSIDE

Dropped objects on the platform can potentially cause fatalities directly by falling on personnel, but generally personnel will not be permitted to work within the lift path and travel footprint of the crane. The likelihood of dropped object directly causing fatalities on the platform may thus only occur in the event of personnel deliberately violating procedures.

Dropped objects on the platform can also impact on hydrocarbon vessels and equipment located on Main Deck. Dropped objects impact on vessels and equipment could lead to hydrocarbon release and subsequent fire on the topside.

6.3 DROPPED OBJECTS IMPACTING SUPPLY VESSEL

The consequences of loads dropped onto the supply vessels are outside the scope for this assessment.

6.4 SWUNG LOAD

An object being hoisted by the crane may have the potential to impact process equipment sideways when the crane boom is being moved from one side to another.

Depending on the slew speed, it is possible that the swung objects could dent and damage process equipment. In this analysis, the dropped objects frequency discussed in Section 5.2 already includes swung load accidents data. Risk from dropped objects estimated in this analysis thus includes both dropped objects and swung loads accidents.

6.5 OBJECTS FALLING OVER SEA

An objects falling into sea may have the potential of impacting on risers/ pipelines of the RF platform leading to a release of hydrocarbons. It may also sink, depending on the shape, size, entry angle, and current, and hit subsea pipelines. An object can be dropped at any point on the path between the Supply Vessel and the laydown area.

The object excursion is further very dependant on the shape and weight of the object. Long slender objects, e.g. pipes, may experience an oscillating behaviour, while massive boxlike objects will tend to fall more or less vertical. Also the actual fall pattern for a pipe is dependent on the entry angle into the sea. The probability of a falling object actually hitting any of the future subsea pipelines is thus associated with a large degree of uncertainty due to the fall pattern in the water.

7 DROPPED OBJECTS RISK ANALYSIS RESULTS

Based on the assessment methodology presented in the previous sections, **Table 7.1** presents the estimated frequency of dropped objects hitting the topside equipment on the RF Platform. These are estimated based on the number of lifts that pass above the exposed equipment multiplied by the dropped object frequency presented in Section 5.2.

Table 7.1 Impact Frequencies on Exposed Hydrocarbon Inventories

Area	Impact Frequency (per year)
Platform	5.43E-04

Based on the impact frequencies above, the breakdown of lift categories in Section 5.1, the conditional probabilities of impact energies (***Table 5.3***), and damage classification (***Table 5.4***), the leak frequencies due to dropped objects are estimated.

Annex 5

Waste Management Plan

Cairn India Ltd

Ravva Operations

Waste Management Plan

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Revision Status

Revision Number	Details	Date
A	For approval	December-2005
0	For implementation	08 Mar 06
1	key waste handling, minimisation and disposal decisions	15 Jun 06
2	e- waste management included	10 Oct 07
3	Health and safety requirement associated with waste handling included.	12 Jul 08
4	X- ray film, respiratory canisters, cartridges and used ATF management included	22 Aug 08
5	Collection, segregation and storage procedures included. The disposal procedure for fluorescent tubes and mercury bulbs added. Disposal path ways and options were updated. Disposal pathways of Insulation material, paper and food waste was reviewed. Requirement of audit of hazardous waste disposal / recycling facilities has been added.	27Oct10
6	Disposal pathways of oil soaked cotton waste and used ATF has been added. Requirement of assessing fire suppression system requirements for waste storage yard has been added. Guide lines for the facility audit were included	Jan11
7	Reference to Plastic waste (Management and Handling) Rules, 2011 and The e-waste (management and handling) Rules, 2011 has been included.	Dec 11
8.	Disposal path ways and methods has been updated. Dust bins adequacy and locations were reviewed	Sep 12
9.	Additional requirement added to metal scrap collection	Nov 13
10.	Disposal path ways and methods has been updated for CFL lamps and tube lights.	Jan 14
11	New CFO conditions were incorporated.Disposal path ways were updated.	Feb 15
12	New CFO conditions were incorporated. Disposal path ways were updated. Update with respect to HWM rules 2016,BMW rules 2016 & EWM rules 2016.	Dec 16

Table of Contents

S No.	TOPICS	PAGE No.
1	Commitment and Policy	5
2	Philosophy	6
3	Definitions	7
4	Key waste handling, minimization and disposal decisions	8
5	Waste Management	9
6	Liquid waste	10
7	Gaseous emissions	13
8	Solid waste	16
9	Responsibilities	22

1 . COMMITMENT & POLICY

Fundamental to the success of the waste management programme is a companywide commitment to waste management. Cairn's commitment to effective waste management has at its starting point the group HSE policy complimented by the Group HSE Performance standard in the "Planning & Procedures" of the Group HSE management system which requires procedures and practices aimed at achieving the following:

- Operations to comply with the intent of the international standard ISO 14001 & OHSAS18001 , thereby including the consideration of significant environmental aspects;
- Use of water based mud with environmentally friendly additives in all wells where this is reasonably practical;
- All operations to be covered by a waste management plan to identify and classify all waste streams, minimize all waste streams to the extent that it is cost effective to do so, and specify a safe method of disposal for each waste stream;
- Production chemical usage shall be the minimum necessary to achieve the desired objectives;
- Environmental monitoring process to be installed to ensure accurate measurement of the level of emissions, releases etc.;
- All environmental incidents reported and investigated, as appropriate
- All cost effective measures shall be taken to minimize produced water volumes;
- Oil and / or condensate in produced water will not exceed a set target monthly average e.g., less than 25 mg/l;
- All cost effective measures shall be taken to minimise greenhouse gas emissions;
- Night time noise levels at the nearest planned residence outside site not to exceed 70 dB (A)
- Oil spills response plans should exist and be regularly tested
- Measure percentage implementation of these plans.

2 . PHILOSOPHY

The principles of waste management include the incorporation of a hierarchy of waste management practices in the development of waste management plans. Proper management of waste begins with pollution prevention. It refers to the elimination, change in operating practices, which result in reduction/elimination of discharges to land, air or water. Responsible waste management shall be accomplished through hierarchal application of the practices of source prevention, reduction, reuse, recycling, recovery, treatment and responsible disposal.

3 . DEFINITIONS

Definitions as mentioned in Rule No. 03 of Hazardous Waste (Management, Handling& Trans-boundary movement) Rules 2016:

1. " Responsible disposal" means deposit, treatment, storage and recovery of any hazardous wastes;

2. "environmentally sound management of hazardous wastes" means taking all steps to ensure that the hazardous wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes;

3. "hazardous waste" means, any waste which by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances. Specified in the schedules in the Rules.

4. "hazardous wastes site" means a place for collection, reception, treatment, storage and disposal of hazardous wastes which has been duly approved by the competent authority;

5. "operator of facility" means a person who owns or operates a facility for collection, reception, treatment, storage and disposal of hazardous wastes;

6. "storage" means keeping hazardous wastes for a temporary period, at the end of which the hazardous wastes is treated and disposed off,

7. "transport' means movement of hazardous waste by air, rail, road or water;

8. "treatment" means a method, technique or process, designed to change the physical, chemical or biological characteristics or composition of any hazardous waste so as to render such wastes harmless;

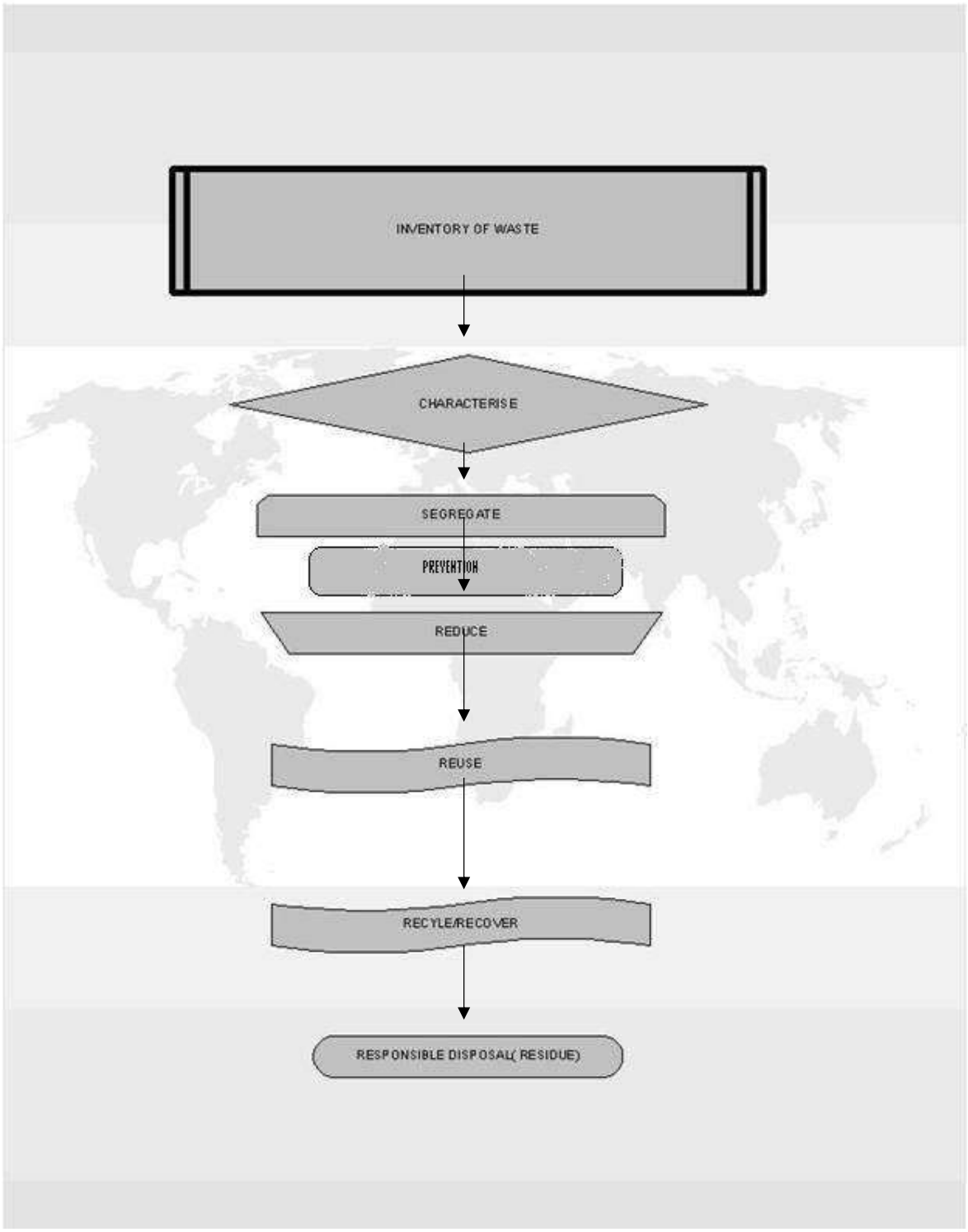
9. "used oil" – means any used lubricating oil that has been derived from crude oil and mixtures containing synthetic oil and includes used engine oils, gear oils, hydraulic oils, turbine oils, compressor oils, industrial gear oils, heat transfer oils, transformer oils, spent oils, etc. Used lubricating oils are suitable for re-refining provided the final product meets the specifications laid down by statutory guideline.

10. "Waste oil" – means any oil that is contaminated so as to make it unsuitable for recycling. It includes spills of crude oil, tank bottom sludge, emulsions, etc. and can be used as fuel in furnaces and cement kilns.

11. "co-processing" means the use of waste materials in manufacturing processes for the purpose of energy or resource recovery or both and resultant reduction in the use of conventional fuels or raw materials or both through substitution;

12. "Disposal" means any operation which does not lead to reuse, recycling, recovery, utilization including co-processing and includes physico-chemical treatment, biological treatment, incineration and disposal in secured landfill;

4 . KEY WASTE HANDLING, MINIMISATION AND DISPOSAL DECISIONS



5 . WASTE MANAGEMENT

As in any aspect of environmental management, there are Six R's & one P' over good practices that should be employed. These good practices not only protect health and the environment but also from potential long-term liabilities associated with waste disposal.

Waste management methods should be selected based upon the hierarchy presented. An important aspect of a waste management programme is the need to segregate waste materials according to their general physical and chemical characteristics.

Apart from safety concerns, an initial waste characterization will help determine which waste streams are similar and may be combined to simplify storage, treatment, recycling, and/or disposal, and which streams should remain segregated.

Failure to recognize the need for waste segregation may result in the creation of a waste mixture incompatible with the desired recycling or disposal option and result in the need for extensive higher waste disposal costs.

Waste categorization: The following categories of wastes are generated in Ravva Oil and Gas field involving offshore, on-shore and marine operations

1) Liquid Waste

2) Gaseous emissions

3) Solid waste

Wastes are categorized into hazardous and non-hazardous wastes.

All hazardous wastes shall be stored, transported, disposed or treated as per the guidelines stipulated in The Hazardous Waste (Management, Handling& Trans-boundary movement) Rules 2008 and amendments thereof. Hazardous Waste authorization shall be sought from the state pollution control board for storing and disposing of the hazardous waste.

For generation, storage and disposing of bio-medical waste, the conditions laid down in Bio-Medical Waste (Management and Handling) (Amendment) Rules, 2016 is to be followed.

For generation, storage and disposing of battery wastes, the conditions laid down in the Batteries (Management and Handling) Amendment Rules, 2010 is to be followed.

For generation, storage and disposing of plastic waste the conditions laid down in Plastic waste (Management and Handling) Rules, 2016 is to be followed.

For generation, storage and disposing of electronic waste the conditions laid down in The e-waste (management and handling) Rules, 2016 is to be followed.

6 . LIQUID WASTE

6.1.1 Sources

- Produced water
- Contaminated wash water
- Sewage water from LQ and Plant

6.1.2 Responsible disposal

Produced water or contaminated wash water:

This oil-contaminated water (produced water or contaminated wash water) gets collected in the oil compartment of the API separator, wherein, the liquids will have enough residence time so that oil and water are physically separated. Heating coils are provided in the channel to facilitate the separation and keep the oil fluidity. While floating oil gets collected in an oil sump and pumped to the LP separator, water flows down into the water compartment. This water is pumped to ETP for removal of free and dissolved oil so as to maintain an oil concentration less than 10 ppm in the discharge water, as specified in the CFO. Discharge from the oil treatment is taken to the biological treatment to maintain a BOD of 30 ppm. Finally the treated water is discharged into the sea at an outfall point which 0.5 km from the coast.

Sewage water/Domestic water

The sewage water treatment package at the LQ/Plant consists of:

- Primary settlement pits
- Aerator
- Sand and activated carbon filtration system at plant
- Treated water collection reservoir Aerator.

Raw effluent flows into the primary settlement pit. Sewage water will be pumped into the aerator for oxygen balancing. Discharge of aerator gets collected in a sump and will be pumped to the plant premises and passed through STP and treated water will be used for green belt developmwent.

6.1.3 Applicable responsible disposal limits as per APPCB CTO (Water Act):

Parameter	Limiting Standards	Parameter	Limiting Standards
PH	5.50-9.00	Chromium (Cr)	0.10 mg/lt
Oil and Grease	10 mg/lt	Fluoride as (F)	1.50 mg/lt
Total Suspended solids (103-105 C)	100 mg/lt	Zinc as (Zn)	0.10mg/lt
BOD 27 ^{0}C for 3 Days	30 mg/lt	Nickel as (Ni)	0.10mg/lt
Cyanide (CN)	0.005 mg/lt	Mercury as (Hg)	0.01 mg/lt
Lead (Pb)	0.05 mg/lt	Copper (Cu)	0.05 mg/lt

LIQUID WASTE STREAM – RESPONSIBLE DISPOSAL

Liquid Waste	Points of generation	Treatment Strategy	Monitoring	Discharge Medium
Produced water/contaminated water	Formation water from wells Drainage (tanks, separators etc) and wash down	Collection and physical separation of water and oil in API separator and subsequent treatment in ETP to remove oil and maintain BOD levels.	Daily monitoring by chemical lab. Monthly monitoring by third party. Annual post project monitoring (on and off-shore)	Reinjection to the reservoir Partial Discharge through marine out fall point.
Sewage water	LQ toilets & kitchen water, Plant sewage	Treatment to remove odour and colour by flowing through aeration system, ACF and sand filters.	Random sampling and analysis in Chemical lab. (Satisfying growth rate of plans is an indication of good quality of water)	Used for watering greenbelt plants.
Laboratory wash water	Chemical Laboratory	Routed to plant sewage sump.	No separate monitoring.	API separator
Water from vehicle servicing bay	Vehicle wash bay at workshop	Routed to API pit	No separate monitoring	API separator
Used ATF	GVHL Heli hanger	Stored in a designated area; controlled issue for reusing the same.	Fire chief responsible for the issue of ATF to departments.	NA

7 . GASEOUS EMISSIONS

7.1 Sources

- Flare stacks
- Gas turbine exhausts
- Export pumps, AGC, GLPUP Compressor engines exhausts
- Diesel Fire pumps
- Hot oil heater stack
- Off-shore Platforms: Cold Venting of natural gas

7.1.1 Flare system

- The high pressure flare system will collect discharges from relief valves and blowdown valves and direct them to a flare for safe disposal. The HP flare is sized for the emergency blowdown of the onshore facilities. Height of the stack is less than 30 mts but an exemption from Pollution Control Board exists.
- LP flare burns the relief and control valve outlets from LP separator system. Normally this burning is zero as the third stage gas recovery plant is available. However, flare lines are purged with continuous with gas, to prevent air ingression, amounts to 600-700 m3 per day. This gas will be continuously burnt at the flare tip.
- On Off-shore platforms cold venting of natural gas through a vent stack is allowed. This stack is meant to vent out the reliefs and control valves, by which venting is occasional. But the header is kept under gas purging with a minimum flow of gas.

FLARE

7.1.2 Gas turbine generators

GAS TURBINES

7.1.3 Hot oil system

The heat transfer media used throughout the system is therminol. Hot is used as the source of heat in the process exchanges to heat up the liquids. Heating of the oils takes place in a heater by burning fuel gas.

7.1.4 Applicable emission standards from APPCB-CTO (Air Consent):

Parameter	Emission Standards
Particulate matter	115 mg/Nm3
AAQ Standards	
PM_{10}	100 µg/m^3
$PM_{2.5}$	60 µg/m3
SO2	80 ug/m3
NOx	80 ug/m3

Noise Levels: Day time (6 am to 9 pm) = 75 dB (A)

Night time (9 pm to 6 am) = 70 dB (A)

GASSEOUS EMISSION STREAM – RESPONSIBLE DISPOSAL

Emissions	Points of generation	Treatment Strategy	Monitoring	Discharge Medium
Flared Natural Gas	Lean gases Fugitive emission from production vessel reliefs	Flaring after scrubbing from oily particles.	Monthly Ambient Air Quality monitoring.	Open air (Atmosphere)
Cold venting of Natural gas	Platform vents	No treatment. Cold venting only. Minimized flow rates of purging and instrument gas venting.	Annual Post Project monitoring at off-shore	Open air (Atmosphere)
Gas Turbines flue gases	Solar GTG (4 nos) vents.	---	Monthly stack gases monitoring	Open air (Atmosphere)
Diesel Generator vent gases	Plant & LQ EmDGs vents.	---	Monthly stack gases monitoring. (In operation only during GTG breakdowns, which is a very remote scenario).	Open air (Atmosphere)

Emissions	Points of generation	Treatment Strategy	Monitoring	Discharge Medium
Flue gas emissions	• Hot Oil heater vent • AGCs vent (4 nos) • TSGR vent (2 nos) • RSGDP gas compressor vents (3) • Export pump vents (2) • Diesel fire water pumps vents (7 nos) • GLUP Vents (2nos.)	---	Monthly Ambient Air Quality monitoring	Open air (Atmosphere)
Vapours from glycol re-boiler	Glycol re-boiler	Traces of glycol vapors venting from glycol re-boiler	---	Open air (Atmosphere)

8 SOLID WASTE

8.1 Sources

The generating sources are considered as all the areas like process plant, offshore, workshops, office buildings, LQ, ware house, pantries, mess Helihanger etc. Solid waste is mainly classified by the characteristic nature into two categories: Hazardous waste and non-hazardous waste. Generation, storage, treatment, transportation and disposal of hazardous wastes are carried out under the guidelines of Hazardous Waste Management Rules.

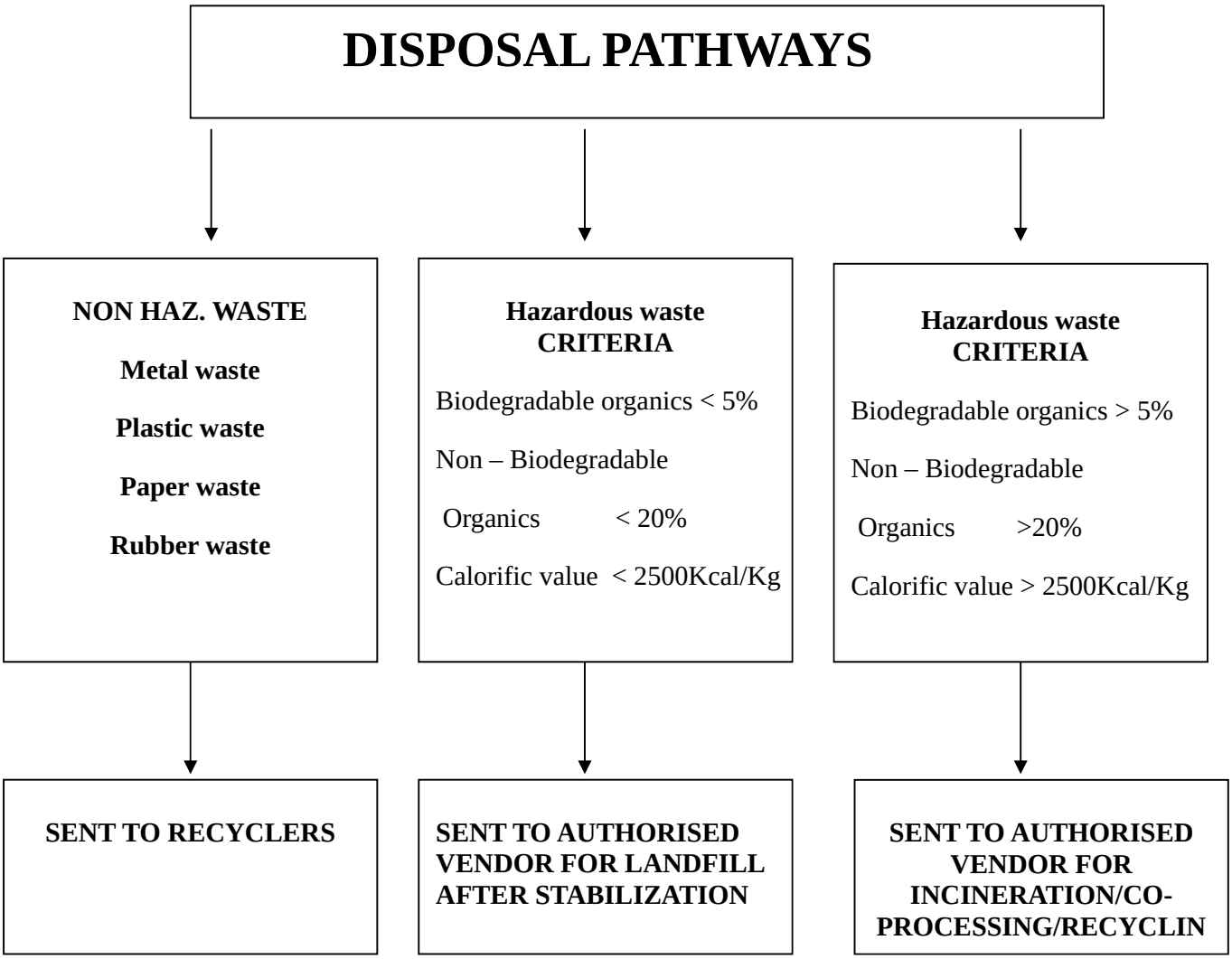
8.2 Solid waste collection, segregation, storage and disposal

The solid waste will be collected from the bins located at required locations and directly from the generating sources and will be segregated at storage yard by the Waste management team. The quantity will be recorded on daily basis. In order to segregate the waste at source, the colour bins were introduced and placed at strategic locations. After complete segregation the wastes will be stored at designated locations. Equipment/pipes removed from operation shall be free of oil/oil traces before taking in to metal scrap yard. The Hazardous waste collected from the locations will be sent for incineration or stored in Hazardous waste storage yard according to category of the waste.

Metal scarp yard is for storing all Metal waste

Non-metal scarp Yard is for storage of all Non-metal disposable items such as: Paper, Plastic, Insulation waste, Glass waste, Non-hazardous filters, cut cables, rubber tubes, etc.,

WASTE DISPOSAL CRITERIA



Type of waste	Category	Point (s) of generation	Waste bins location	Colour coding of waste bin	Disposal method
Oil Sludge	Hazardous	Storage tanks, API, Vessels, drains & maintenance works in the plant	No need to locate separate bins. Mobilize bins as and when required and place them in hazardous waste storage area.	Nil	Co processing in cement kilns
Waste oil	Hazardous	Storage tanks, API, Vessels,	No need to locate separate bins. Moblize in drums as and when required and place them in hazardous waste storage area.	Nil	To be disposed to recyclers
Oil soaked saw dust	Hazardous	Separators, CDDs, ETP, skimmer vessels, drain pits and lines, collected sand during cleaning operations	1.C.S.U 2.Fire station	Pink	Co processing in cement kilns
Oil soaked cotton waste	Hazardous	Offshore / Onshore	Offshore / Onshore		Sent for co processing./TSDF
Used ATF	Hazardous	UHPL Base	Collected in drums		Recycling in to the system / used in fire training ground
Waste lube oil	Hazardous	Engines, turbines, pumps	Collected in drums as and when generated and Pumping back to the system	Nil	Recycling in to the system
Waste Battery	Hazardous	Electrical battery room, Instrument work shop.	Store the batteries in HWS shed.	N/A	Authorized vendors/return to Dealers
Glass Waste(Normal glass,	Non-Hazardous	Chemical lab, Electrical work shop, Inst work shop, LQ	1. Chemical Lab (2 nos) 2. Behind LQ kitchen (2 nos)	Blue	Disposed to Recyclers
CFL lamps and tube lights.	Hazardous	Electrical work shop, LQ	1. Electrical sub-station (2 nos) 2. Behind LQ kitchen (1 nos	Blue	Disposed to TSDF
Bio-medical waste	Hazardous	Plant clinic, village clinic	1. Small bins in clinic, Village clinic and LQ-sick bay room (2 nos each-one for sharps and one for solid waste) 2. Drums in HWS area - 3 nos	Waste medicines - Black container Sharps-Blue Solid waste – Yellow Plastic -Red	Authorized vendors
Insulation material	Hazardous	On-shore and off-shore vessels and pipe lines	Pack in bags and place in Non-metal scrap yard	N/A	Disposed to TSDF
Aerosol cans	Non Hazardous	Mechanical work shop, off-shore, Inst work shop, Electrical workshop, Projects workshop, LQ	1. Mechanical work shop 2. Electrical dept 3. Projects work shop 4. LQ-behind kitchen	Orange	Disposed as metal waste after decontamination
Metal Scrap	Non-Hazardous	Mechanical/Projects/Instrument work shops	1. Mechanical work shop (large) 2. Electrical dept (Medium) 3. Projects work shop (Large) 4. LQ-behind kitchen (Medium) 5. CSU	Blue band	Disposed to Recyclers
Filters (Oil & Glycol services)	Hazardous	On-shore and off-shore	Filters will be mobilized to hazardous storage yard as and when generated.	NIL	Disposed to TSDF
Filters (Water Injection service)	Hazardous	Off-shore	To be transported back to site from off-shore and dump in the Non-metal yard.	Nil	Disposed to Recyclers
ETP centrifuge waste	Hazardous	Centrifuge waste	Collect in barrels and transfer them the HWS area. Do not store in the ETP area	Nil	Co-processing in cement kilns/TSDF
Chemical drums	Hazardous	Chemical storage yard	Empty drums shall be decontaminated and placed in the HWS area.	N/A	Will be Taken back by the chemical vendor /PCB authorized vendor
Oily cotton waste	Hazardous	All plant areas	Yellow colour bins were placed at different locations in the plant area.	Yellow	Co-processing cement kilns
Kitchen waste	Non-Hazardous	LQ catering, Plant pantries (3)	1. LQ-behind kitchen (Large) 2. Mech work shop (Small) 3. Projects bldg (Small)	Green	Composting in our own facility / sent to piggery

			4. Old Control room (Small)		
Plastic waste	Non-Hazardous	LQ catering, Plant pantries (3), Workshop, Warehouse, Off-shore	1. LQ-behind kitchen (Large) 2. Mech work shop (Large) 3. Projects bldg (Large) 4. Old Control room (Large)	Green	Disposed to Recyclers
Paper waste	Non-Hazardous	All offices & LQ	All departments shall store the waste papers in designated containers and will be collected and stored at designated location.	Small blue bins	Disposed to recyclers /used in OWC
Thermocol	Hazardous	Warehouse, workshops	Departments to pack the material in bags and place in non-metal scrap yard.	N/A	Disposed to TSDF
Electrical cables / cable cuts	Non-Hazardous	Electrical dept. Instruments	1. Electrical dept (large) 2. Instruments dept (Small)	Tan	Disposed to recyclers
Paint cans / Paint peelings	Hazardous	Paint stores	Place the cans in the vacant bunded place beside HWS shed after decontamination. Store the paint peeling s in the HWS.	N/A	Disposed to TSDF
STP sludge	Non-Hazardous	Plant STP tank	Engage Septiclean. No storage required.	N/A	Septiclean,
Dry grass	Non-Hazardous	Plant areas	Remove from plant as and when cut in the plant areas.	N/A	Direct land fill
PVC hoses, pipes	Non-Hazardous	Plant	Bin used for plastic waste bin can be used for dumping PVC waste. Can be segregated at non-metal scrap yard.	N/A	To be sent to Recyclers
Rubber tyres and mats	Non-Hazardous	Cycle maintenance shop, Electrical dept, Fire department	Cycle repairer shall dump directly in the non-metal scrap yard.	N/A	To be sent to Recyclers
E. Waste	Hazardous.	Instrument work shop, Electrical work shop I.T.Centre,Ware house.	Electrical, instrumentation, I.T, Ware house.	Silver Band	To be disposed to authorised facility
X-ray films,	Hazardous	Plant	No need to locate separate bins. Moblize bins as and when required and place them in hazardous waste storage area.	Nil	Disposed to TSDF
Respiratory canister / cartridges,	Hazardous	Plant	No need to locate separate bins. Moblize bins as and when required and place them in hazardous waste storage area.	Nil	Disposed to TSDF
printer cartridges	Hazardous	Plant	No need to locate separate bins. Moblize bins as and when required and place them in hazardous waste storage area.	Nil	Old cartridges are sent back to IT department.
Asset Scrap	Non Hazardous	Plant	NA	Nil	As per asset scrap disposal procedure
Activated carbon		Plant	Collect in barrels and transfer them the HWS area. Do not store in the ETP area	Nil	Sent to co processing
Contaminated Copper slag	Hazardous	Plant	Collect in drums and store them in HWSY	Nil	Sent to secured land fill
Contaminated Oily sand	Hazardous	Plant	Collect in drums and store them in HWSY	Nil	Sent to TSDF/APPCB Authorized vendors/co-processing in cement kilns.

8.3 Health & Safety requirements for collection, segregation, transportation & disposal.

- Make sure floors [**walking and working surface**] is clean, free of slip, trip or fall hazards, protrusions, nails, biological hazards etc ; all openings covered or barricaded & proper drainage (in an orderly manner)is maintained.
- Adequate **Ventilation for** the intended purpose to be maintained at all times.
- Walking and working areas to be **adequately illuminated** during periods of occupancy at all times.
- Always **maintain normal body positions** when (seated or standing) while working. Lifting and twisting in combination not to be done in any case. Always prefer for mechanical material handling / transport, in any case restrict the weight to 30 Kg if being carried manually.
- Maintain **normal body position** while using hand tools.
- Use all **PPE** required (Dust mask, Goggles, Hand gloves etc.).
- Take appropriate personnel safety measures while handling waste.
- Aisle ways and access paths to be kept clear and unobstructed;
- Small or irregular shaped items to be properly blocked, inter-linked, with proper limitations in height of storage; All stocks to be made stable and to be secured against sliding/ collapsing. Proper drainage to be maintained at all times in storage area
- Always keep the storage area clean and cleared of foreign objects/ materials;
- Comply with the lifting load limits posted and observed.
- All waste storage areas shall be assessed for the fire potential and appropriate fire suppression system shall be provided.

9 RESPONSIBILITY

Obtaining the consent to operate (and its renewal) for the production facility lies with the Manager- Environment & GM- Operations.

Obtaining and renewal of Hazardous waste authorization and Bio-medical waste authorization lies with Manager- Environment & GM- Operations

Implementation of Waste Management Plan lies with FMP, FMM, and all departmental In-charges.

Monitoring overall waste management plan implementation lies with Fire chief-Ravva

Facilitation and authorisation for Solid Hazardous Waste disposal lies with Fire chief Ravva.

Analysing and compiling the data of waste water stream to the CRMS database lies with laboratory, IM-Secretary & HSE-Ravva.

Operational maintenance of all the pollution control equipment lies with the production department.

Monitoring & statutory reports compliance of the APPCB consent conditions lies with HSE.

Request for quotation for hazardous waste disposal / recycling shall be floated to only those facilities which have been approved after auditing by CIL personnel. Audit validity shall be limited to 2 years or as and when any process change has been made in the particular facility. Manager – Fire shall be responsible for this.

Asset scrap disposal frequency dependent on JV approval hence disposal shall be carried out within 90 days from the date of receipt of approval from JV.

Annex 6

Relevant Excerpts from Oil Spill Contingency Plan (OSCP) for Offshore Operations of Ravva Field,

Vedanta Limited (Vedanta Ltd (Cairn Oil & Gas), Doc Ref: VL-RV-QHSE-OSCP-01, July 2017

Oil Spill Modeling Outputs
(OSCP Ref: Page 60-65)

a. January:

In the beginning of this month, the resultant currents of both surface currents and winds are towards Southwest & west. The currents are changing the direction based on the resultant forces for wind and surface currents. The circulation is highly complex with the residual currents (maximum) of the order of 0.2 m/sec.

The slick movement is variable and moves in Southwest direction based on the wind forcing. The effect of wind forcing is significantly higher than surface current drift. **Figs.A3.1 – A3.3** shows the spill trajectory of 100 t instantaneous spills at SBM, RA/RC and at pipeline respectively. The spill at SBM will be moving parallel to the coast and westwards to the spill location and landing between the geo-coordinates 81012′ and 81036′ after 15 days. In case of spill at RA/RC will be landing partially at 810 36′ after 264 hours and remaining portion between 810 24′ and 81012′ after 12 days. The spill at pipeline will be reaching to the coast early after 7 days partially and landing remaining portion of oil along the coast between longitudes 81.230 E - 81.88 0E. **Figs.A4.1 – A4.3** shows the spill trajectory of 1000 tons at SBM, RA/RC and at pipeline respectively. **Figs.A5.1 – A5.3** shows the spill trajectory of 5000 tons and at pipeline respectively. From the figures it can be seen that the behaviour of slick movement is more or less similar in various scenarios irrespective of quantities of oil spilled.

The extent of spreading of oil differs depending on the source quantities. The details of the spill losses during its movement and time taken to reach the coast from all locations have been furnished in **Table-1**. From the table, it can be inferred that nearly 75% of oil volume has been lost due to evaporation and dissolution processes and the remaining quantity will be on the coast.

b. February:

In this month, wind direction varies from Northeast direction to Southwest. The resultant currents of both surface currents and winds are towards Northeast direction. The currents are changing the direction based on the tide Southwest to Northeast. The circulation is highly complex with residual currents (maximum) of the order of 0.15 m/s.

The slick movement is variable and moves in Northeast direction based on the wind forcing. The effect of wind forcing is significantly higher than surface current drift. **Figs.A3.4 – A3.6** shows the spill trajectory of 100 t instantaneous spills at SBM, RA/RC and at pipeline respectively. The spill at SBM will be moving towards the coast northwards to the spill location and landing between the geo-coordinates 82.190 E and 82.350 E after 4.2 days. In case of spill at RA/RC will be landing partially at 82.190 E after 3 days and remaining portion between 82.190 E and 82.350 E after 3 days. The spill at pipeline will be reaching to the coast early after 2 days partially and landing remaining portion of oil along the coast between longitudes 82.190 E and 82.350 E after 4 days. The behaviour of slick movement is more or less similar in various scenarios irrespective of quantities of oil spilled.

The extent of spreading of oil differs depending on the source quantities. **Figs.A4.4 – A4.6** shows the spill trajectory of 1000 tons at SBM, RA/RC and at pipeline respectively. **Figs.A5.4 – A5.6** shows the spill trajectory of 5000 tons and at pipeline respectively. The details of the spill losses during its movement and time taken to reach the coast from all locations have been furnished in **Table-2**. From the table, it can be inferred that nearly 40% to 70% of oil volume has been lost due to evaporation and dissolution processes depending on the their trajectory period and the remaining quantity will be on the coast.

c. March

In the beginning of this month, the resultant currents of both surface currents and winds are towards Southwest to Northeast. The currents are changing the direction based on the tide Northeast to Southwest. The circulation is highly complex with the residual currents (maximum) of the order of 0.17 m/sec.

The slick movement is variable and moves in Southwest direction based on the wind forcing. The effect of wind forcing is significantly higher than surface current drift. **Figs.A3.7 – A3.9** shows the spill trajectory of 100 t instantaneous spills at SBM, RA/RC and at pipeline respectively. The spill at SBM will be moving southwest direction to the spill location and landing at 82.010 E after 2 days. In case of spill at RA/RC will be landing partially at 81.010 E after 1.5 days and remaining portion between 81.990 E and 82.010 E after 3.2 days. The spill at pipeline will be reaching to the coast early after 0.5 days partially and landing remaining portion of oil along the coast between longitudes 82.010 E - 82.15 0E. The behaviour of slick movement is more or less similar in various scenarios irrespective of quantities of oil spilled.

The extent of spreading of oil differs depending on the source quantities. **Figs.A4.7 – A4.9** shows the spill trajectory of 1000 tons at SBM, RA/RC and at pipeline respectively. **Figs.A5.7 – A5.9** shows the spill trajectory of 5000 tons and at pipeline respectively. The details of the spill losses during its movement and time taken to reach the coast from all locations have been furnished in **Table-3**. From the table, it can be inferred that nearly 60% of oil volume has been lost due to evaporation and dissolution processes and the remaining quantity will be on the coast.

d. April

The spill in the beginning of the month also behaves like March spill scenario, the resultant of both surface currents and winds are towards North and Northeast. The currents are changing the direction based on the tide Northeast to Southwest. The circulation is highly complex with residual currents (maximum) of the order of 0.15 m/s.

The slick movement is variable and moves in Northeast direction based on the wind forcing. The effect of wind forcing is significantly higher than surface current drift. **Figs.A3.10 – A3.12** shows the spill trajectory of 100 t instantaneous spill at SBM, RA/RC and at pipeline respectively. The spill at SBM will be moving Northeast direction to the spill location and landing at 82.150 after 2 days. In case of spill at RA/RC will be landing partially at 82.150 after 1.5 days and remaining portion between 82.150 and 82.280 after 3 days. The spill at pipeline will be reaching to the coast early after 0.3 days partially and landing remaining portion of oil along the coast between 82.150 E and 82.280 E after 3

days. The behaviour of slick movement is more or less similar in various scenarios irrespective of quantities of oil spilled.

The extent of spreading of oil differs depending on the source quantities. **Figs.A4.10 – A4.12** shows the spill trajectory of 1000 tons at SBM, RA/RC and at pipeline respectively. **Figs.A5.10 – A5.12** shows the spill trajectory of 5000 tons and at pipeline respectively. The details of the spill losses during its movement and time taken to reach the coast from all locations have been furnished in **Table-4**. From the table, it can be inferred that nearly 60% of oil volume has been lost due to evaporation and dissolution processes and the remaining quantity will be on the coast.

e. May

In the beginning of this month, the resultant currents of surface currents and winds are towards Northeast and Southwest. The currents are changing the direction based on the tide Southwest to Northeast. The circulation is highly complex with the residual currents (maximum) of the order of 0.2 m/sec.

The slick movement is variable and moves in North direction based on the wind forcing. The effect of wind forcing is significantly higher than surface current drift. **Figs.A3.13 – A3.15** shows the spill trajectory of 100 t instantaneous spill at SBM, RA/RC and at pipeline respectively. The spill at SBM will be moving North direction to the spill location and landing at around 82.130 E after 2 days. In case of spill at RA/RC will be landing partially at 82.130 E after 1.5 days and remaining portion between 82.130 E and 82.250 E after 3 days. The spill at pipeline will be reaching to the coast early after 0.3 days partially and landing remaining portion of oil along the coast between 82.130 E and 82.250 E after 3 days. The behaviour of slick movement is more or less similar in various scenarios irrespective of quantities of oil spilled.

The extent of spreading of oil differs depending on the source quantities. **Figs.A4.13 – A4.15** shows the spill trajectory of 1000 tons at SBM, RA/RC and at pipeline respectively. **Figs.A5.13 – A5.15** shows the spill trajectory of 5000 tons and at pipeline respectively. The details of the spill losses during its movement and time taken to reach the coast from all locations have been furnished in **Table-5**. From the table, it can be inferred that nearly 65% of oil volume has been lost due to evaporation and dissolution processes and the remaining quantity will be on the coast.

f. June

In the beginning of this month, the resultant currents of both surface currents and winds are towards Northeast. The currents are changing the direction based on the tide Southwest to Northeast. The circulation is highly complex with the residual currents (maximum) of the order of 0.17 m/sec.

The slick movement is variable and moves in Northeast direction based on the wind forcing. The effect of wind forcing is significantly higher than surface current drift. **Figs.A3.16 – A3.18** shows the spill trajectory of 100 tons instantaneous spill at SBM, RA/RC and at pipeline respectively. The spill at SBM will be moving northwards to the spill location and landing between the geo-coordinates 82.150 E and 82.280 E after 3.5

days. In case of spill at RA/RC will be landing partially at 82.150 E after 2 days and remaining portion between 82.150 E and 82.280 E after 5 days. The spill at pipeline will be reaching to the coast early after 0.5 days partially and landing remaining portion of oil along the coast between longitudes 82.150 E and 82.280 E. The behaviour of slick movement is more or less similar in various scenarios irrespective of quantities of oil spilled.

The extent of spreading of oil differs depending on the source quantities. **Figs.A4.16 – A4.18** shows the spill trajectory of 1000 tons at SBM, RA/RC and at pipeline respectively. **Figs.A5.16 – A5.18** shows the spill trajectory of 5000 tons and at pipeline respectively. The details of the spill losses during its movement and time taken to reach the coast from all locations have been furnished in **Table-6**. From the tables, it can be inferred that nearly 70% of oil volume has been lost due to evaporation and dissolution processes and the remaining quantity will be on the sea.

g. July

The resultant currents of both the surface currents and winds are towards Northeast in the beginning of this month. The currents are changing the direction based on the tide Southwest to Northeast. The circulation is highly complex with the residual currents (maximum) of the order of 0.16 m/sec.

The slick movement is variable and moves in Northeast direction based on the wind forcing. The effect of wind forcing is significantly higher than surface current drift. The spill at SBM will be moving Northeast wards to the spill location and moving out of computational domain after 12 days. In case of spill at RA/RC and pipeline spills will be moving towards open sea and crossing the computational domain after 12 days. The behaviour of slick movement is more or less similar in various scenarios irrespective of quantities of oil spilled.

The extent of spreading of oil differs depending on the source quantities. **Figs.A3.19 – A3.21** shows the spill trajectory of 100 t instantaneous spill at SBM, RA/RC and at pipeline respectively. **Figs.A4.19 – A4.21** shows the spill trajectory of 1000 tons at SBM, RA/RC and at pipeline respectively. **Figs.A5.19 – A5.21** shows the spill trajectory of 5000 tons and at pipeline respectively. The details of the spill losses during its movement and time taken to reach the coast from all locations have been furnished in **Table-7**. From the tables, it can be inferred that nearly 78% of oil volume has been lost due to evaporation and dissolution processes and the remaining quantity will be on the sea.

h. August

The spill trajectory in this month is similar to July and the resultant currents of both the surface currents and winds are towards Northeast. The currents are changing the direction based on the tide Southwest to Northeast. The circulation is highly complex with the residual currents (maximum) of the order of 0.19 m/sec.

The slick movement is variable and moves in Northeast direction based on the wind forcing. The effect of wind forcing is significantly higher than surface current drift. The spill at SBM will be moving Northeast wards to the spill location and moving out of

computational domain after 15 days. In case of spill at RA/RC and pipeline spills will be moving towards open sea and crossing the computational domain after 15 days. The behaviour of slick movement is more or less similar in various scenarios irrespective of quantities of oil spilled.

The extent of spreading of oil differs depending on the source quantities. **Figs.A3.22 – A3.24** shows the spill trajectory of 100 t instantaneous spill at SBM, RA/RC and at pipeline respectively. **Figs.A4.22 – A4.24** shows the spill trajectory of 1000 tons at SBM, RA/RC and at pipeline respectively. **Figs.A5.22– A5.24** shows the spill trajectory of 5000 tons and at pipeline respectively. The details of the spill losses during its movement and time taken to reach the coast from all locations have been furnished in **Table-8**. From the table, it can be inferred that nearly 78% of oil volume has been lost due to evaporation and dissolution processes and the remaining quantity will be on the sea.

i. September

In the beginning of this month, the surface currents and winds are towards Northeast. The currents are changing the direction based on the tide Southwest to Northeast. The circulation is highly complex with residual currents (maximum) of the order 0.20 m/s.

The slick movement is variable and moves in East direction based on the wind forcing. The effect of wind forcing is significantly higher than surface current drift. The spill at SBM will be moving East wards to the spill location and moving out of computational domain after 18 days. In case of spill at RA/RC and pipeline spills will be moving towards open sea and crossing the computational domain after 18 days. The behavior of slick movement is more or less similar in various scenarios irrespective of quantities of oil spilled.

The extent of spreading of oil differs depending on the source quantities. **Figs.A3.25 – A3.27** shows the spill trajectory of 100 t instantaneous spill at SBM, RA/RC and at pipeline respectively. **Figs.A4.25 – A4.27** shows the spill trajectory of 1000 tons at SBM, RA/RC and at pipeline respectively. **Figs.A5.25– A5.27** shows the spill trajectory of 5000 tons and at pipeline respectively. The details of the spill losses during its movement and time taken to reach the coast from all locations have been furnished in **Table-9**. From the table, it can be inferred that nearly 79% of oil volume has been lost due to evaporation and dissolution processes and the remaining quantity will be on the sea.

j. October

In the beginning of this month the results forces due to surface currents and winds are towards West and Southwest. The currents are changing the direction based on the tide Southwest to Northeast. The circulation is highly complex with the residual currents (maximum) of the order of 0.2 m/sec.

The slick movement is variable and moves in west in the beginning and then Southwest direction based on the wind forcing. The effect of wind forcing is significantly higher than surface current drift. The spill at SBM will be moving parallel to the coast westwards to the spill location and crossing the computational domain after 19 days. In case of spill at RA/RC will be landing partially at 81.930 E after 5 days and remaining portion crosses

the open sea boundary after 18 days. The spill at pipeline will be reaching to the coast early after 4 days partially and landing remaining portion of oil crosses the open sea boundary after 23 days. The behaviour of slick movement is more or less similar in various scenarios irrespective of quantities of oil spilled.

The extent of spreading of oil differs depending on the source quantities. **Figs.A3.28 – A3.30** shows the spill trajectory of 100 t instantaneous spill at SBM, RA/RC and at pipeline respectively. **Figs.A4.28 – A4.30** shows the spill trajectory of 1000 tons at SBM, RA/RC and at pipeline respectively. **Figs.A5.28 – A5.30** shows the spill trajectory of 5000 tons and at pipeline respectively. The details of the spill losses during its movement and time taken to reach the coast from all locations have been furnished in **Table-10**. From the table, it can be inferred that nearly 80% of oil volume has been lost due to evaporation and dissolution processes and the remaining quantity will be on the sea.

k. November

In the beginning of this month the resultant of both surface currents and winds are towards Southwest. The currents are changing the direction based on the tide Southwest to Northeast. The circulation is highly complex with the residual currents (maximum) of the order of 0.18 m/sec.

The slick movement is variable and moves in Southwest direction based on the wind forcing. The effect of wind forcing is significantly higher than surface current drift. The spill at SBM will be moving Southeast wards to the spill location and moving out of computational domain after 12 days. In case of spill at RA/RC and pipeline spills will be moving towards open sea and crossing the computational domain after 12 days. The behaviour of slick movement is more or less similar in various scenarios irrespective of quantities of oil spilled.

The extent of spreading of oil differs depending on the source quantities. **Figs.A3.31 – A3.33** shows the spill trajectory of 100 t instantaneous spill at SBM, RA/RC and at pipeline respectively. **Figs.A4.31 – A4.33** shows the spill trajectory of 1000 tons at SBM, RA/RC and at pipeline respectively. **Figs.A5.31– A5.33** shows the spill trajectory of 5000 tons and at pipeline respectively. The details of the spill losses during its movement and time taken to reach the coast from all locations have been furnished in **Table-11**. From the table, it can be inferred that nearly 78% of oil volume has been lost due to evaporation and dissolution processes and the remaining quantity will be on the sea.

l. December

The spill during December also behaves like November spill scenarios and the surface currents and winds are towards Southwest. The currents are changing the direction based on the tide Southwest to Northeast. The circulation is highly complex with the residual currents (maximum) of the order of 0.18 m/sec.

The slick movement is variable and moves in Southwest direction based on the wind forcing. The effect of wind forcing is significantly higher than surface current drift. The spill at SBM will be moving Southeast wards to the spill location and moving out of computational domain after 12 days. In case of spill at RA/RC and pipeline spills will be

moving towards open sea and crossing the computational domain after 12 days. The behaviour of slick movement is more or less similar in various scenarios irrespective of quantities of oil spilled.

The extent of spreading of oil differs depending on the source quantities. **Figs.A3.33 – A3.36** shows the spill trajectory of 100 t instantaneous spill at SBM, RA/RC and at pipeline respectively. **Figs.A4.33 – A4.36** shows the spill trajectory of 1000 tons at SBM, RA/RC and at pipeline respectively. **Figs.A5.33– A5.36** shows the spill trajectory of 5000 tons and at pipeline respectively. The details of the spill losses during its movement and time taken to reach the coast from all locations have been furnished in **Table-10**. From the table, it can be inferred that nearly 79% of oil volume has been lost due to evaporation and dissolution processes and the remaining quantity will be on the sea.

Oil Spill Modeling Tables *(OSCP Ref: Appendix 2)*

Table 1: Oil Spill Analysis: Spill Quantity, amount of oil reaching the land / domain boundaries and oiling in the coast (m) due to continuous oil spill for the month of– January

Spill Location	Spill Quantity (tons) of Crude Oil	Losses (tons)	Time taken to reach coast/open boundaries (days)	Quantity of oil on surface (tons)	Quantity of oil reaching to the coast/domain boundaries (tons)		Oiling in the coast, (m)	Location
					Coast	Domain Boundaries		
SPM	100	78	16.8	22	22	-	2000m	Reached Northern coast (1803463 N 540745 E)
RA/RC	100	78	12	22	22	-	20000m	Reached Northern coast (1805239N 569857 E)
Pipeline	100	78	6	22	22	-	10000m	Reached Northern coast (1811885N 596828 E)
SPM	1000	750	16.8	250	250	-	3000m	Reached Northern coast (1803463 N 540745 E)
RA/RC	1000	750	12	250	250	-	23000m	Reached Northern coast (1805239N 569857 E)
Pipeline	1000	750	6	250	250	-	20000m	Reached Northern coast (1811885N 596828 E)
SPM	5000	3400	16.8	1600	1600	-	5000m	Reached Northern coast (1803463 N 540745 E)
RA/RC	5000	3400	12	1600	1600	-	25000m	Reached Northern coast (1805239N 569857 E)
Pipeline	5000	3400	6	1600	1600	-	25000m	Reached Northern coast (1811885N 596828 E)

Table 2: Oil Spill Analysis: Spill Quantity, amount of oil reaching the land / domain boundaries and oiling in the coast (m) due to continuous oil spill for the month of– February

Spill Location	Spill Quantity (tons) of Crude Oil	Losses (tons)	Time taken to reach coast/open boundaries (days)	Quantity of oil on surface (tons)	Quantity of oil reaching to the coast/domain boundaries (tons)		Oiling in the coast, (m)	Location
					Coast	Domain Boundaries		
SPM	100	79	5	21	21	-	6000	Reached Northern coast (1828131N 630303 E)
RA/RC	100	79	4.5	21	21	-	6000	Reached Northern coast (1827441N 628845 E)
Pipeline	100	79	3.5	21	21	-	6000	Reached Northern coast (1826093N 625882 E)
SPM	1000	700	5	300	300	-	7000	Reached Northern coast (1828131N 630303 E)
RA/RC	1000	700	4.5	300	300	-	8000	Reached Northern coast (1827441N 628845 E)
Pipeline	1000	700	3.5	300	300	-	8000	Reached Northern coast (1826093N 625882 E)
SPM	5000	3200	5	1800	1800	-	9000	Reached Northern coast (1828131N630303 E)
RA/RC	5000	3200	4.5	1800	1800	-	12000	Reached Northern coast (1827441N 628845 E)
Pipeline	5000	3200	3.5	1800	1800	-	10000	Reached Northern coast (1826093N 625882 E)

Table 3: Oil Spill Analysis: Spill Quantity, amount of oil reaching the land / domain boundaries and oiling in the coast (m) due to continuous oil spill for the month of– March

Spill Location	Spill Quantity (tons) of Crude Oil	Losses (tons)	Time taken to reach coast/open boundaries (days)	Quantity of oil on surface (tons)	Quantity of oil reaching to the coast/domain boundaries (tons)		Oiling in the coast, (m)	Location
					Coast	Domain Boundaries		
SPM	100	62	1.66	38	38	-	10000m	Reached Northern coast (1814851N 605003E)
RA/RC	100	62	1.25	38	38	-	10000m	Reached Northern coast (1817196N 609934E)
Pipeline	100	62	0.83	38	38	-	10000m	Reached Northern coast (1822388N 618529E)
SPM	1000	600	1.66	47	47	-	10000m	Reached Northern coast (1814851N 605003E)
RA/RC	1000	600	1.25	47	400	-	11000m	Reached Northern coast (1817196N 609934E)
Pipeline	1000	600	0"83	47	300	-	11000m	Reached Northern coast (1822388N 618529E)
SPM	5000	3000	1.66	2000	2	-	10000m	Reached Northern coast (1814851N 605003E)
RA/RC	5000	3000	1.25	2000	2	-	11000m	Reached Northern coast (1817196N 609934E)
Pipeline	5000	3000	0.83	2000	2000	-	11000m	Reached Northern coast (1822388N 618529E)

Table 4: Oil Spill Analysis: Spill Quantity, amount of oil reaching the land / domain boundaries and oiling in the coast (m) due to continuous oil spill for the month of– April

Spill Location	Spill Quantity (tons) of Crude Oil	Losses (tons)	Time taken to reach coast/open boundaries (days)	Quantity of oil on surface (tons)	Quantity of oil reaching to the coast/domain boundaries (tons)		Oiling in the coast, (m)	Location
					Coast	Domain Boundaries		
SPM	100	70	1.66	30	30	-	1007	Reached Northern coast (1825615N 624047E)
RA/RC	100	70	1.25	30	30	-	1107	Reached Northern coast (1825117N 623044E)
Pipeline	100	70	0.83	30	30	-	9000	Reached Northern coast (1824435N 622655E)
SPM	1000	610	1.66	3	390	-	1007	Reached Northern coast (1825615N 624947E)
RA/RC	1000	610	1.25	390	390	-	1107	Reached Northern coast (1825117N 623944E)
Pipeline	1000	610	0.83	390	390	-	9000	Reached Northern coast (1824435N 622655E)
SPM	5000	3000	1.66	2000	2000	-	10000	Reached Northern coast (1825615N 624947E)
RA/RC	5000	3000	1.25	2000	2000	-	11000	Reached Northern coast (1825117N 623944E)
Pipeline	5000	3000	0.83	2000	2000	-	9000	Reached Northern coast (1824435N 622655E)

Table 5: Oil Spill Analysis: Spill Quantity, amount of oil reaching the land / domain boundaries and oiling in the coast (m) due to continuous oil spill for the month of– May

Spill Location	Spill Quantity (tons) of Crude Oil	Losses (tons)	Time taken to reach coast/open boundaries (days)	Quantity of oil on surface (tons)	Quantity of oil reaching to the coast/domain boundaries (tons)		Oiling in the coast, (m)	Location
					Coast	Domain Boundaries		
SPM	100	60	1.5	40	40	-	2000	Reached Northern coast (1822542N 618803E)
RA/RC	100	60	1.1	40	40	-	2000	Reached Northern coast (1823187N 620176E)
Pipeline	100	60	0.35	40	40	-	1000	Reached Northern coast (1823832N 621497 **E)**
SPM	1000	590	1.5	410	410	-	2000	Reached Northern coast (1822542N 618803E)
RA/RC	1000	590	1.1	410	410	-	2000	Reached Northern coast (1823187N 620176E)
Pipeline	1000	590	0.35	410	410	-	1000	Reached Northern coast (1823832N 621497 **E)**
SPM	5000	2800	1.5	2200	2200	-	2000	Reached Northern coast (1822542N 618803E)
RA/RC	5000	2800	1.1	2200	2200	-	2000	Reached Northern coast (1823187N 620176E)
Pipeline	5000	2800	0.35	2200	2200	-	1000	Reached Northern coast (1823832N 621497 **E)**

Table 6: Oil Spill Analysis: Spill Quantity, amount of oil reaching the land / domain boundaries and oiling in the coast (m) due to continuous oil spill for the month of– June

Spill Location	Spill Quantity (tons) of Crude Oil	Losses (tons)	Time taken to reach coast/open boundaries (days)	Quantity of oil on surface (tons)	Quantity of oil reaching to the coast/domain boundaries (tons)		Oiling in the coast, (m)	Location
					Coast	Domain Boundaries		
SPM	100	77	1.66	33	33	-	970	Reached Northern coast (1823972N 621721E)
RA/RC	100	77	1.5	33	33	-	970	Reached Northern coast (1824698N 623220E)
Pipeline	100	77	0.4	33	33	-	170	Reached Northern coast (1824335N 622512E)
SPM	1000	700	1.66	300	300	-	970	Reached Northern coast (1823972N 621721E)
RA/RC	1000	700	1.5	300	300	-	970	Reached Northern coast (1824698N 623220E)
Pipeline	1000	700	0.4	300	300	-	170	Reached Northern coast (1824335N 622512E)
SPM	5000	3200	1.66	1800	1800	-	970	Reached Northern coast (1823972N 621721E)
RA/RC	5000	3200	1.5	1800	1800	-	970	Reached Northern coast (1824698N 623220E)
Pipeline	5000	3200	0.4	1800	1800	-	170	Reached Northern coast (1824335N 622512 E)

Table 7: Oil Spill Analysis: Spill Quantity, amount of oil reaching the land / domain boundaries and oiling in the coast (m) due to continuous oil spill for the month of– July

Spill Location	Spill Quantity (tons) of Crude Oil	Losses (tons)	Time taken to reach coast/open boundaries (days)	Quantity of oil on surface (tons)	Quantity of oil reaching to the coast/domain boundaries (tons)		Oiling in the coast, (m)	Location
					Coast	Domain Boundaries		
SPM	100	78	13.2	22		22	-	Reaching the Eastern open ocean
RA/RC	100	78	13.2	22		22	-	Reaching the Eastern open ocean
Pipeline	100	78	13.2	22		22	-	Reaching the Eastern open ocean
SPM	1000	700	13.2	300		300	-	Reaching the Eastern open ocean
RA/RC	1000	700	13.2	300		300	-	Reaching the Eastern open ocean
Pipeline	1000	700	13.2	300		300	-	Reaching the Eastern open ocean
SPM	5000	3300	13.2	1700		1700	-	Reaching the Eastern open ocean
RA/RC	5000	3300	13.2	1700		1700	-	Reaching the Eastern open ocean
Pipeline	5000	3300	13.2	1700		1700	-	Reaching the Eastern open ocean

Table 8: Oil Spill Analysis: Spill Quantity, amount of oil reaching the land / domain boundaries and oiling in the coast (m) due to continuous oil spill for the month of– August

Spill Location	Spill Quantity (tons) of Crude Oil	Losses (tons)	Time taken to reach coast/open boundaries (days)	Quantity of oil on surface (tons)	Quantity of oil reaching to the coast/domain boundaries (tons)		Oiling in the coast, (m)	Location
					Coast	Domain Boundaries		
SPM	100	78	14.4	22	-	22	-	Reaching the Eastern open ocean
RA/RC	100	78	14.4	22	-	22	-	Reaching the Eastern open ocean
Pipeline	100	78	14.4	22	-	22	-	Reaching the Eastern open ocean
SPM	1000	700	14.4	300	-	300	-	Reaching the Eastern open ocean
RA/RC	1000	700	14.4	300	-	300	-	Reaching the Eastern open ocean
Pipeline	1000	700	14.4	300	-	300	-	Reaching the Eastern open ocean
SPM	5000	3200	14.4	1800	-	1800	-	Reaching the Eastern open ocean
RA/RC	5000	3200	14.4	1800	-	1800	-	Reaching the Eastern open ocean
Pipeline	5000	3200	14.4	1800	-	1800	-	Reaching the Eastern open ocean

Table 9: Oil Spill Analysis: Spill Quantity, amount of oil reaching the land / domain boundaries and oiling in the coast (m) due to continuous oil spill for the month of– September

Spill Location	Spill Quantity (tons) of Crude Oil	Losses (tons)	Time taken to reach coast/open boundaries (days)	Quantity of oil on surface (tons)	Quantity of oil reaching to the coast/domain boundaries (tons)		Oiling in the coast, (m)	Location
					Coast	Domain Boundaries		
SPM	100	79	19.5	21	-	21	-	Reaching the Eastern open ocean
RA/RC	100	79	19.5	21	-	21	-	Reaching the Eastern open ocean
Pipeline	100	79	19.5	21	-	21	-	Reaching the Eastern open ocean
SPM	1000	700	19.5	300	-	300	-	Reaching the Eastern open ocean
RA/RC	1000	700	19.5	300	-	300	-	Reaching the Eastern open ocean
Pipeline	1000	700	19.5	300	-	300	-	Reaching the Eastern open ocean
SPM	5000	3400	19.5	1600	-	1600	-	Reaching the Eastern open ocean
RA/RC	5000	3400	19.5	1600	-	1600	-	Reaching the Eastern open ocean
Pipeline	5000	3400	19.5	1600	-	1600	-	Reaching the Eastern open ocean

Table 10: Oil Spill Analysis: Spill Quantity, amount of oil reaching the land / domain boundaries and oiling in the coast (m) due to continuous oil spill for the month of– October

Spill Location	Spill Quantity (tons) of Crude Oil	Losses (tons)	Time taken to reach coast/open boundaries (days)	Quantity of oil on surface (tons)	Quantity of oil reaching to the coast/domain boundaries (tons)		Oiling in the coast, (m)	Location
					Coast	Domain Boundaries		
SPM	100	80	24	20	-	20	-	Reaching the Western open ocean
RA/RC	100	80	24.2	20	-	20	-	Reaching the Western open ocean
Pipeline	100	80	25.5	20	-	20	-	Reaching the Western open ocean
SPM	1000	750	24	250	-	250	-	Reaching the Western open ocean
RA/RC	1000	750	24.2	250	-	250	-	Reaching the Western open ocean
Pipeline	1000	750	25.5	250	-	250	-	Reaching the Western open ocean
SPM	5000	3500	24	1500	-	1500	-	Reaching the Western open ocean
RA/RC	5000	3500	24.2	1500	-	1500	-	Reaching the Western open ocean
Pipeline	5000	3500	25.5	1500	-	1500	-	Reaching the Western open ocean

Table 11: Oil Spill Analysis: Spill Quantity, amount of oil reaching the land / domain boundaries and oiling in the coast (m) due to continuous oil spill for the month of– October

Spill Location	Spill Quantity (tons) of Crude Oil	Losses (tons)	Time taken to reach coast/open boundaries (days)	Quantity of oil on surface (tons)	Quantity of oil reaching to the coast/domain boundaries (tons)		Oiling in the coast, (m)	Location
					Coast	Domain Boundaries		
SPM	100	78	13.5	22	-	22	-	Reaching the Western open ocean
RA/RC	100	78	14.3	22	-	22	-	Reaching the Western open ocean
Pipeline	100	78	15	22	-	22	-	Reaching the Western open ocean
SPM	1000	700	13.5	300	-	300	-	Reaching the Western open ocean
RA/RC	1000	700	14 3	300	-	300	-	Reaching the Western open ocean
Pipeline	1000	700	15	300	-	300	-	Reaching the Western open ocean
SPM	5000	3300	13.5	1700	-	1700	-	Reaching the Western open ocean
RNRC	5000	3300	14 3	1700	-	1700	-	Reaching the Western open ocean
Pipeline	5000	3300	15	1700	-	1700	-	Reaching the Western open ocean

Table 12: Oil Spill Analysis: Spill Quantity, amount of oil reaching the land / domain boundaries and oiling in the coast (m) due to continuous oil spill for the month of– October

Spill Location	Spill Quantity (tons) of Crude Oil	Losses (tons)	Time taken to reach coast/open boundaries (days)	Quantity of oil on surface (tons)	Quantity of oil reaching to the coast/domain boundaries (tons)		Oiling in the coast, (m)	Location
					Coast	Domain Boundaries		
SPM	100	79	15	21	-	21	-	Reaching the Western
RA/RC	100	79	16.2	21	-	21	-	open ocean
Pipeline	100	79	16.2	21	-	21	-	Reaching the Western
SPM	1000	700	15	300	-	300	-	open ocean
RA/RC	1000	700	16.2	300	-	300	-	Reaching the Western
Pipeline	1000	700	16.2	300	-	300	-	open ocean
SPM	5000	3200	15	1800	-	1800	-	Reaching the Western
RNRC	5000	3200	16.2	1800	-	1800	-	open ocean
Pipeline	5000	3200	16.2	1800	-	1800	-	Reaching the Western

Modeling and Simulation of Oil Spill Trajectory for Ravva Field

Considering Crude Spill of 100 tons

(OSCP Ref: Annexure III)

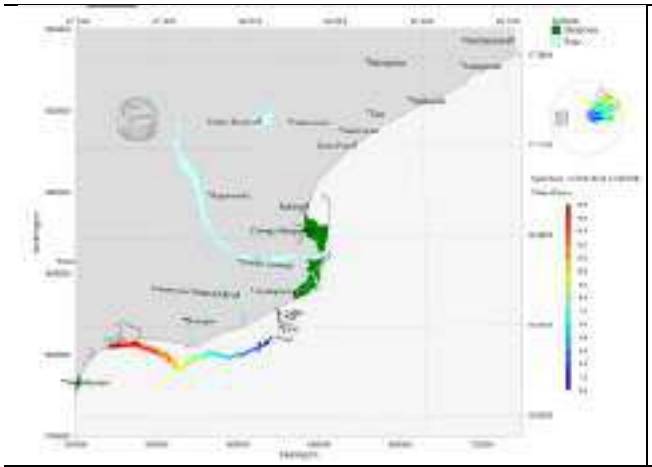


Fig.A3.1 Oil Spill trajectory due to instantaneous crude spill of 100 tons at SPM after 16.8 days in the month of January.

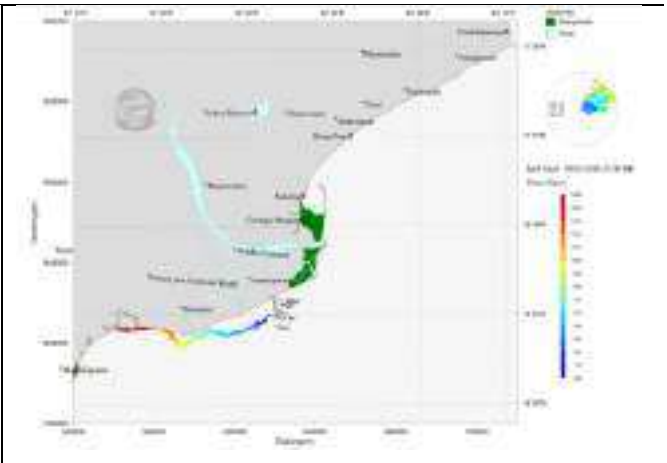


Fig.A3.2 Oil Spill trajectory due to instantaneous crude spill of 100 tons at RA/RC after 16.8 days in the month of January.

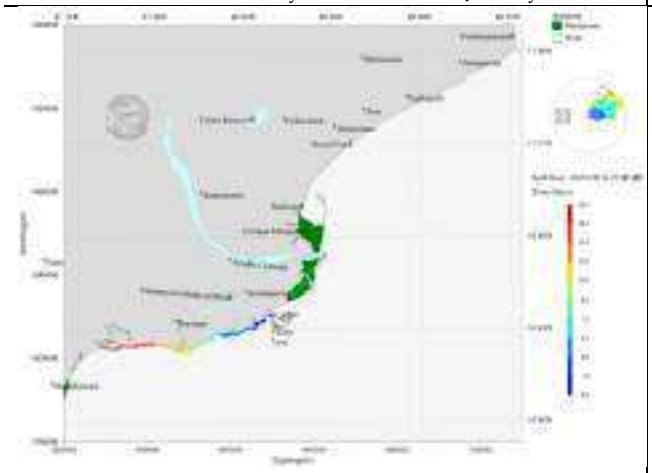


Fig.A3.3 Oil Spill trajectory due to instantaneous crude spill of 100 tons at Pipeline after 18 days in the month of January

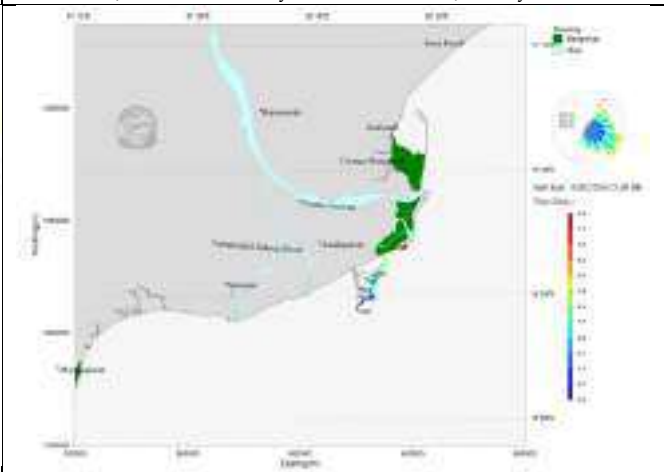


Fig.A3.4 Oil Spill trajectory due to instantaneous Crude spill of 100 tons at SPM after 8.4 days in the month of February

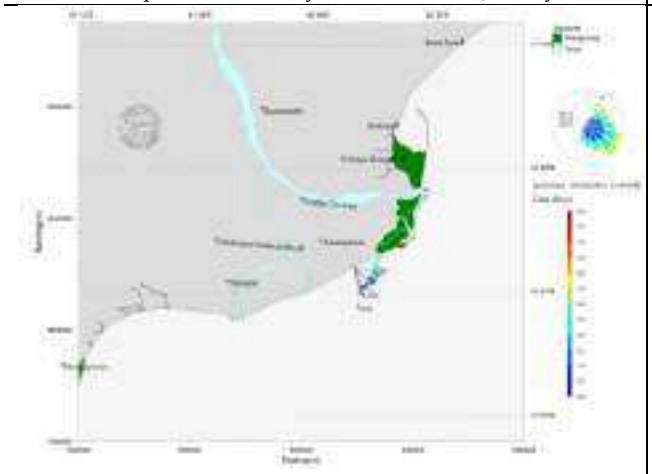


Fig.A3.5 Oil Spill trajectory due to instantaneous crude spill of 100 tons at RA/RC after 8.4 days in the month of February

Fig.A3.6 Oil Spill trajectory due to instantaneous crude spill of 100 tons at Pipeline after 8.4 days in the month of February

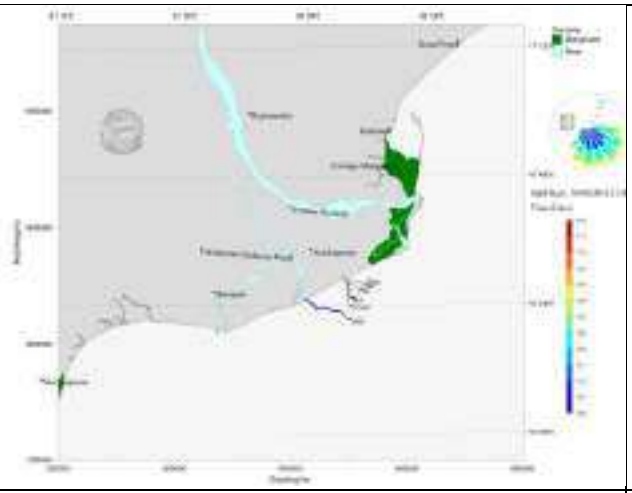


Fig.A3.7 Oil Spill trajectory due to instantaneous crude spill of 100 tons at SPM after 8.4 days in the month of March

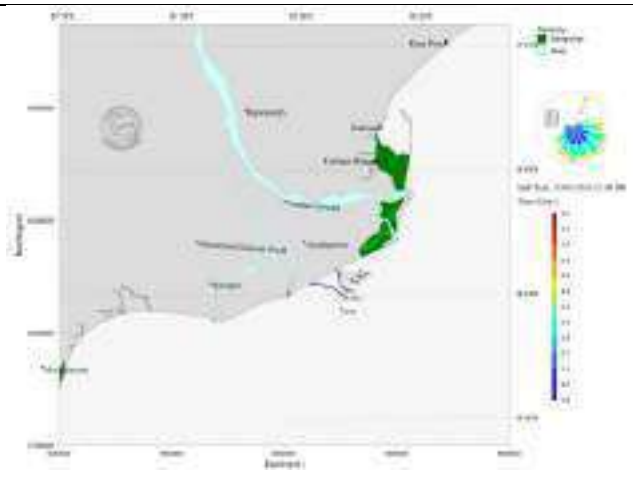


Fig.A3.8 Oil Spill trajectory due to instantaneous crude spill of 100 tons at RA/RC after 8.4 days in the month of March

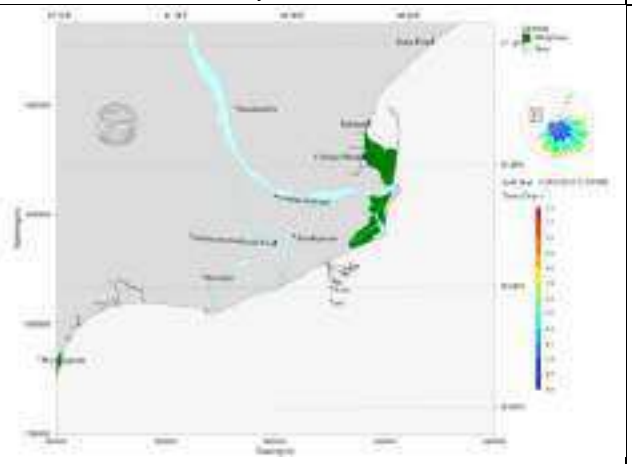


Fig.A3.9 Oil Spill trajectory due to instantaneous crude spill of 100 tons at Pipeline after 8.4 days in the month of March

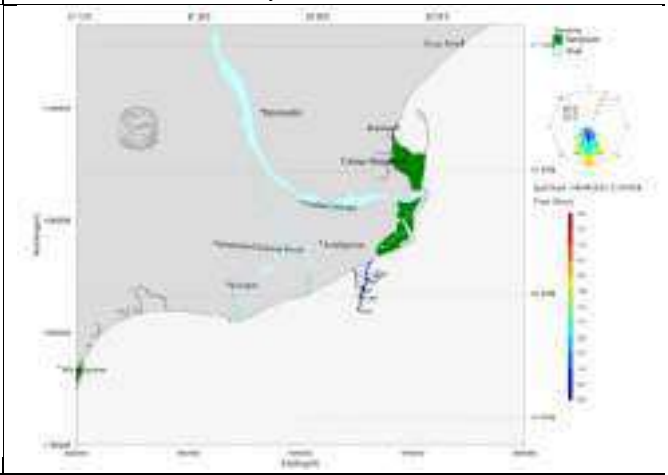


Fig.A3.10 Oil Spill trajectory due to instantaneous crude spill of 100 tons at SPM after 8.4 days in the month of April

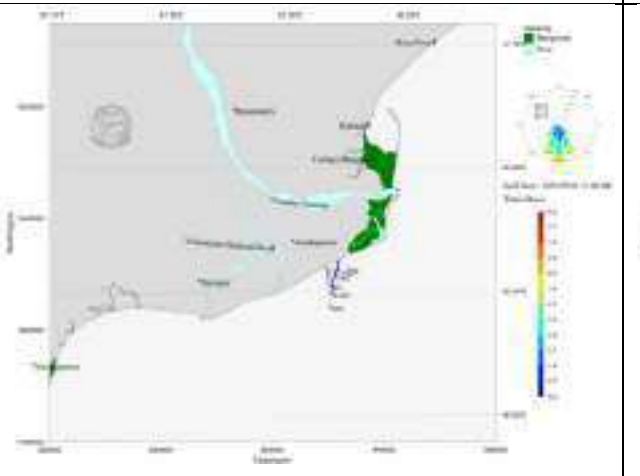


Fig.A3.11 Oil Spill trajectory due to instantaneous crude spill of 100 tons at RA/RC after 8.4 days in the month of April

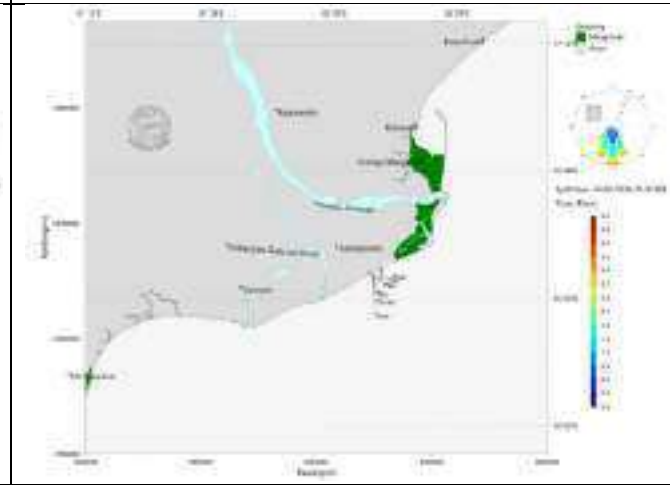


Fig.A3.12 Oil Spill trajectory due to instantaneous crude spill of 100 tons at Pipeline after 4.2 days in the month of April

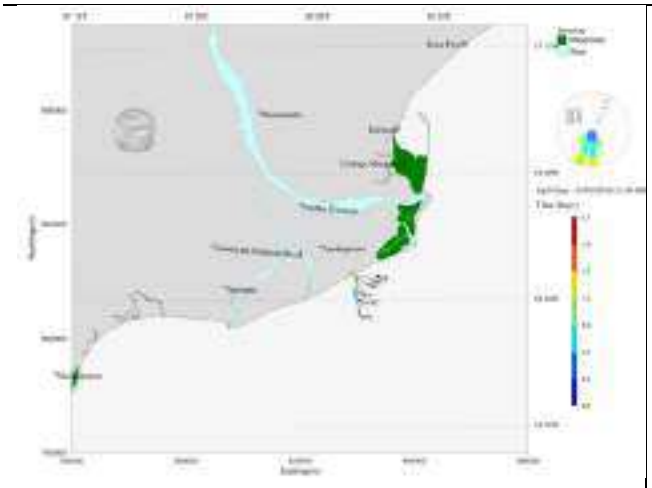


Fig.A3.13 Oil Spill trajectory due to instantaneous crude spill of 100 tons at SPM after 2.1 days in the month of May

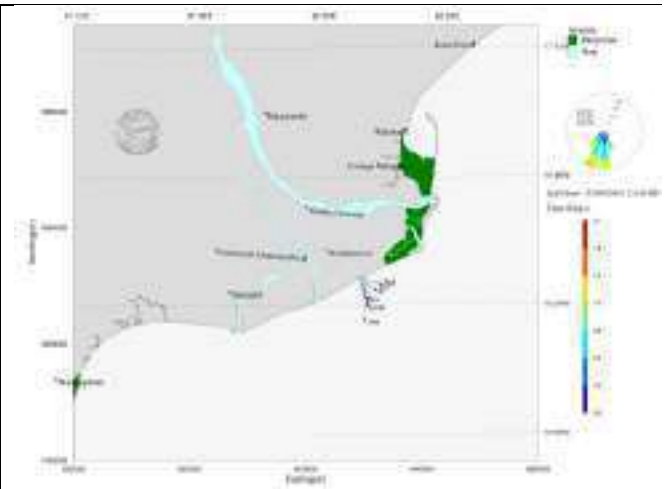


Fig.A3.14 Oil Spill trajectory due to instantaneous crude spill of 100 tons at RA/RC after 2.1 days in the month of May

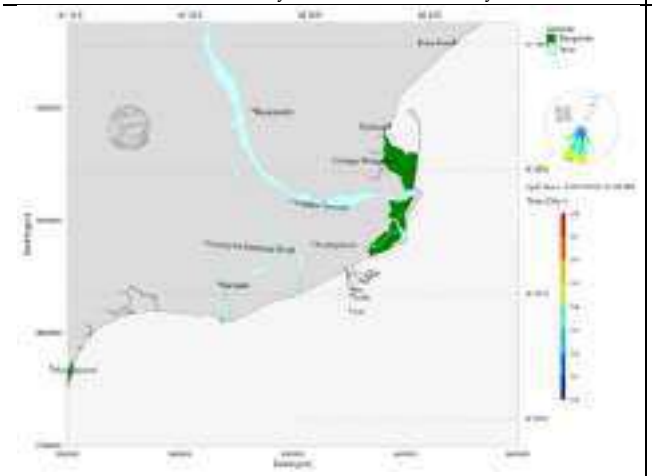


Fig.A3.15 Oil Spill trajectory due to instantaneous crude spill of 100 tons at Pipeline after 0.8 days in the month of May

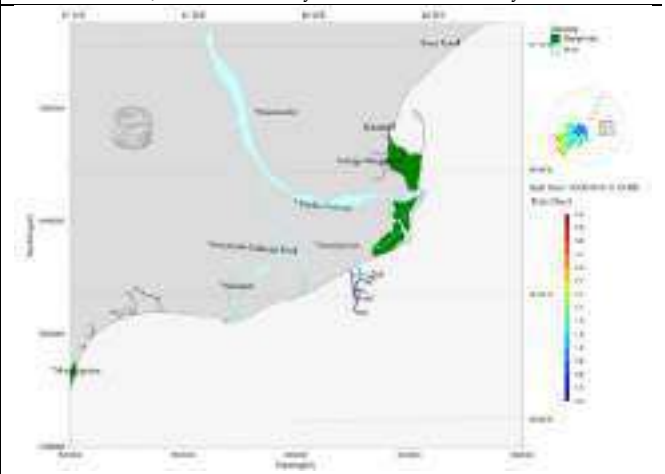


Fig.A3.16 Oil Spill trajectory due to instantaneous crude spill of 100 tons at SPM after 4.2 days days in the month of June

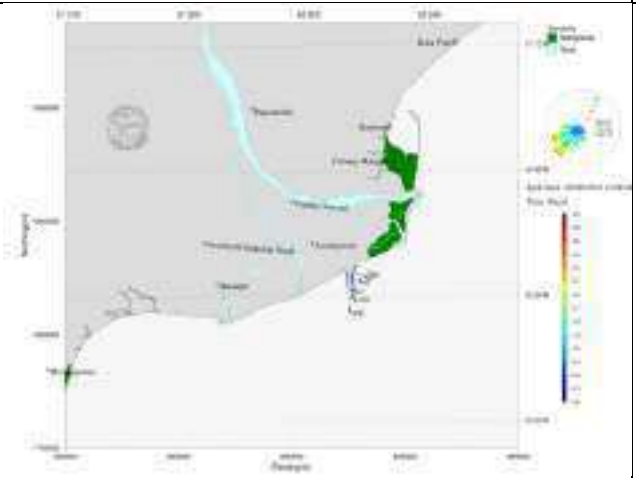


Fig.A3.17 Oil Spill trajectory due to instantaneous crude spill of 100 tons at RA/RC after 4.2 days in the month of June

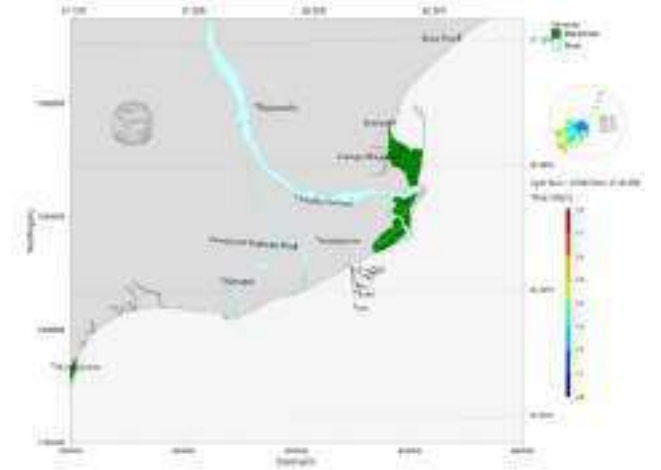


Fig.A3.18 Oil Spill trajectory due to instantaneous crude spill of 100 tons at Pipeline after 0.8 days in the month of June

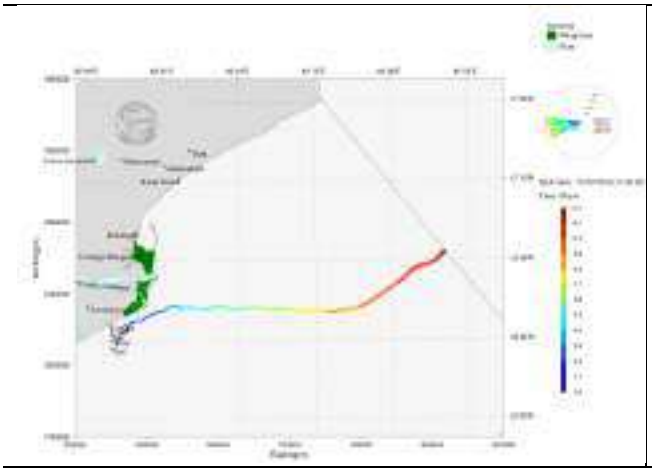


Fig.A3.19 Oil Spill trajectory due to instantaneous crude spill of 100 tons at SPM after 13.2 days in the month of July

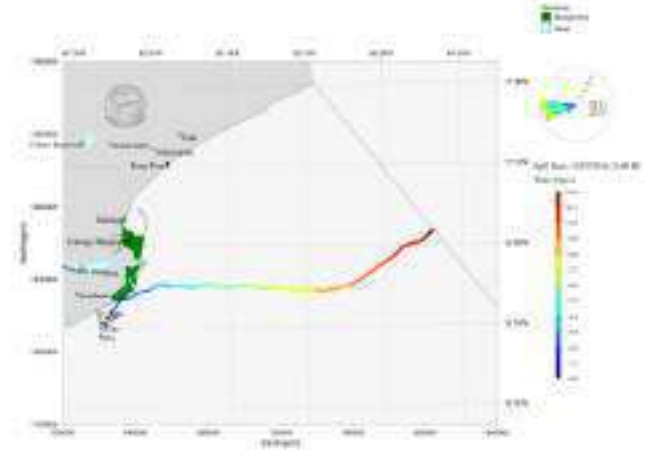


Fig.A3.20 Oil Spill trajectory due to instantaneous crude spill of 100 tons at RA/RC after 13.2 days in the month of July

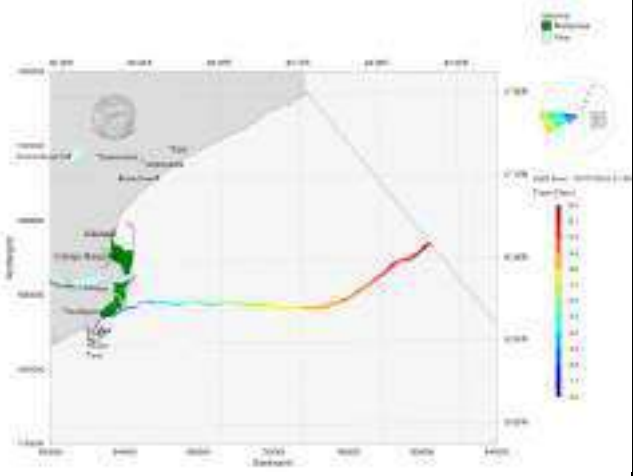


Fig.A3.21 Oil Spill trajectory due to instantaneous crude spill of 100 tons at Pipeline after 13.2 days in the month of July

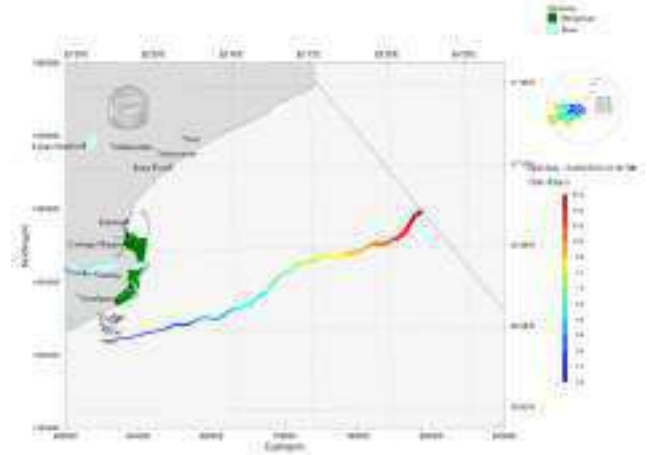


Fig.A3.22 Oil Spill trajectory due to instantaneous crude spill of 100 tons at SPM after 14.4 days in the month of August

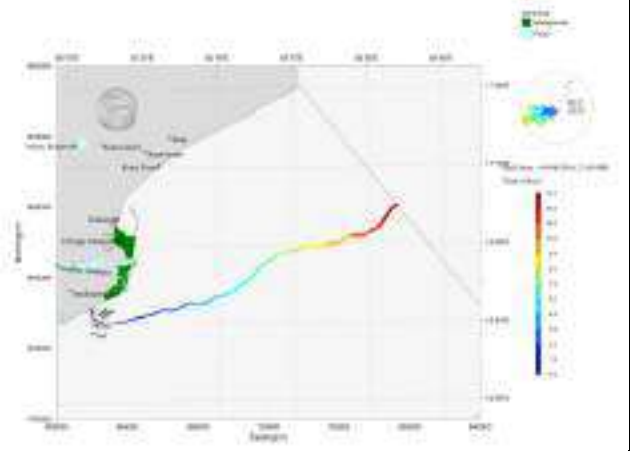


Fig.A3.23 Oil Spill trajectory due to instantaneous crude spill of 100 tons at RA/RC after 14.4 days in the month of August

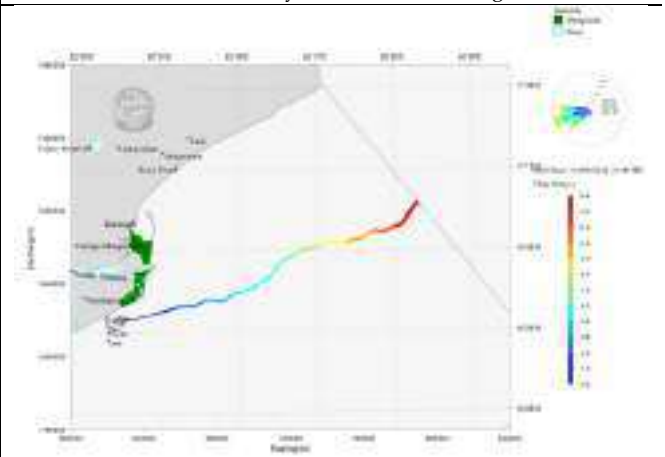


Fig.A3.24 Oil Spill trajectory due to instantaneous crude spill of 100 tons at Pipeline after 14.4 days in the month of August

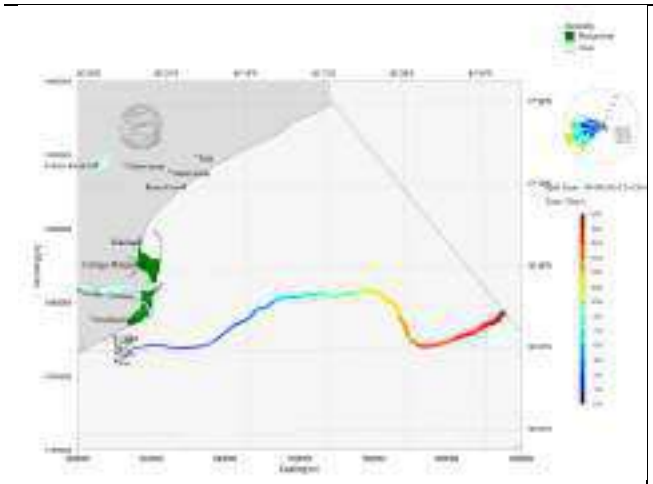


Fig.A3.25 Oil Spill trajectory due to instantaneous crude spill of 100 tons at SPM after 19.5 days in the month of September

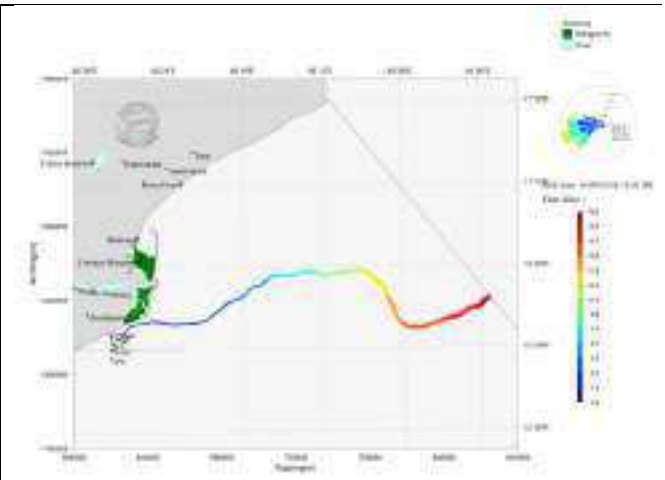


Fig.A3.26 Oil Spill trajectory due to instantaneous crude spill of 100 tons at RA/RC after 19.5 days in the month of September

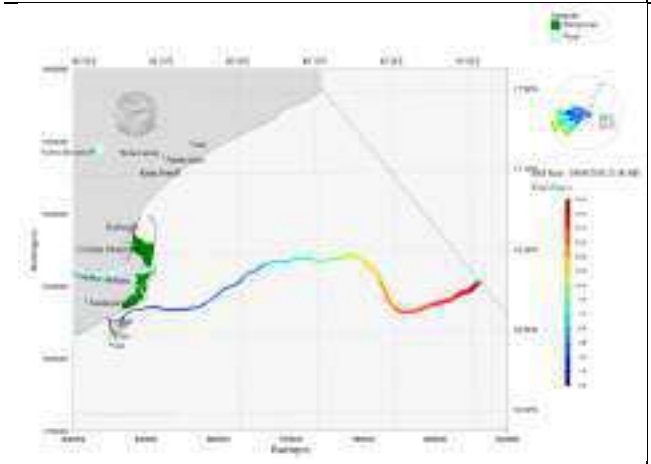


Fig.A3.27 Oil Spill trajectory due to instantaneous crude spill of 100 tons at Pipeline after 19.5 days in the month of September

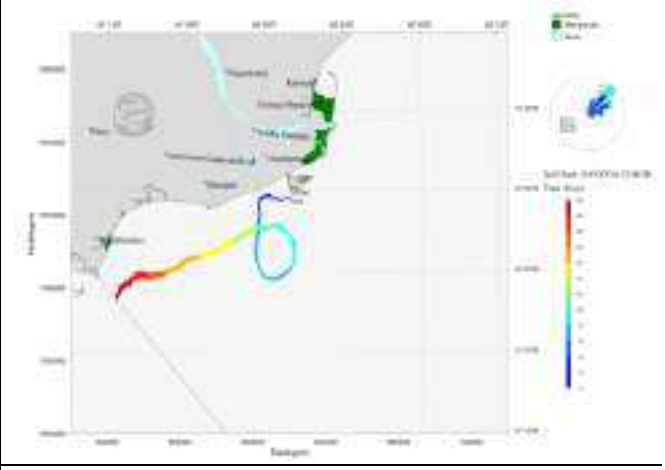


Fig.A3.28 Oil Spill trajectory due to instantaneous Crude spill of 100 tons at SPM after 24 days in the month of October

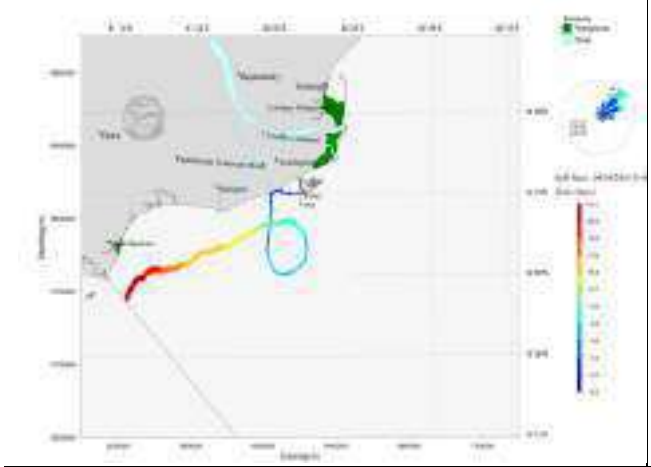


Fig.A3.29 Oil Spill trajectory due to instantaneous crude spill of 100 tons at RA/RC after 24.2 days in the month of October

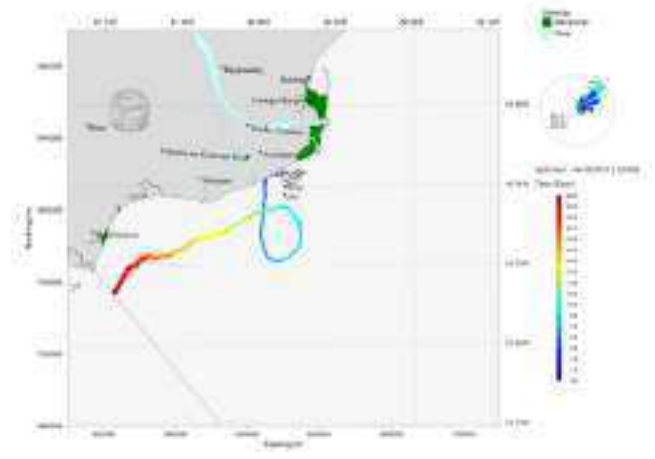


Fig.A3.30 Oil Spill trajectory due to instantaneous crude spill of 100 tons at Pipeline after 25.5 days in the month of October

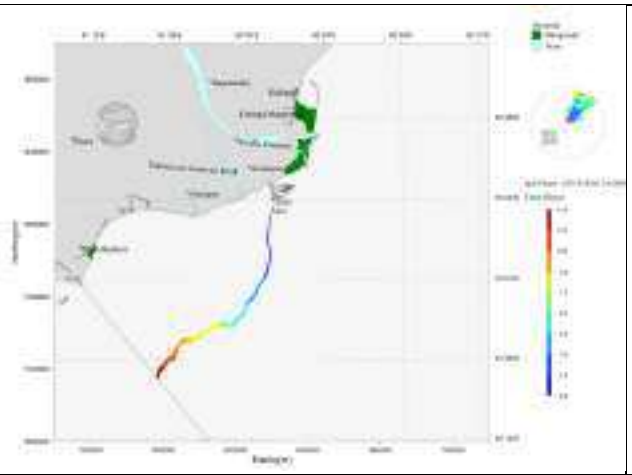


Fig.A3.31 Oil Spill trajectory due to instantaneous crude spill of 100 tons at SPM after 13.5 days in the month of November

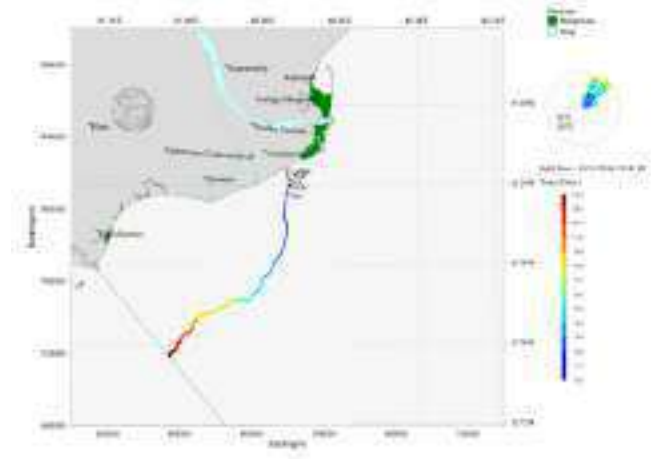


Fig.A3.32 Oil Spill trajectory due to instantaneous crude spill of 100 tons at RA/RC after 14.3 days in the month of November

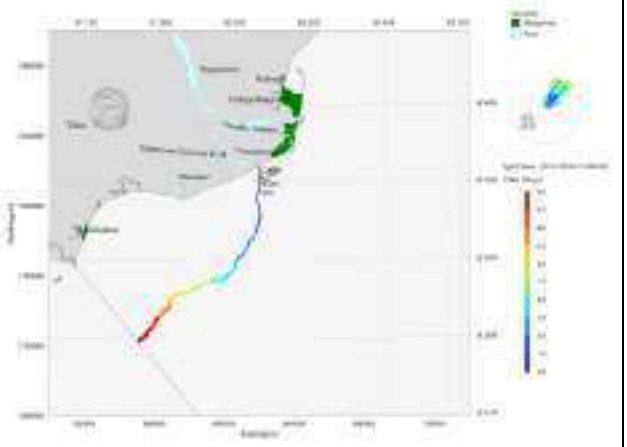


Fig.A3.33 Oil Spill trajectory due to instantaneous crude spill of 100 tons at Pipeline after 15 days in the month of November

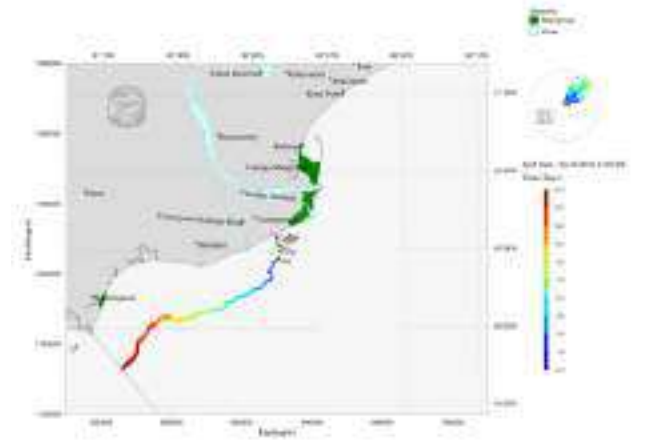


Fig.A3.34 Oil Spill trajectory due to instantaneous crude spill of 100 tons at SPM after 15 days in the month of December

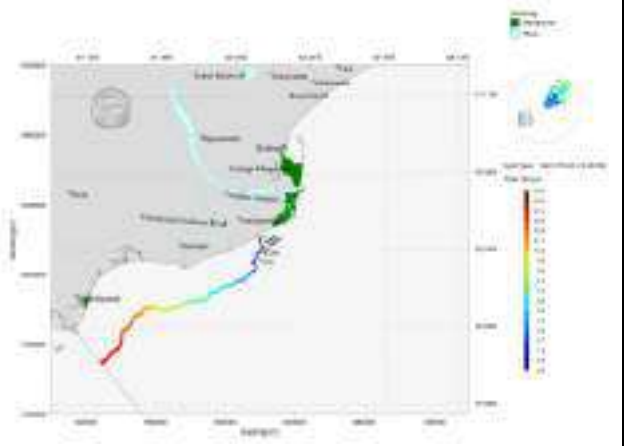


Fig.A3.35 Oil Spill trajectory due to instantaneous crude spill of 100 tons at RA/RC after 16.2 days in the month of December

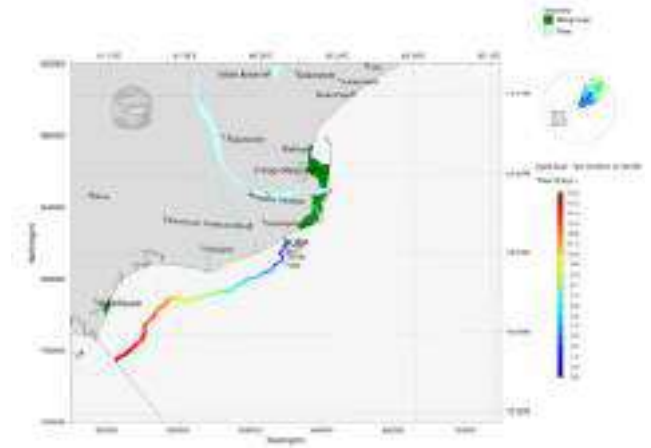


Fig.A3.36 Oil Spill trajectory due to instantaneous crude spill of 100 tons at Pipeline after 16.2 days in the month of December

Modeling and Simulation of Oil Spill Trajectory for Ravva Field

Considering Crude Spill of 1000 tons

(OSCP Ref: Annexure IV)

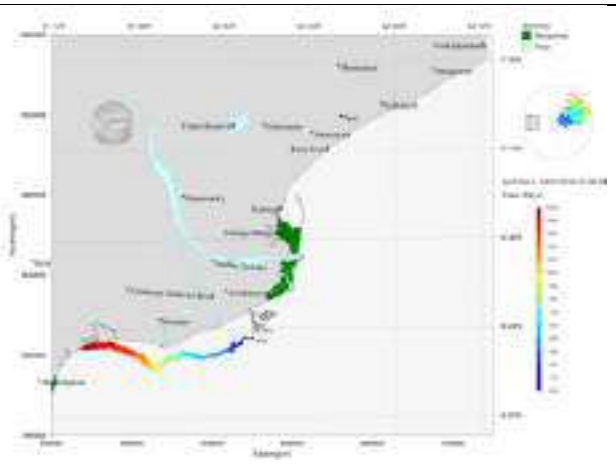


Fig.A4.1 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at SPM after 16.8 Days in the month of January

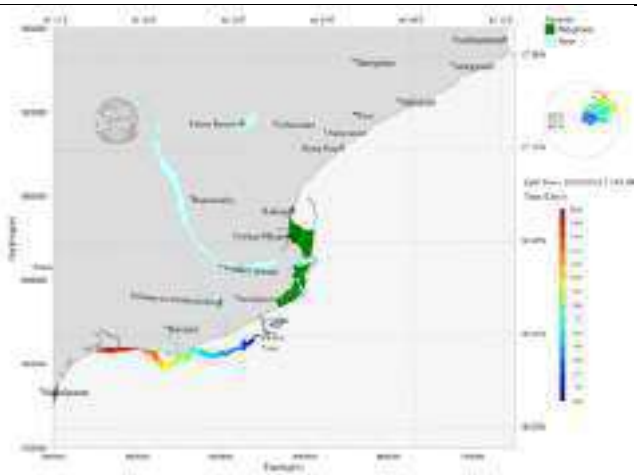


Fig.A4.2 Oil Spill trajectory due to instantaneous Crude spill of 1000 tons at RA/RC after 16.8 Days in the month of January

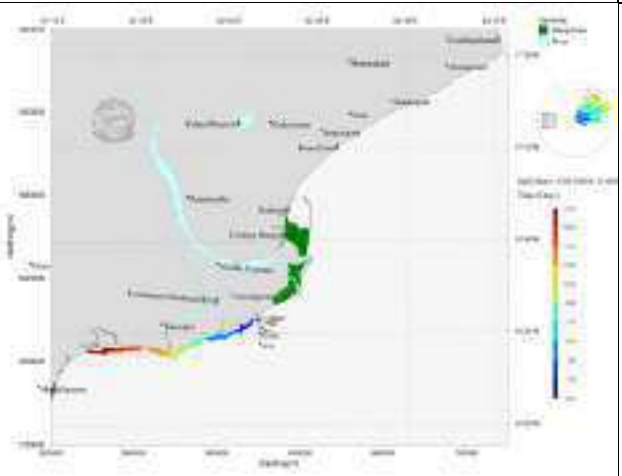


Fig.A4.3 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at Pipeline after 18 Days in the month of January

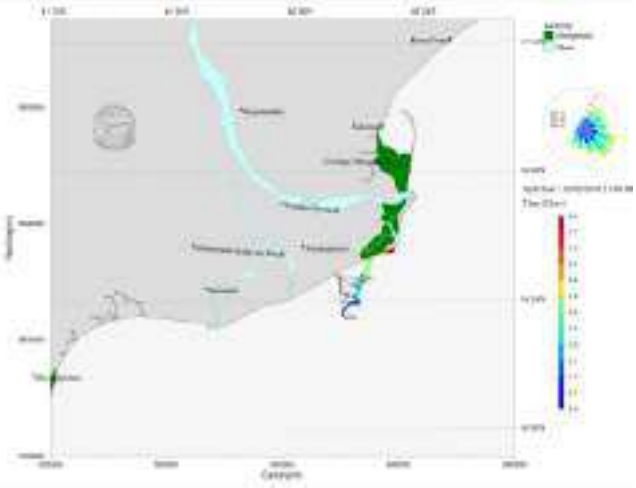


Fig.A4.4 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at SPM after 8.4 Days in the month of February

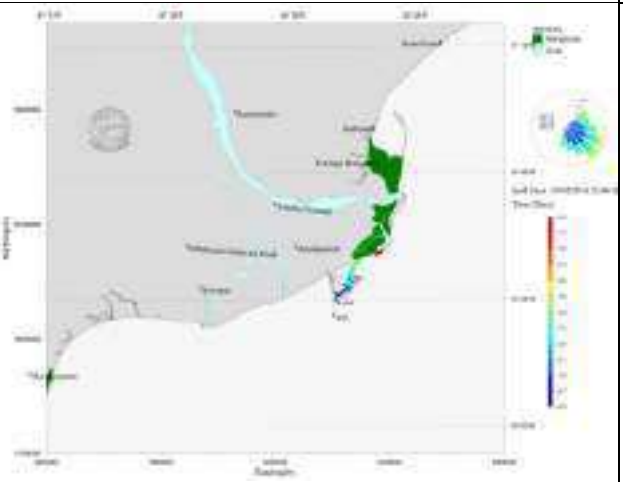


Fig.A4.5 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at RA/RC after 8.4 Days

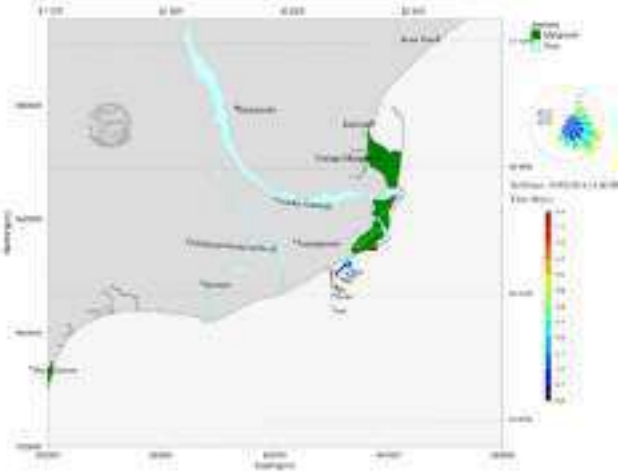


Fig.A4.6 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at Pipeline after 8.4

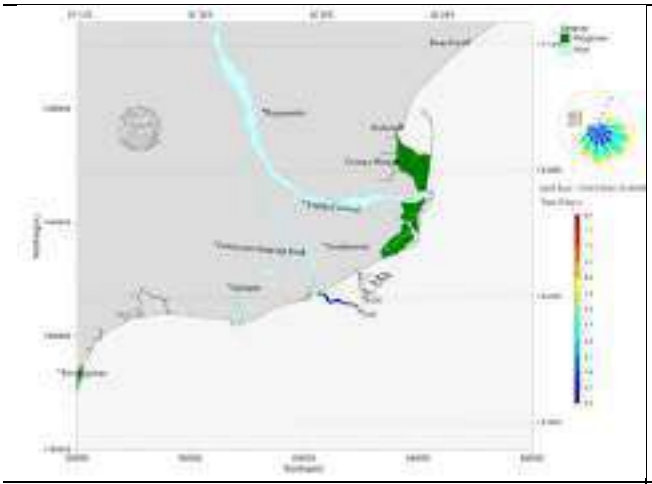


Fig.A4.7 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at SPM after 8.4 Days in the month of March

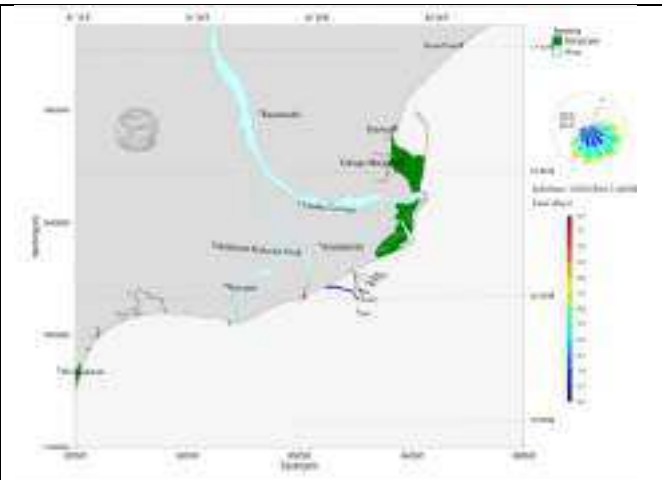


Fig.A4.8 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at RA/RC after 8.4 Days in the month of March

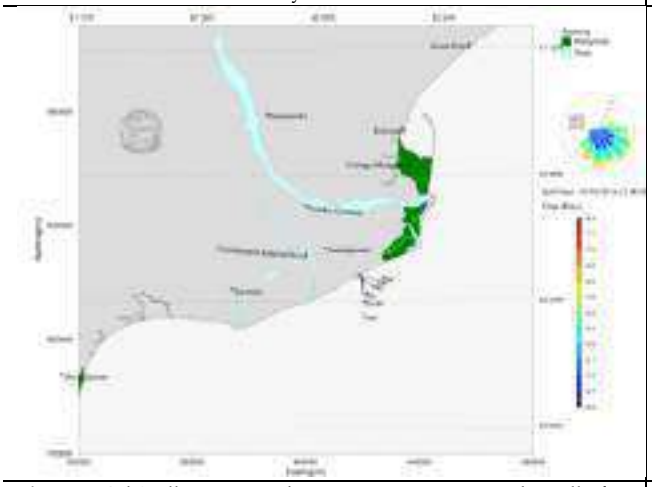


Fig.A4.9 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at Pipeline after 8.4 Days in the month of March

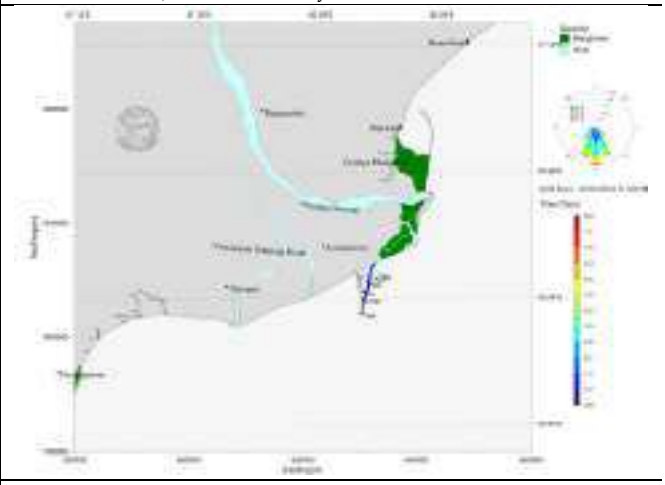


Fig.A4.10 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at SPM after 8.4 Days in the month of April

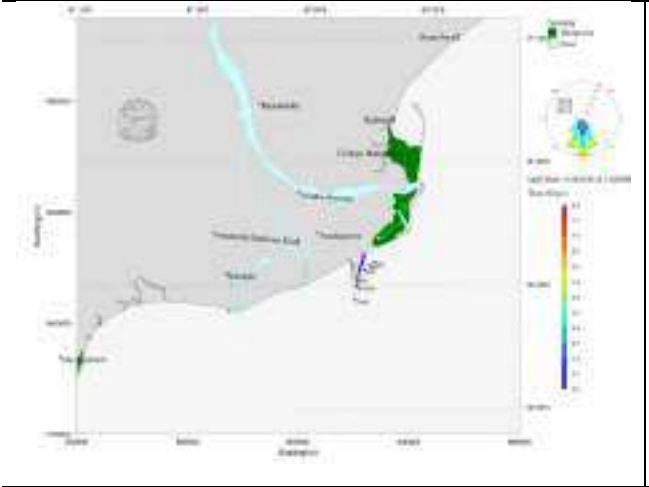


Fig.A4.11 Oil Spill trajectory due to instantaneous Crude spill of 1000 tons at RA/RC after 8.4 Days in the month of April

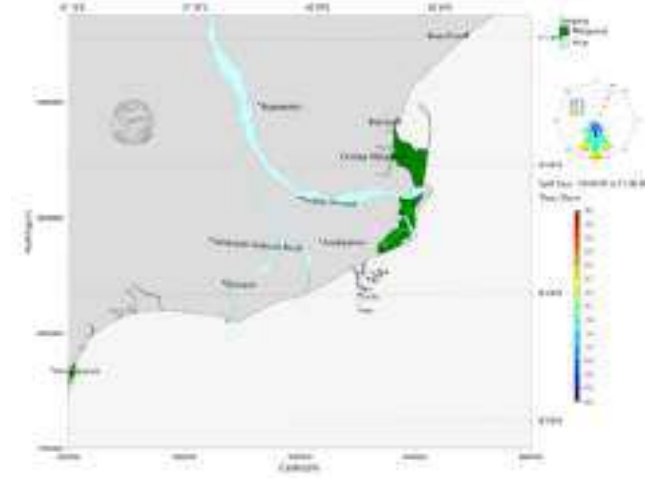


Fig.A4.12 Oil Spill trajectory due to instantaneous Crude spill of 1000 tons at Pipeline after 4.2 Days in the month of April

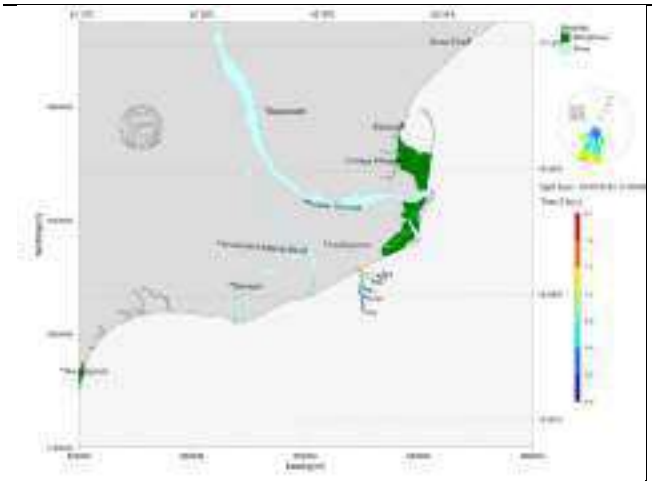


Fig.A4.13 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at SPM after 2.1 Days in the month of May

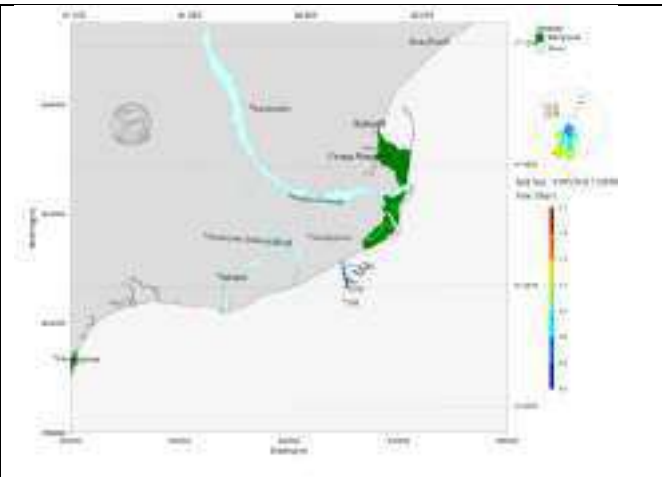


Fig.A4.14 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at RA/RC after 2.1 Days in the month of May

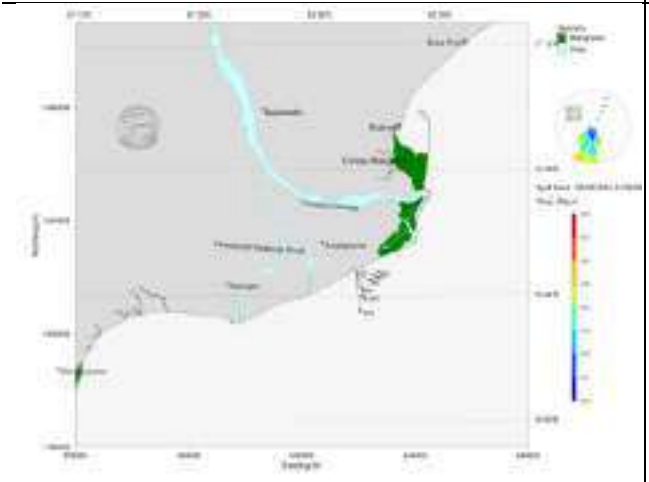


Fig.A4.15 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at Pipeline after 0.8 Days in the month of May

Fig.A4.16 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at SPM after 4.2 Days in the month of June

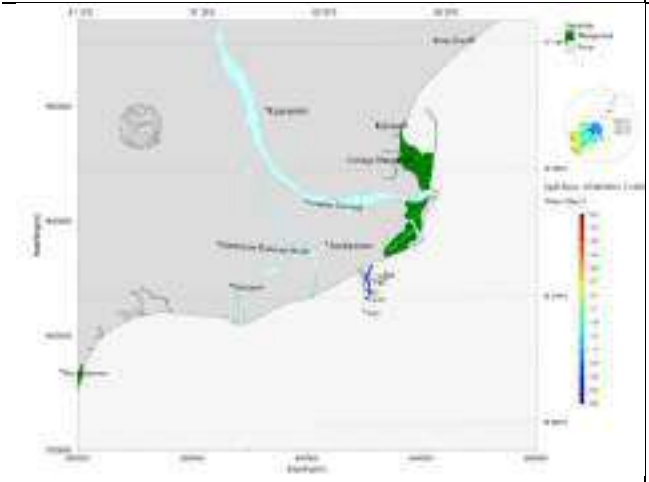


Fig.A4.17 Oil Spill trajectory due to instantaneous Crude spill of 1000 tons at RA/RC after 4.2 Days in the month of June

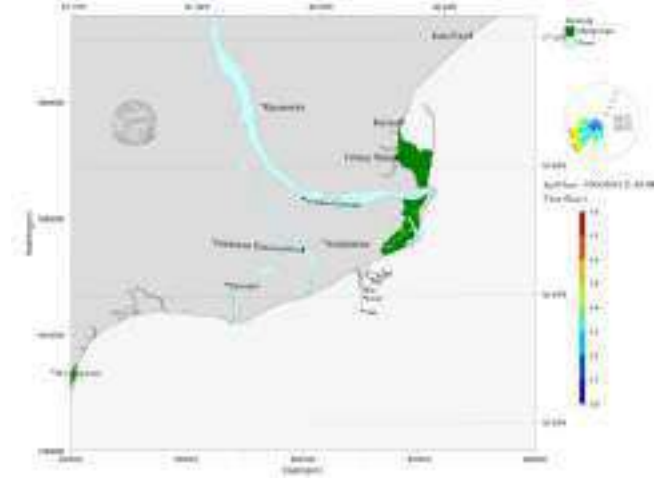


Fig.A4.18 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at Pipeline after 0.8 Days in the month of June

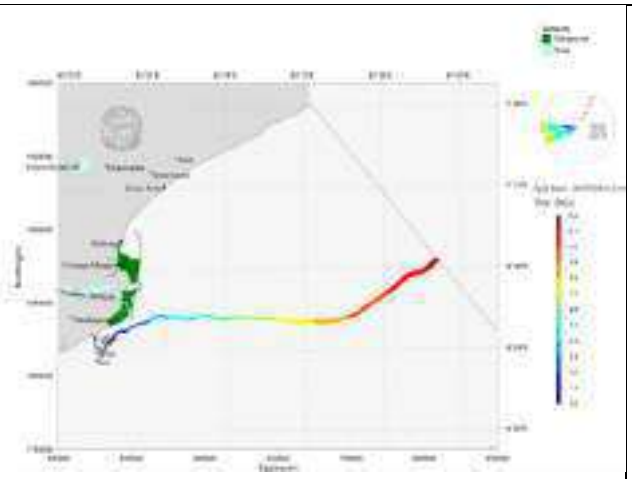


Fig.A4.19 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at SPM after 13.2 Days in the month of July

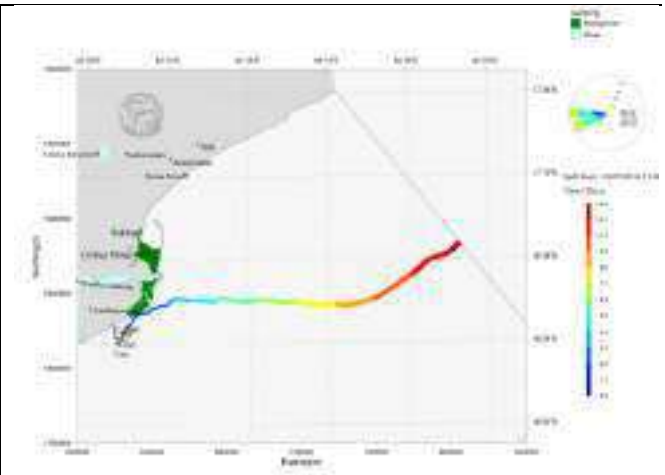


Fig.A4.20 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at RA/RC after 13.2 Days in the month of July

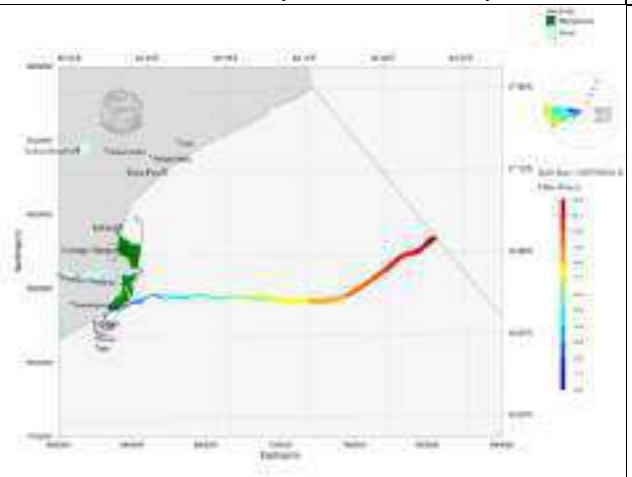


Fig.A4.21 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at Pipeline after 13.2 Days in the month of July

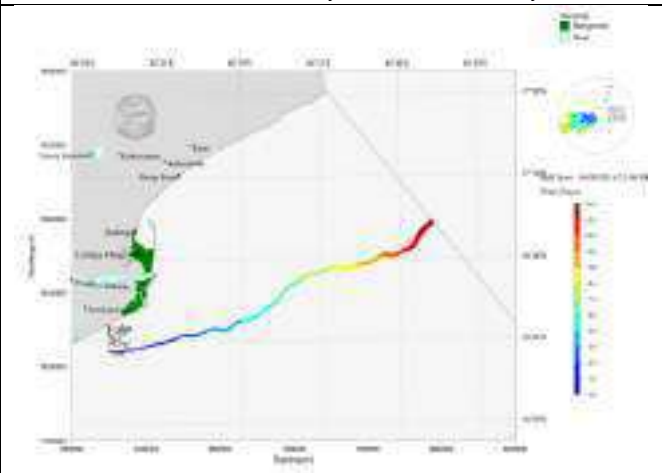


Fig.A4.22 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at SPM after 14.4 Days in the month of August

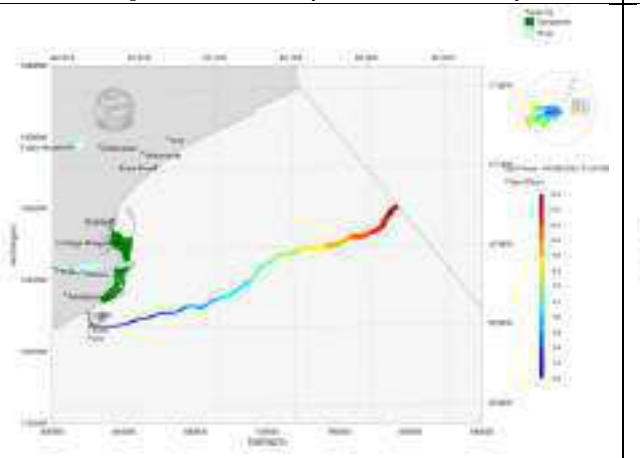


Fig.A4.23 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at RA/RC after 14.4 Days in the month of August

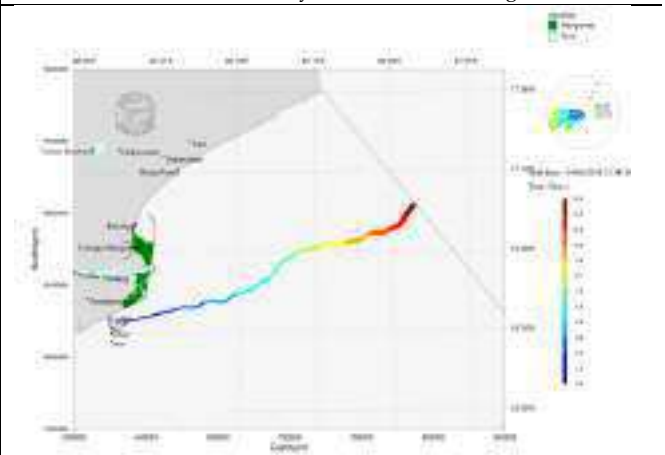


Fig.A4.24 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at Pipeline after 14.4 Days in the month of August

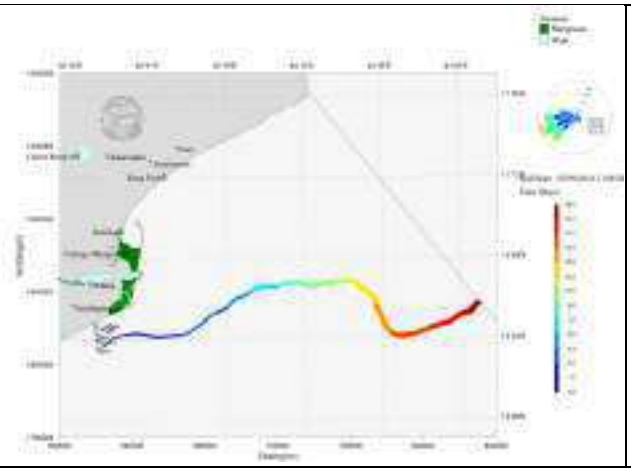


Fig.A4.25 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at SPM after 19.5 Days in the month of September

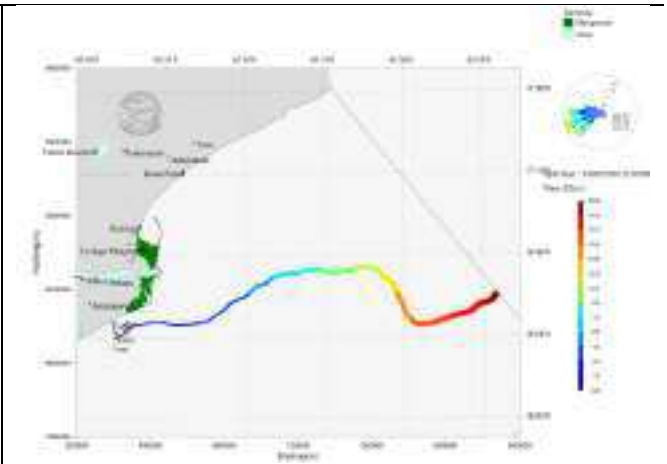


Fig.A4.26 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at RA/RC after 19.5 Days in the month of September

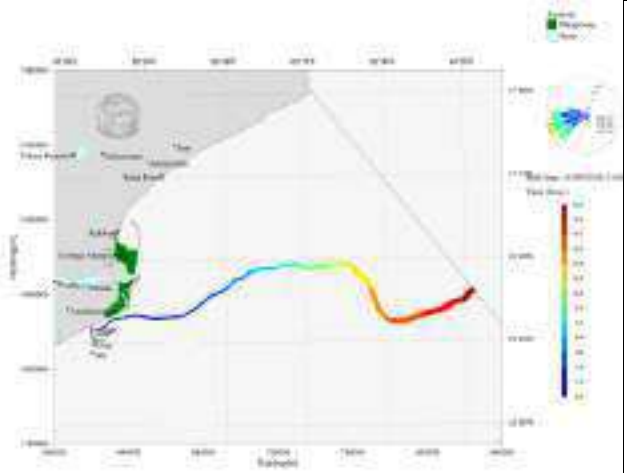


Fig.A4.27 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at Pipeline after 19.5 Days in the month of September

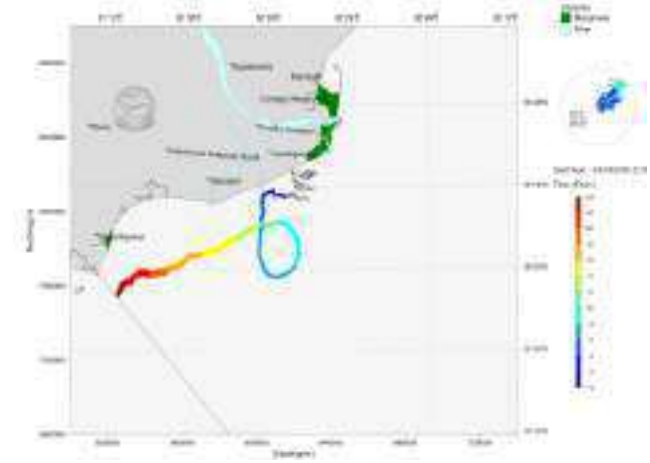


Fig.A4.28 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at SPM after 24 Days in the month of October

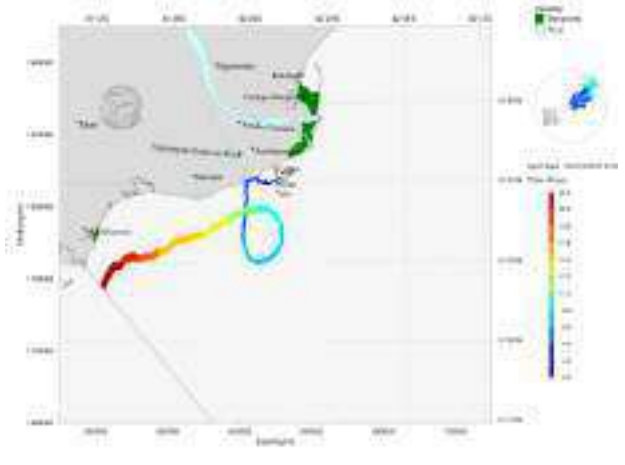


Fig.A4.29 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at RA/RC after 24.2 Days in the month of October

Fig.A4.30 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at Pipeline after 25.5 Days in the month of October

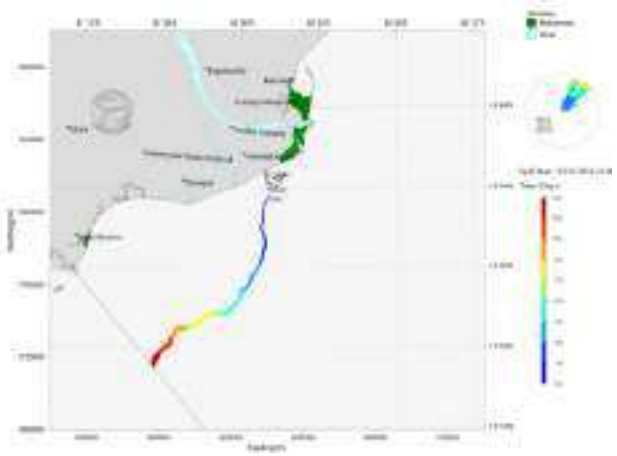


Fig.A4.31 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at SPM after 13.5 Days in the month of November

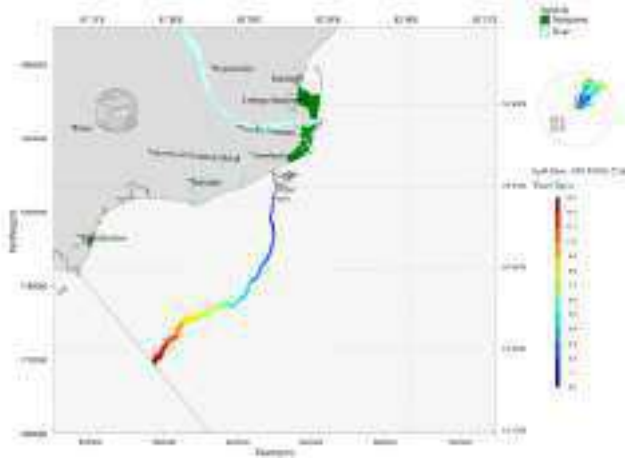


Fig.A4.32 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at RA/RC after 14.3 Days in the month of November

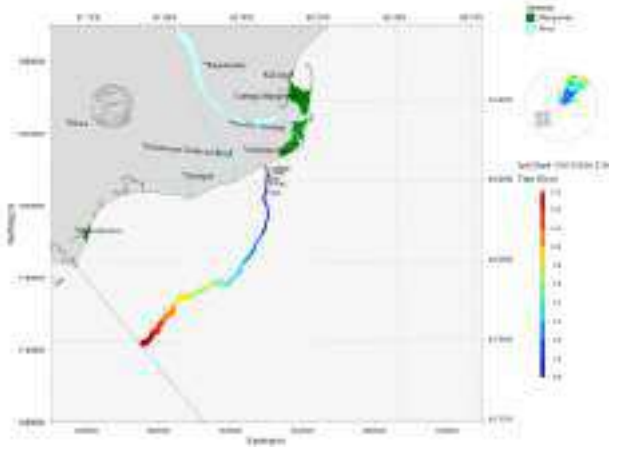


Fig.A4.33 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at Pipeline after 15 Days in the month of November

Fig.A4.34 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at SPM after 15 Days in the month of December

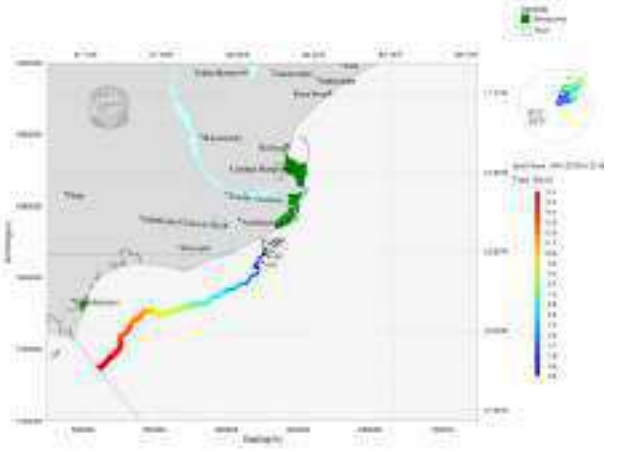


Fig.A.4.35 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at RA/RC after 16.2 Days in the month of December

Fig.A4.36 Oil Spill trajectory due to instantaneous crude spill of 1000 tons at Pipeline after 16.2 Days in the month of December

Modeling and Simulation of Oil Spill Trajectory for Ravva Field

Considering Crude Spill of 1000 tons

(OSCP Ref: Annexure V)

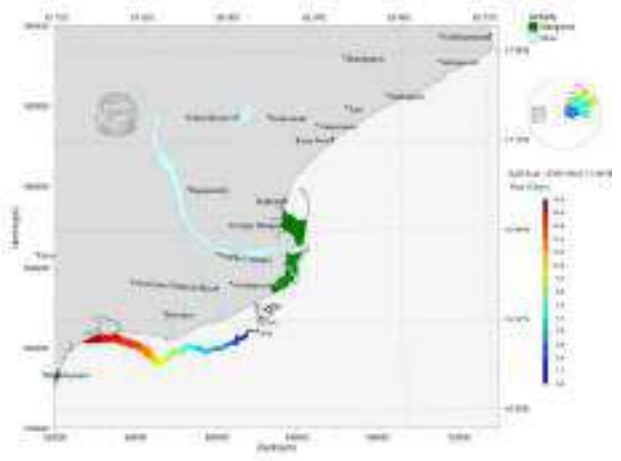


Fig.A5.1 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at SPM after 16.8 days in the month of January.

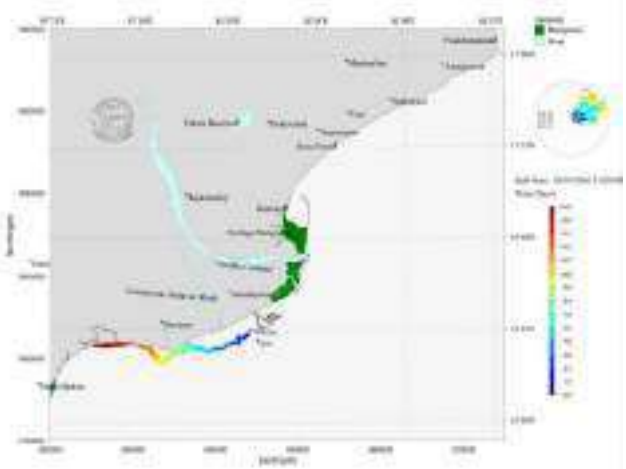


Fig.A5.2 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at RA/RC after 16.8 days in the month of January.

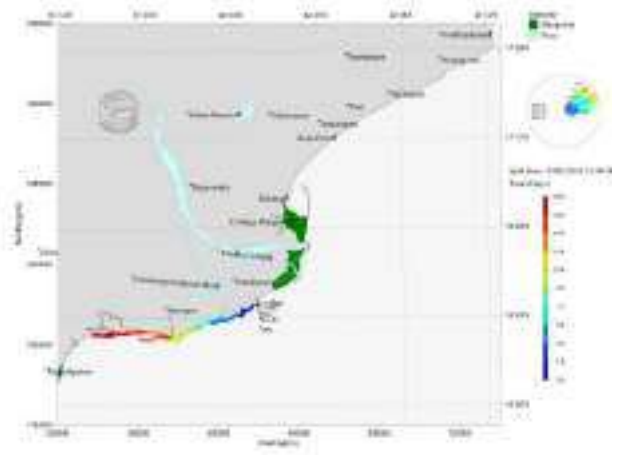


Fig.A5.3 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at Pipeline after 18 days in the month of January.

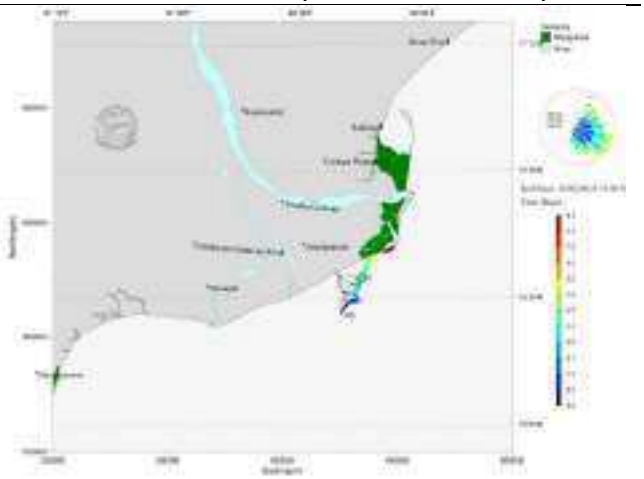


Fig.A5.4 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at SPM after 8.4 days in the month of February.

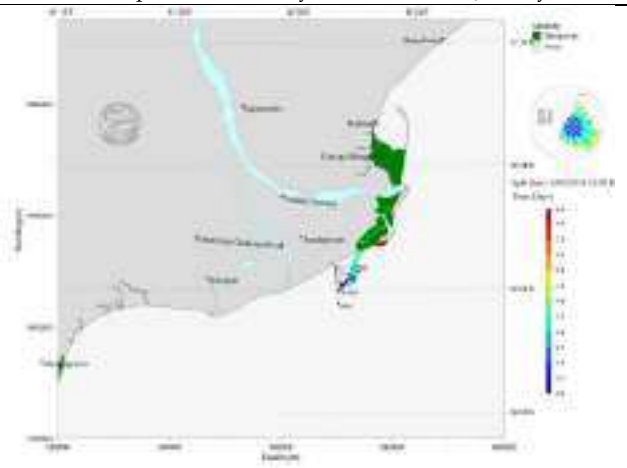


Fig.A5.5 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at RA/RC after 8.4 days in the month of February.

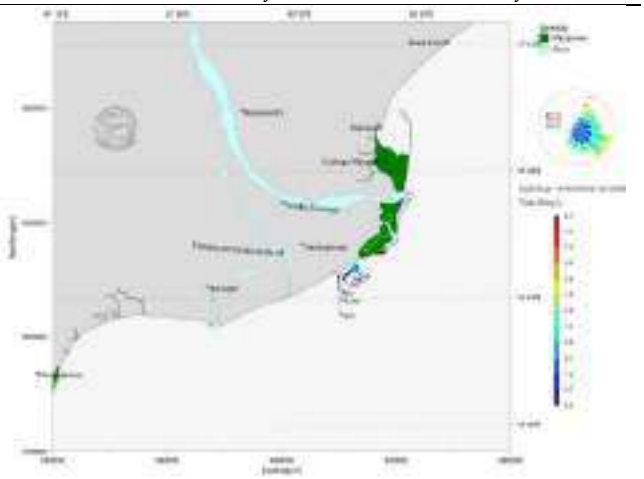


Fig.A5.6 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at Pipeline after 8.4 days in the month of February.

Fig.A5.7 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at SPM after 8.4 days in the month of March.

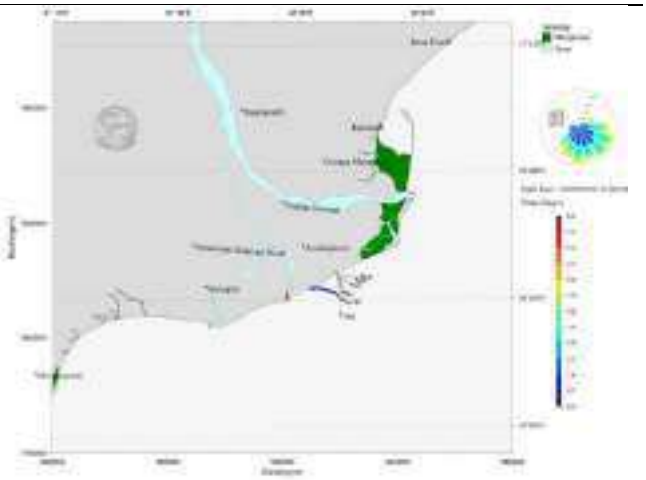


Fig.A5.8 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at RA/RC after 8.4 days in the month of March.

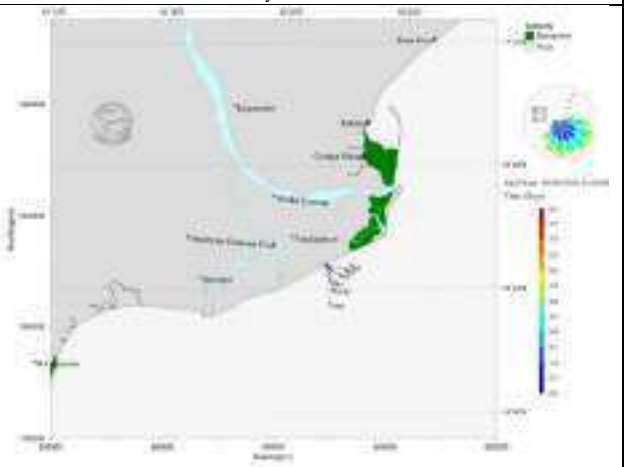


Fig.A5.9 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at Pipeline after 8.4 days in the month of March.

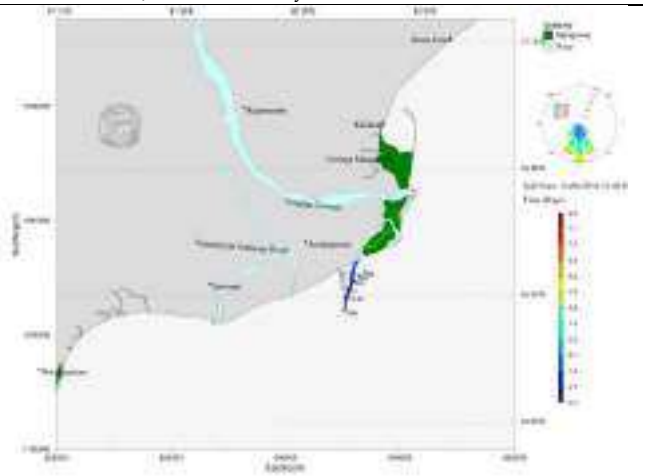


Fig.A5.10 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at SPM after 8.4 days in the month of April.

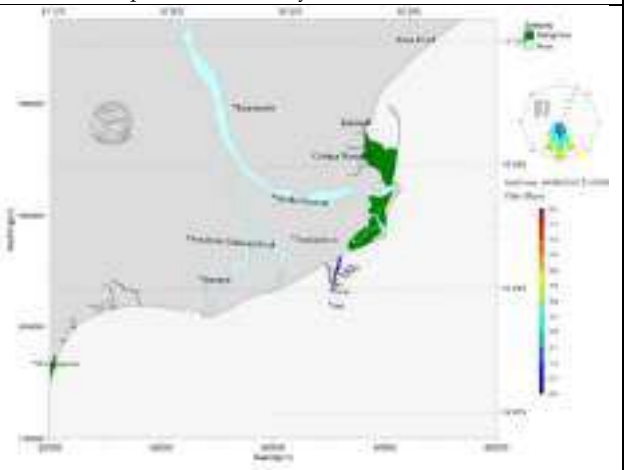


Fig.A5.11 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at RA/RC after 8.4 days in the month of April.

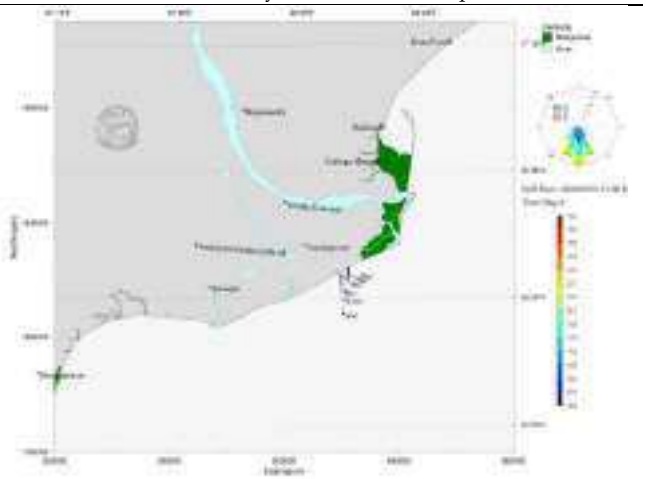


Fig.A5.12 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at Pipeline after 4.2 days in the month of April.

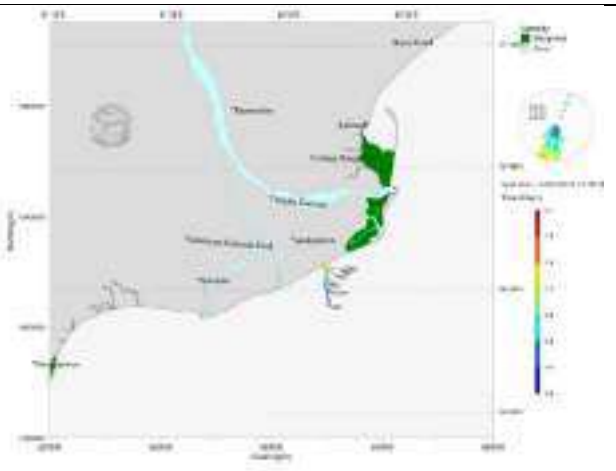


Fig.A5.13 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at SPM after 2.1 days in the month of May.

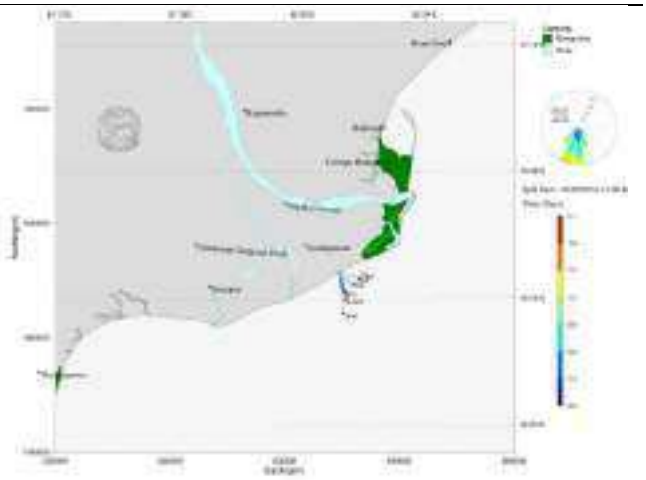


Fig.A5.14 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at RA/RC after 2.1 days in the month of May.

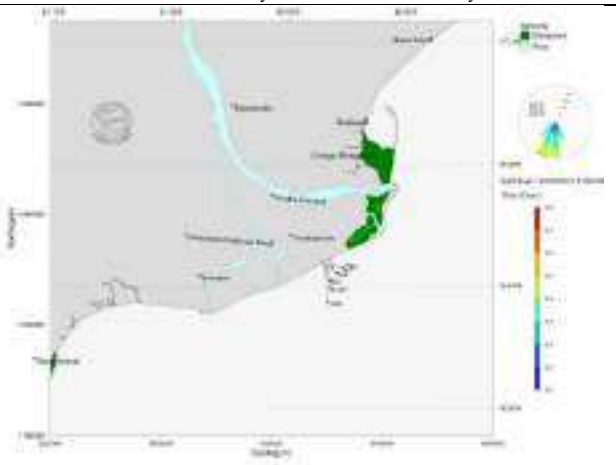


Fig.A5.15 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at Pipeline after 0.8 days in the month of May.

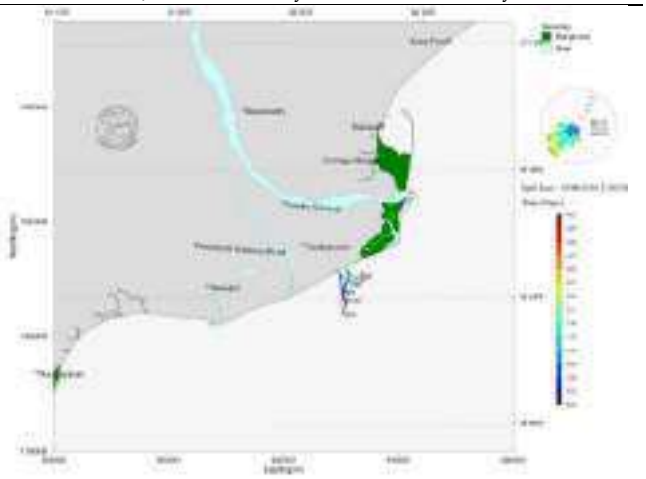


Fig.A5.16 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at SPM after 4.2 days in the month of June.

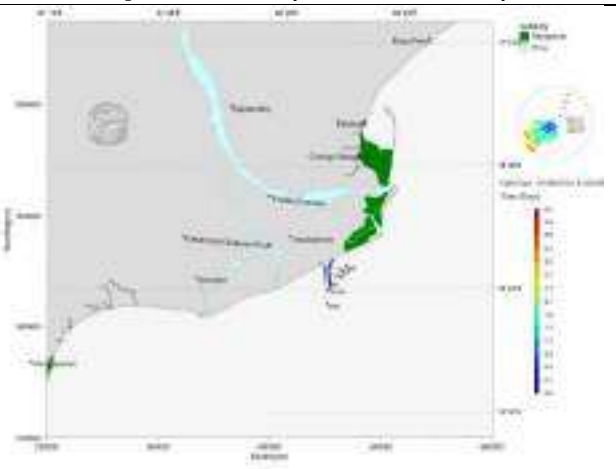


Fig.A5.17 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at RA/RC after 4.2 days in the month of June.

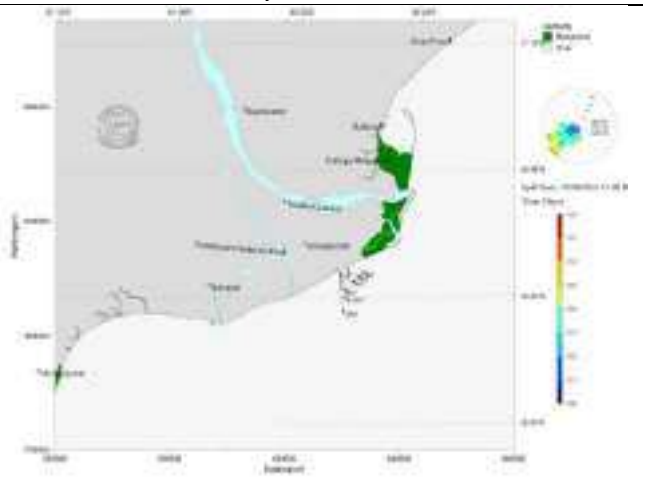


Fig.A5.18 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at Pipeline after 0.8 days in the month of June.

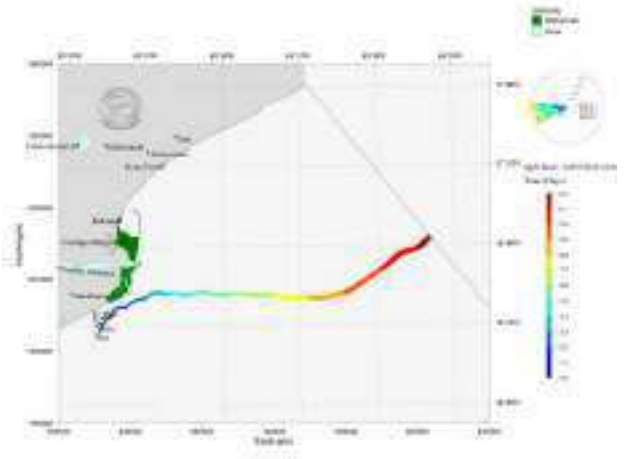


Fig.A5.19 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at SPM after 13.2 days in the month of July.

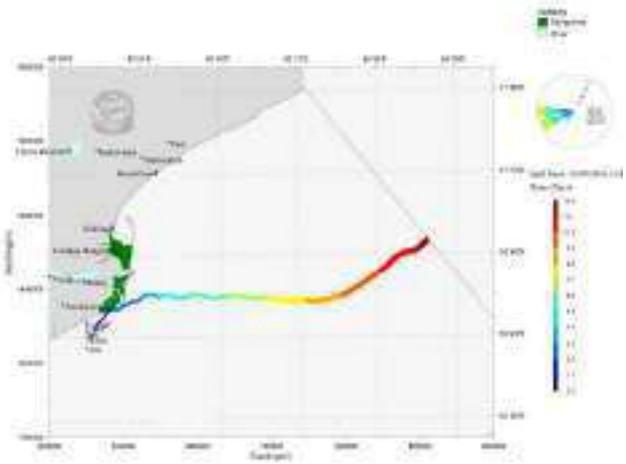


Fig.A5.20 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at RA/RC after 13.2 days in the month of July.

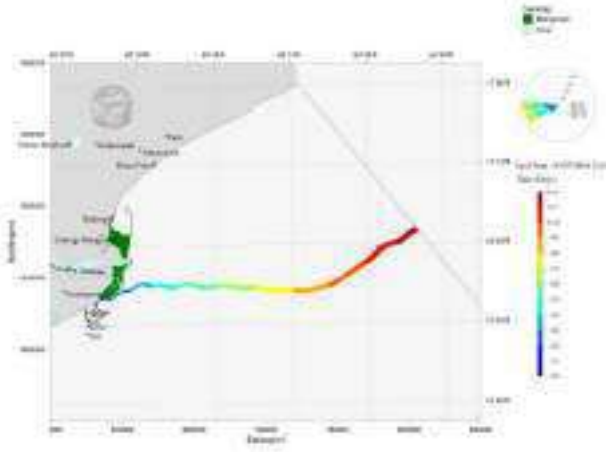


Fig.A5.21 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at Pipeline after 13.2 days in the month of July.

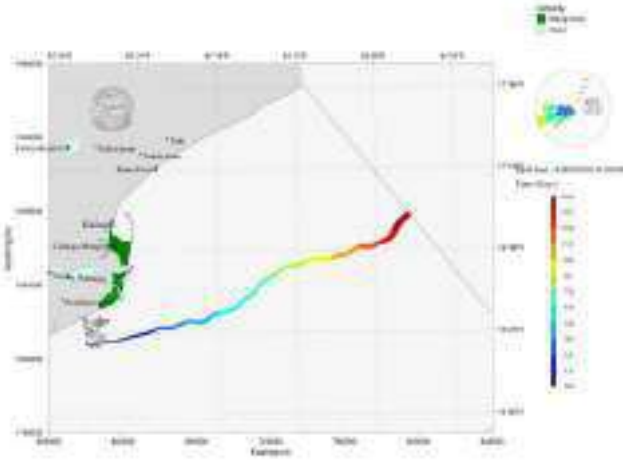


Fig.A5.22 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at SPM after 14.4 days in the month of August.

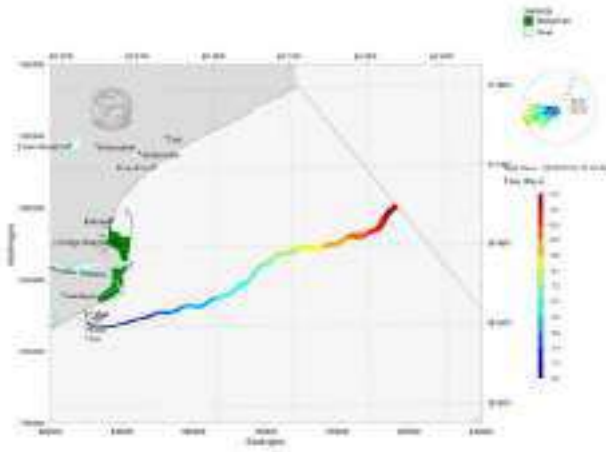


Fig.A5.23 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at RA/RC after 14.4 days in the month of August.

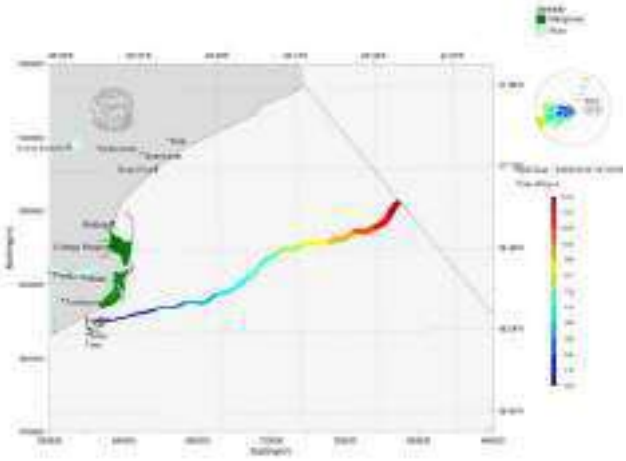


Fig.A5.24 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at Pipeline after 14.4 days in the month of August.

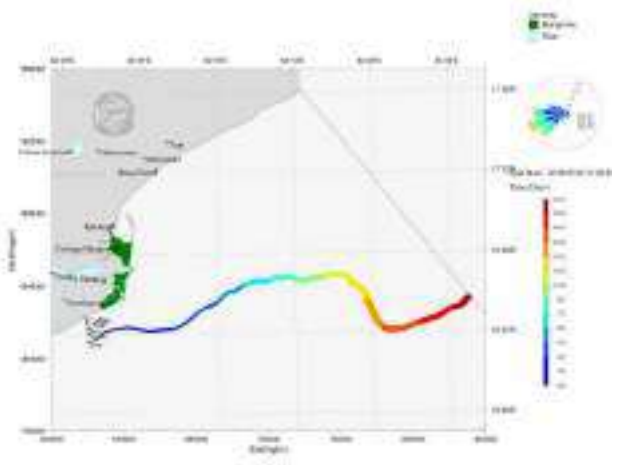


Fig.A5.25 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at SPM after 19.5 days in the month of September.

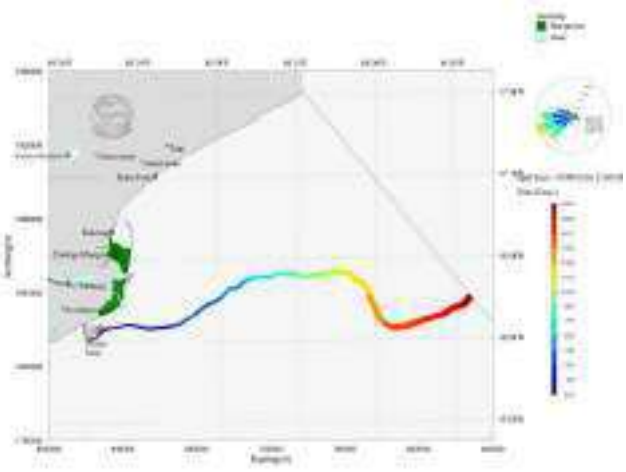


Fig.A5.26 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at RA/RC after 19.5 days in the month of September.

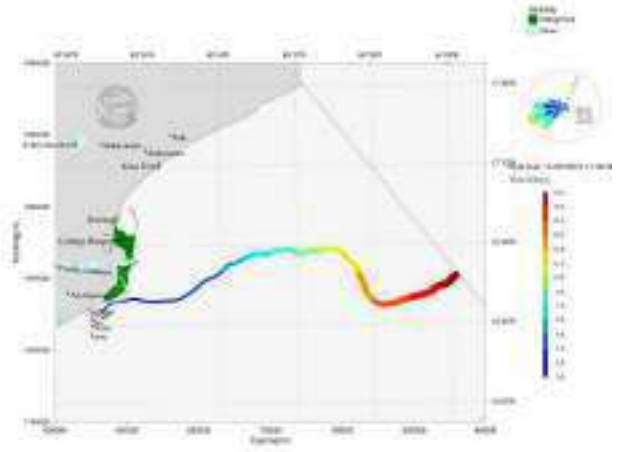


Fig.A5.27 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at Pipeline after 19.5 days in the month of September.

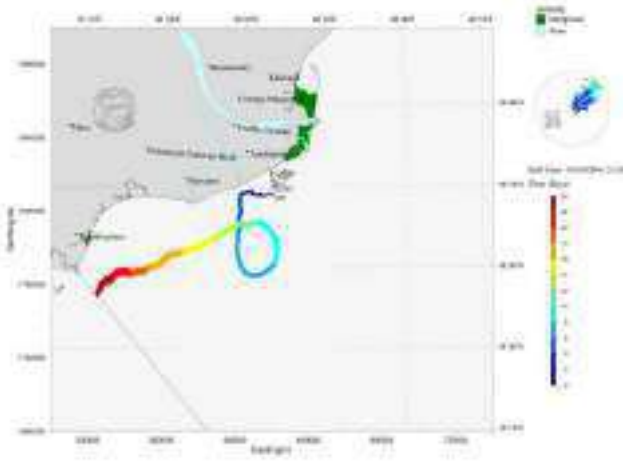


Fig.A5.28 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at SPM after 24 days in the month of October.

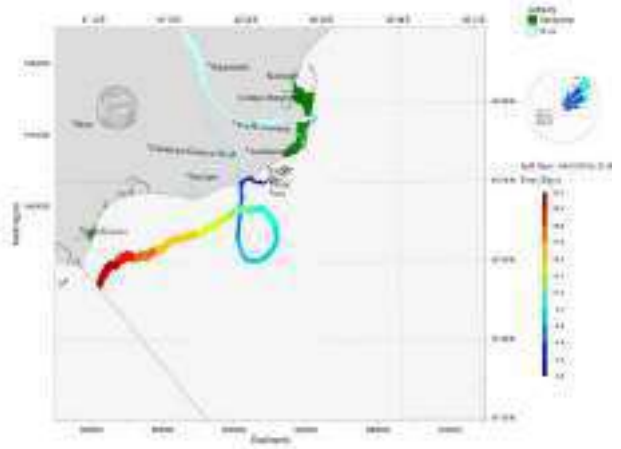


Fig.A5.29 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at RA/RC after 24.2 days in the month of October.

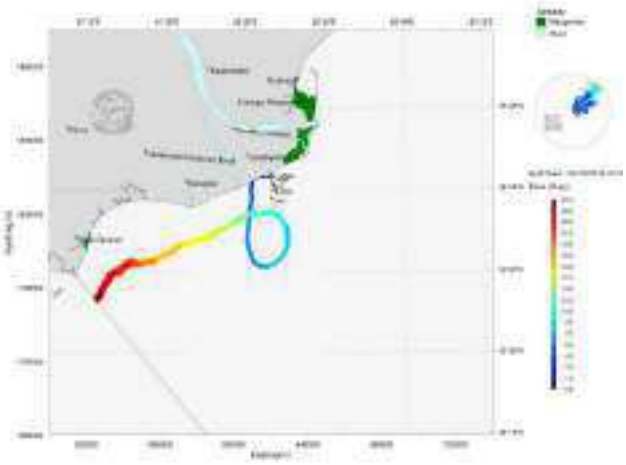


Fig.A5.30 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at Pipeline after 25.5 days in the month of October.

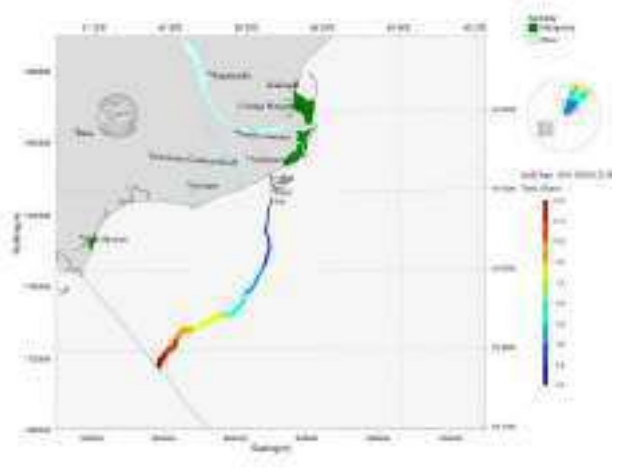


Fig.A5.31 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at SPM after 13.5 days in the month of November.

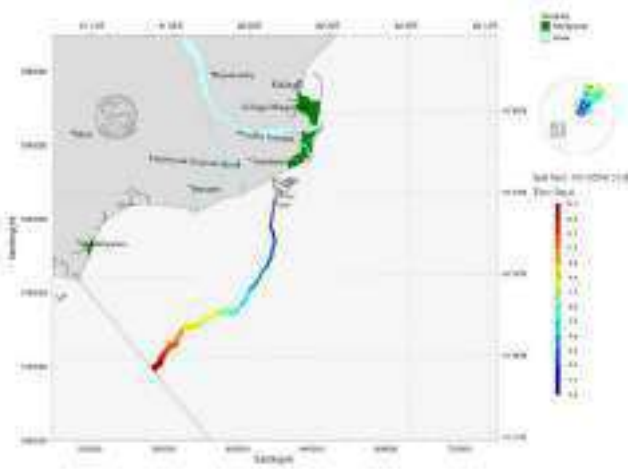


Fig.A5.32 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at RA/RC after 14.3 days in the month of November.

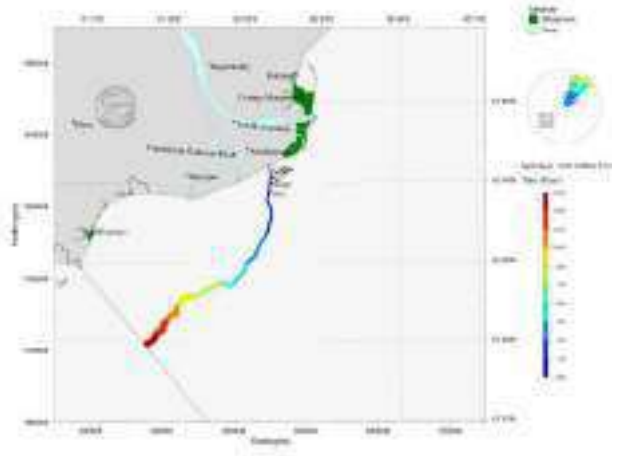


Fig.A5.33 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at Pipeline after 15 days in the month of November.

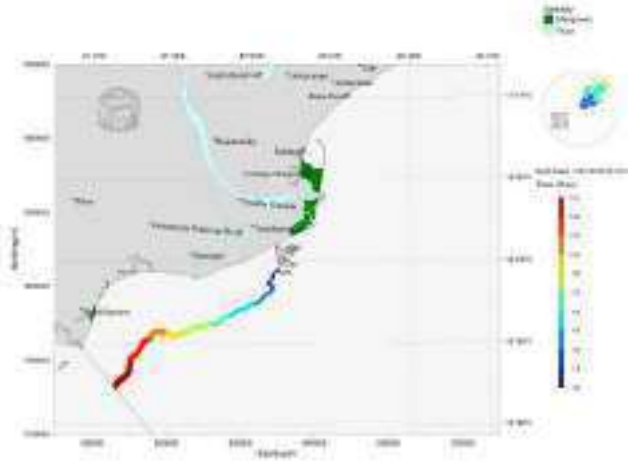


Fig.A5.34 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at SPM after 15 days in the month of December.

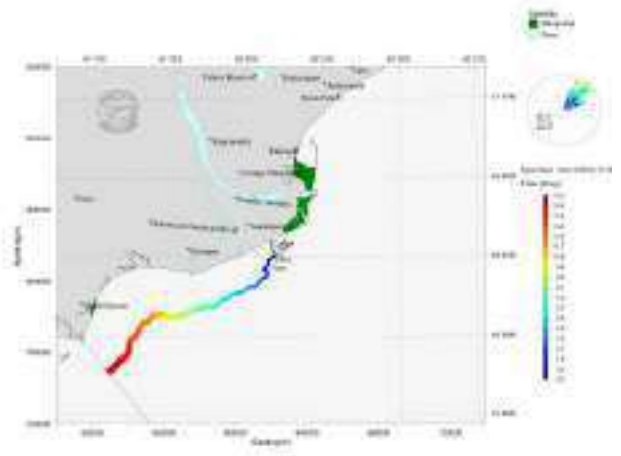


Fig.A5.35 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at RA/RC after 16.2 days in the month of December.

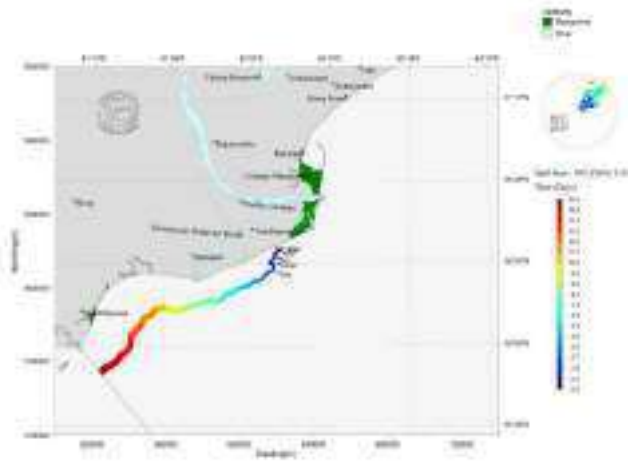


Fig.A5.36 Oil Spill trajectory due to instantaneous crude spill of 5000 tons at Pipeline after 16.2 days in the month of December.

List of Equipments

(OSCP Ref: Appendix 7)

A. Oil Spill Response Equipment with Vedanta Ltd (Cairn Oil & Gas)

S. N.	Name of the item	Quantity	Location	Specification
1	Containment booms Rubber max	1200 m	Kakinada / Vessel	200m x 4nos-1200 m with all accessories Length 50m Connector ASTM Universal slide
2	Shore Guard Boom	103 no	Kakinada	
3	Power Pac Yanmar	3 no	Vessel/Kakinada	
4	Air Blower with Control Stand & adapter	2 no	Vessel/Kakinada	
5	Weir Skimmer unit (Sea Skater)	2 no	Kakinada / Vessel	118m^3/hr., Discharge pressure 5.6 bar, Pump weight; 21kW, power unit 22hp/16kw
6	OSD Applicator - spray system with pump	3 no	Kakinada / Vessel	-
7	Storage Bladder Box	10 no	Kakinada	
8	Flex Barae-10 tons	4 no	Kakinada	
9	Dispersant chemical quantity	10 kl	Kakinada	Nova Chemicals Type 11/111
10	Sorbent boom pack	684 Ms	Kakinada	
11	Spill kits	2 nos	Kakinada	--
12	Sorbent rolls	144	Kakinada	
13	Air Hose 2 sets - for Air Blower	2 no	Kakinada	
14	Towing Assembly with Inflatable boom	4 no	Kakinada	
15	Cable Assembly (Rubber max)	1no	Kakinada	
16	3" Transfer Pump with Discharge Hose	2 no	Kakinada	
17	Sorbent booms (21x3mx4) (252ml)	21	Kakinada	
18	Shovel head skimmer system	3 no	Kakinada	
19	4" Transfer Pump with Discharge Hose & Hydraulic hose	1 no	Kakinada	
20	Back Pac Blower unit (STIHL BR 340) with air hose	2 no	Kakinada	
21	Sorbents for offshore use	171	Kakinada	Oil Absorbent pillows 2 and Oil Absorbent rolls 4.
22	Back Portable Dispersant Beach Spray Unit (OSD applicator)	10 no	Kakinada	
23	Diesel Driven Diaphragm Pump3"	5 no	Kakinada	
24	OSD Silicone - Steel Drum	2 no	Kakinada	
25	OSD Silicone - Plastic Drum	14 no	Kakinada	
26	OSR equipment spares 1 set & Manuals 1 set	1	Kakinada	
27	Tyvek Suits	25 no	Kakinada	
28	Oiled waste sacks & ties box of 50	1 no	Kakinada	
29	Snares (box of 30x4)	4 no	Kakinada	
30	Sorbent pads	2465 no	Kakinada	
31	Inflatable Boat with Accessories	1 no	Kakinada	
32	Motor Suzuki 25hp - for inflatable boat	1 no	Kakinada	
33	Metal takes	100 no	Kakinada	
34	Sledge hammer	10 no	Kakinada	
35	Machete/ cutter	9 no	Kakinada	
36	Shovel	10 no	Kakinada	

B. Offshore Fleet for Spill Response

S.N.	Name of the Vessel	Call Sign	Location	Specification
1	OSV	AUWL	Offshore	M V Mahananda
2	PSV		Offshore	-
3	Security chase boats		Offshore	

4	Tug boats		Offshore	
5	Aircraft	VT-GVL	Offshore/Onshore	Bell 412 (11 seater)
6	Vessels of opportunity		Offshore	Offshore Fishing vessels available in the location to be noted & recorded
7	Line boat	AUAB	Offshore	M.T. Josh – Specifications attached

C. Shoreline/Beach Clean-up Equipment

S.N.	Name of the Item	Quantity	Location	Specification
1	Shovels	20	S.Yanam	-
2	Scrappers	20	S.Yanam	-
3	Sieves of various sizes	15	S.Yanam	-
4	Spades with handle	20	S.Yanam	-
5	Aluminium Gamela big	30	S.Yanam	-
6	Stainless steel buckets big	10	S.Yanam	-
7	Crowbar	10	S.Yanam	-
8	Hand digging trowel	10	S.Yanam	-
9	Hand cultivator	10	S.Yanam	-
10	Wider	2	S.Yanam	-
11	Oil Absorbent pads	100	S.Yanam	-
12	Intertidal booms	10	S.Yanam	-
13	Oil mops	20	S.Yanam	-
14	Trolleys	2	S.Yanam	-

D. Wastes Collection, Handling and Storage Facilities

S.N.	Name of the Item	Quantity	Location	Specification
1	Flexi tanks	5	Kakinada	Quick tank 15 kl-1 No. Fast tank 1500 Ltrs– 4 Nos.
2	Tarpaulin sheet	20	Kakinada	-
3	Wastes collection facilities at the S.Yanam terminal	2 Nos.	Hazardous waste storage yard Scrap yard	-

E. Consumables for Oil Spill Cleanup

S.N.	Name of the Item	Quantity	Location	Specification
1	Polythene bags	500	Warehouse	-
2	Hand gloves	1500	Fire Station	-
3	Gum boots and coveralls	10	S.Yanam	-
4	Polythene sheet for temporary sheds	4	S.Yanam	-
5	Drinking water dispensers for work force	5	S.Yanam	-
6	Surfactants for hand wash and washing materials	5	S.Yanam	-

F. Service Providers and their Locations

S.N.	Name of the Service	No of Personnel Required	Location	Service Provider Details
1	Offshore materials/ safety deck crew	10-20	Kakinada shorebase	Srivalli Shipping 9393285953 Global Offshore Services 9848227653
2	Manpower suppliers for shore clean-up	100-500	Various locations on need	
3	Service providers for transportation of wastes	20-50	Various locations on need	
4	Service providers for disposal of waste	Landfill/ Incinerator	Kakinada / Vizag	Incineration/Secured land fill at Ramky Enviro Engineers, Parawada, Vizag SAR Chandra Enviro, at Kakinada

G. Equipment Available with Other Industries/Operators (under Mutual Aid Agreement)

SN	Name of the Item	ONGC, Kakinada	Reliance Industries, Kakinada	GSPC, Kakinada
1	Offshore containment booms	1500 Ms	250 Ms	200 Ms
2	In-shore containment booms	1500 Ms		
3	Skimmers – type and capacity	30 TPH (Advance) x 5	1 (Brush belt skimmer)	1
4	Sorbents quantity		500	
5	Dispersants, type and quantity	18000 lit	13000 lit	1000 lit

H. Equipment available with M/S OSRL Singapore for Mobilization on Call

SN.	Name of the Item	Qty. Available for Despatch	Packaging Details	Distinct ID Code Numbers of M/s OSRL
1	Offshore containment booms	As per Appendix 7	As per Appendix 7	As per Appendix 7
2	In-shore containment booms	As per Appendix 7	As per Appendix 7	As per Appendix 7
3	Skimmers – type and capacity	As per Appendix 7	As per Appendix 7	As per Appendix 7
4	Sorbents quantity	As per Appendix 7	As per Appendix 7	As per Appendix 7
5	Dispersants, type and quantity	As per Appendix 7	As per Appendix 7	As per Appendix 7
6	Dispersant spray sets- type and numbers	As per Appendix 7	As per Appendix 7	As per Appendix 7
7	Mops and other items if any	As per Appendix 7	As per Appendix 7	As per Appendix 7

Annex 7

Relevant Excerpts from Ravva Field Emergency Response Plan (Section 1-2) Vedanta Limited (Vedanta Ltd (Cairn Oil & Gas), Doc Ref: RFERP-000-001), Date of Issue: 01 Dec 2017

VEDANTA LIMITED
Cairn Oil & Gas

RAVVA FIELD EMERGENCY RESPONSE PLAN

Sr. Engineer- HSE	Installation Manager
Rohith K V / M Yuvaraj	K Sriharipprasad Reddy/Muthukumarasamy D
Prepared by	**Approved By**

For Annex-7 to EIA Volume 2 on

Relevant Excerpts from Ravva Field Emergency Response Plan (Section 1-2) Vedanta Limited (Cairn Oil & Gas), Doc Ref: RFERP-000-001), Date of Issue: 01 Dec 2017

Access the document through link below

https://drive.google.com/file/d/1NtsT5vIX1ghnZgYhkPeXbfbPi97YWdDu/view?usp=sharing

Annex 8

Occupational Health & Hygiene Procedures

vedanta	CAIRN OIL AND GAS VEDANTA LIMITED	CAIRN

Revision Number	4.00	Date of Issue	10 Jan 2018	Next Review	10 Jan 2020
Owner	MEDICAL & OCCUPATIONAL HEALTH				
Application	RAVVA ONSHORE AND OFFSHORE OPERATIONS				
Classification	Internal				

OCCUPATIONAL HEALTH & INDUSTRIAL HYGIENE & OEL

(Identification & Evaluation of OH Hazards, Occupational Exposure Limits, Control Measures, Monitoring, OH Audit & Health care System)

Doctor	HSE	Installation manager
Dr. P.S.R. Murty	K.V. Rohit	D. Muthukumarasamy
Prepared By	Reviewed by	Approved By

TABLE OF CONTENTS (INDEX)

SL.No	Title	Page No
1	INTRODUCTION	4
2	SCOPE	4
3	DEFINITIONS	4
4	APPLICATION	5
5	PROCESS AND STANDARDS	5
6	RISK ASSESSMENT	6
7	LIMITATIONS OF OCCUPATIONAL EXPOSURE LIMITS (OEL)	6
8	STATUTORY REQUIREMENTS	6
9	MONITORING OF PHYSICAL HAZARDS	7
	NOISE	7
	NOISE HAZARD OEL	7
	CHEMICAL HAZARD	9
	TEMPERATURE EXTEREMES	12
	ERGONOMIC HAZARDS	12
	ILLUMINATION HAZARD	13
	RADIATION HAZARD (NORM)	16
	DUST HAZARD	17
	STRESS HAZARDS	18
	BIOLOGICAL HAZARDS	18
10	OCCUPATIONAL HEALTH AUDIT	20
11	HEALTH CARE SYSTEM	21

1. INTRODUCTION:

The purpose of this procedure for OH & IH with Occupational exposure limits (OEL'S) is to ensure that Vedanta Limited - Cairn oil & gas effectively manages the occupational health of all the workforce and contractors and to build a positive health and safety culture through effective management systems. This Standard supports Vedanta Limited - Cairn Oil & Gas HSE Policy

2. SCOPE:

Applies to all employees and contractors working in Ravva Operations both onshore and offshore.

3. DEFINITIONS:

Definitions of key terms used in this document are shown in the following table.

Terms	Definition
Occupational Exposure Limit	A concentration of a substance hazardous to health to which most workers can be exposed repeatedly (8 hours/day, 40 hrs/week) without sustaining adverse health effects.
Units of Concentration	Ppm- Parts per million; mg/m3- milligrams per cubic meter; mppcf- millions or a particle per cubic foot; f/cc – fibers per cubic centimeter.
OSHA	Occupational Safety and Health Administration
NIOSH	National Institute of Occupational Safety and Health
ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
WEELs	Workplace Environmental Exposure Levels (As per AIHA)
PEL	Permissible Exposure Limit (as per OSHA)
REL	Recommended Exposure Level (As per NIOSH)
TLV	Thresh hold Limit Value – Refers to Airborne Concentrations.(As per ACGIH) Represents conditions in which nearly all workers may be repeatedly exposed day after day without adverse health effects.
TWA	Refers to the concentration for a normal 8-hr workday and 40hrs workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effects.
Threshold Limit Value - Short Term Exposure Limit (TLV-STEL)	Represents the concentration to which employees can be exposed continuously for a short period of time without suffering from (1) irritation; (2) chronic or irreversible tissue change; (3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency and provided that the daily TLV-TWA also is not exceeded.
STEL	Refers to 15 minute TWA exposure which should not be exceeded at any time during a workday even if the 8hour TWA is within the limits.
Ceiling Limit	Refers to the concentration that should not be exceeded during any part of the working exposure.
Threshold	Represents the concentration of a substance or gas that should not be

Limit Value - Ceiling (TLV-C).	exceeded even instantaneously.
Biological monitoring	Can be defined as assessment of employee exposure by measurement of some "index" chemical in a body fluid as evidence of exposure to a chemical.
The Biological Exposure Index (BEI)	Is defined as an "index" chemical that appears in a biological fluid or in exhaled air following an exposure to a workplace chemical.
Work area	Work Area is a place where people work.
IDLH	Refers to the concentration of hazardous agent that will produce irreversible health effects or death, following a 30minute exposure.
Exposure Limits – For Contaminants	• OSHA - PEL; STEL(short term exposure limit), Ceiling (instantaneous limit); OSHA BEI's(biological exposure indices) • NIOSH – TWA (Time Weighted Average), STEL, Ceiling. • ACGIH – TWA, STEL, Ceiling.
AOT	AOT shows the concentration at which the presence of the substance can be detected by its smell.
PNOC	Particles not otherwise Classified. The particulates which don't have toxicity evidence. Also known as "nuisance dust".
Irritants	Gives rise to relatively acute responses, leading to rapidly observed effects.
Sensitizers	Irritants that has a delayed reaction on subsequent exposure.
Asphyxiant	Dilute the air so Oxygen content is Low or inhibit Oxygen uptake.
Corrosives Hazards	Concern for contact of workers with corrosive substances

4. APPLICATION

OEL's is for risk management and control, In this document, an OEL refers generically to one or more accepted exposure limits including the OSHA-regulated PELs, NIOSH Recommended Exposure Limits (RELs), ACGIH TLVs , the American Industrial Hygiene Association (AIHA) Workplace Environmental Exposure Levels (WEELs), or any occupational exposure limits which provided information on Workplace safety and health, occupational exposure limits, risk management, hazard assessment, and the requirements for protecting Cairn Oil & Gas workforce and contractors and others who are in contact with its all kind of operations.

5. PROCESS AND STANDARDS

As a mechanism to protect Vedanta Ltd, Cairn Oil & Gas employees, Cairn business units should use a risk assessment to determine whether a workplace exposure constitutes Occupational Health hazard/s and then evaluate existing OELs to select the appropriate OEL.
Where a significant risk is identified, a quantitative assessment shall be conducted which shall include personal exposure monitoring to determine the employee exposure in relation to occupational exposure limits (OELs) as defined by relevant national legislation or by international standards, where OELs are absent in national legislation.

6. RISK ASSESSMENT

A risk assessment considers all aspects of the potential hazard and risks in the workplace, including OELs, work procedures, and systems of work. If any Vedanta Cairn business unit's risk assessment concludes that employees could suffer negative effects from exposure to a given hazard, then the agency should follow a risk management strategy based on the hierarchy of controls to reduce or eliminate the hazard. The hierarchy of controls includes, in order of preference:

1. Eliminate the need to use the substance;
2. Substitute a less hazardous substance;
3. Implement engineering controls (i.e. local exhaust ventilation, barriers, etc.)
4. Implement work practice controls and training;
5. Implement administrative controls (i.e. work restrictions/job or task rotation); and in addition to these control methods, and only as a last resort:
6. Proper selection, fitting, and use of personal protective equipment.

After Occupational health hazard Risk assessment and proceed through the hierarchy of controls to conclude that a specific substance cannot be eliminated from the work place, then appropriate workplace OEL must be selected. When selecting an appropriate OEL, the agency must consider the potential for mixed exposures, also referred to as cumulative risk.

7. LIMITATIONS OF OCCUPATIONAL EXPOSURE LIMITS (OEL)

An OEL can indicate the level of hazard posed by exposure to a specific substance but, by itself, cannot determine the likelihood of adverse health effects from that exposure.

8. STATUTORY REQUIREMENTS

The statutory requirements as stipulated inter alia in Factories Act, Oil Mines Regulations, and Petroleum & Natural Gas (Safety in Offshore Operations) Rules as applicable etc. shall be complied with.

THRESHOLD LIMIT VALUE - TIME WEIGHTED AVERAGE (TLV-TWA): It is the maximum concentration of a material that a worker could be exposed to 8 hours a day or 40 hours a week with no ill-effects.

THRESHOLD LIMIT VALUE - SHORT TERM EXPOSURE LIMITS (TLV-STEL): It is the maximum concentration of a material that a person should be exposed to in 15 minutes intervals, up to 4 times a day, without experiencing irritation or chronic or irreversible tissue damage. There should be a minimum 1 hour rest period between any exposures.

TLV (Skin) indicates that direct or air-borne contact with a material could result in possible and significant exposure from absorption through the skin, mucous membranes and eyes.

American Conference of Governmental Industrial Hygienists (ACGIH): ACGIH is an organization open to all practitioners in industrial hygiene, occupational health, environmental health, or safety. They are most famous for their Threshold Limit Values publication which lists the TLV's for over 700 chemical substances and physical agents, as well as 50 Biological Exposure Indices (BEI's) for selected chemicals.

9. MONITORING OF PHYSICAL HAZARDS

NOISE

NIOSH has a recommended exposure limit (REL) for occupational noise exposure of 85dBA as an 8-hour time-weighted average (85 dBA as an 8-hr TWA) compared to OSHA's PEL of 90 dBA as an 8-hr TWA. Since decibels are a logarithmic rather than linear scale, the OSHA PEL is substantially less protective than the NIOSH REL.

OSHA uses a 5-dB exchange rate instead of the 3-dB exchange rate that is supported by scientific evidence for assessing hearing impairment as a function of noise level and duration. In the Federal sector, the Environmental Protection Agency, and the National Aeronautic and Space Administration use the 3-dB exchange rate, as do nearly.

NOISE HAZARD OEL

Noise Level	ACGIH TLV TWA - 83.2 dBA (at 3dB exchange rate)

Note: The above value is for 12 hour TWA (adjusted for 12 hour work shift as per the Energy Principle) and Indian Factories Act 87.1 dBA (at 5 dB exchange rate).

TWA (12 hours) = TWA (8hours) - 10 log (12/8) for 3 dB exchange rate
TWA (12 hours) = TWA (8hours) - 16.67 log(12/8) for 5 dB exchange rate

Threshold Limit Values for Noise *

Duration per day/ Hours	Sound level dBA
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4 or less	115

Note: No exposure to continuous, intermittent, or impact noise in excess of a peak C- weighted level of 140dB. If instrumentation is not available to measure a C- weighted peak, an unweighted peak measurement below 140 dB may be used to imply that the C-weighted peak is below 140dB.

Notified areas of high noise (>85 dB) in the site are AGCs, Propane skid in Gas plant, RSGDP compressor, TSGR compressor, Solar Turbines, VFD room, MPP area, Export pumps, Water Injection pumps, Sand Blasting yard, Flare stack area (during high flaring due to AGC down) & Fire Water pump houses (during pumps operation) & ETP aeration blower area, Ware house area in LQ during helicopter operations.

Rest of the plant areas, which receive reasonable noise levels but well below the permissible levels, viz., North Gate, East Gate, near control rooms, Work shop, south east corner, south end, Incinerator area and bore well areas.

Noise levels shall be checked and recorded every quarterly by Manager Occupational & Community Health.

Once in four years, an external agency shall be assigned to carry out the noise levels in the plant and review the results and suggest suitable control measures. This monitoring shall be conducted with Octave Band Analyser as well as with personal dosimeters. (Personal dosimeters are used to check the TLV of exposure)

Records of Noise Level monitoring will be maintained by Manager Occupational & Community Health.

Noise Hazard Controls:

The following Noise control measures are recommended for adoption in Ravva Operations to maintain OEL 85dB.

Design/Engineering control measures: wherever possible.

Administrative Control Measures:

Information and Training: **Hearing Conservation Program** to all the employees. The HCP Program includes lecture session, video cassette show and evaluation.

Notice Boards: Displaying of Noise Hazard boards in all the notified high noise areas (AGCs, Water Injection pumps area, Export pumps area, Solar Turbines area etc.)

Rotation of Personnel: Personnel are rotated between high noise areas and low noise areas.

PPE: Supplying of Ear Plugs and Ear Muffs to all the personnel entering or working in the

Plant and LQ.
Ear plugs can reduce the noise levels 8 dB to30dB and Ear muffs can reduce noise levels 20dB to 40dB.

Medical Surveillance: Periodic Audiometry to the risk group.

Monitoring:
All the hazard identified areas shall be noise level monitored every *quarterly* by the in-house Manager Occupational & Community Health, with the available Decibel meter.

These reports shall be reviewed for any considerable changes in the noise levels in any particular area and control measures shall be reviewed.

Once in four years an external agency shall be assigned to carry out the noise levels in the plant and review the results and suggest suitable control measures. This monitoring shall be conducted with Octave Band Analyser as well as with personal dosimeters. (Personal dosimeters are used to check the TLV of exposure).

Medical Surveillance:

All the personnel working or exposed to the high noise areas shall undergo an annual Audiometry Test to identify any noise induced hearing loss. This way the preventive controls will be verified for their effectiveness.

Facility of Audiometry with Audio booth is available in-house.

The decibel meter used for monitoring shall be calibrated regularly in order to ensure reliability in monitoring.

Records of Noise Level monitoring and compliance monitoring shall be maintained by Manager Occupational & Community Health.

CHEMICAL HAZARD:

List of Chemicals & areas: Hydrocarbon vapours, Hydrogen Sulphide, Sodium Hypo Chlorite, Glycol, PPD, Biocides, Corrosion Inhibitors, Scale Inhibitor, Demulsifier & Oil spill dispersant in the areas Chemical Storage area at unloading bay, New CSU, Bore well area and Water Injection Plant, ETP, chemical lab and maintenance work shop etc.

Places where chances of H2S exposure are 1.RB Platform (120 – 200PPM) 2.Plant: ETP, PWRI, Terminal area (4 – 5 PPM). As all are concealed operations, the only chance of exposure is during taking samples and emergency leaks / exposures. OEL of H2S is 10PPM.

In-house Chemical Storage areas Survey shall be carried out by Manager Occupational & Community Health with checklists at least once in 6 months. Also the review of MSDS shall be done once in one year.

Once in four years, an external agency shall be assigned to carry out the personal monitoring by fixing the personal samplers to the area operators working in the chemical handling areas. Sampling shall be done for 12 hours during the day (period of shift work) and evaluate the Time

Weighted Average concentration to which the person is exposed. Records will be maintained by Manager Occupational & Community Health.

Chemical Storage Facility

- All the chemicals containers should be chemical-wise segregated.
- All the containers shall be labelled as per the UN classification of hazardous materials.
- Material Safety Data Sheets shall be displayed for all the chemicals stored. MSDS sheets shall be replaced whenever the supplier of the chemical changes.
- Proper ventilation shall be ensured.
- Proper access to the storage area shall be ensured for containers transportation.
- Eye Wash shower shall be provided at the storage area.
- All the containers shall be stored on pallets to prevent contact with spilled chemicals or rain water.
- Chemical Storage area shall be prominently marked and Safety instruction board on safe handling of chemicals shall be displayed.
- Adequate number of Fire extinguishers shall be placed.
- All the storage tanks in the units shall be marked with its content and labelled as per UN Hazardous material classification.
- Any chemical spillage shall be contained properly & shall be diluted to neutralize to permissible limits prior to disposal.
- No spillage shall enter into the storm water drain.
- Material transportation from the storage facility to the utility points shall be done by Fork Lift by authorized personnel through PTW.
- Rolling of containers is strictly prohibited.
- Restrict the material transportation during day light.
- PVC hand gloves, Safety Goggles, Safety Shoes and Helmet are the PPE to be used while handling the containers. While transferring the chemicals from containers to storage tanks, face mask with chemical filter shall be used in addition to the above PPE.
- Check the working condition and water supply to Eye Wash Shower prior to the chemical handling.

Hydrogen Sulphide (H_2S) exposure

Places where chances of H_2S exposure are 1.RB Platform (120 – 200PPM) 2.Plant: ETP, PWRI, Terminal area (4 – 5 PPM). As all are concealed operations, the only chance of exposure is during taking samples and emergency leaks / exposures.

(OEL) Occupational Exposure Limits:

ACGIH 2013 established TLV-TWA (**8 hour shift): 1 ppm** ; ACGIH 2013 established TLV - TWA (**12 hour** shift; derived from Brief and Scala model): **0.5 ppm** ; ACGIH 2013 established TLV-**STEL: 5 ppm**

OEL: The Indian Factories Act prescribed PLE-TWA (**8 hour shift): 5 ppm** ; The Indian Factories Act prescribed PLE-TWA (12 hour shift; derived from Brief and Scala model): 2.5 ppm ; The Indian Factories Act prescribed PLE-**STEL: 15 ppm**

OEL : 1 ppm / 8 hours shift & 0.5 ppm / 12 hours shift

Existing Control Measures:

- H_2S permanent gas sensors on RB on Main deck – one at Well head and one at Manifold. More than 10PPM , it alerts the Control Room
- Emergency escape breathers
- SCBA
- Personal H_2S gas tester
- Portable oxygen cylinder at RB

Rescue & First Aid:

Before Entering Areas with Possible Hydrogen Sulfide

- The air needs to be tested for the presence and concentration of hydrogen sulfide by a qualified person using test equipment. This individual also determines if fire/explosion precautions are necessary.
- If gas is present, the space should be ventilated.
- If the gas cannot be removed, use appropriate respiratory protection and any other necessary personal protective equipment (PPE), rescue and communication equipment.
- Atmospheres containing high concentrations (greater than 100 ppm) are considered immediately dangerous to life and health (IDLH) and a self-contained breathing apparatus (SCBA) is required.
- Ensure that medical personnel are aware of the material involved and take precautions to protect themselves. Do not use mouth-to-mouth artificial respiration. Give artificial respiration with the aid of a pocket mask equipped with a one-way valve ambu bag.
- Move the victim to fresh air.
- Administer 100% oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- Immediately flush skin or eyes with running water for at least 20 minutes.
- There is no specific antidote.
- Recently recommended to use Amyl Nitrate (0.3 ml Aspirols) under the nose of the victims.

Apart from Hydrocarbon vapours, Oil Chemicals are handled in the plant at various locations like Chemical Storage area, New CSU, Gas Plant, Bore well area and Water Injection Plant.

Monitoring of existing Control Measures:

Inspection and checking of control measures& H_2Slevels will be carried out by Doctor and HSE once in every month.

- H_2S levels at Terminal, FWKOD, Trains, AGC Compressors, and Sales Gas metering skid, Fuel gas, skid, GLTP Contractor area and ETP.
- H2S permanent gas sensors on RB on Main deck one at Well head and one at Manifold More than 10PPM, it alerts the Control Room
- H2S permanent gas sensors on RB on Main deck one at Well head and one at Manifold More than 10PPM, it alerts the Control Room
- Emergency escape breathers
- SCBA
- Personal H_2S gas testers
- Portable oxygen cylinder at RB

Plant Chemicals

Any chemical that is brought into the plant for storage or usage shall be accompanied by its MSDS and the copies shall be placed in Chemical lab & OHC and MSDS will be displayed at the point of usage or storage.

Plant chemicals OEL / Threshold Limit Values (ACGIH)		
S.No	**Chemical Name**	**Threshold Limit Values (ACGIH)**
1	Biocide-1 (Bactron SK-4710)	Not Determined
2	Biocide-2(Bactron SK-4674)	Not Determined
3	Calcium Chloride	Not Determined
4	Caustic Soda(Sodium hyrdoxide)	2 ppm
5	Industrial- DAP	5 mg/m3 – respirable
6	Demulsifier (SX-4646, Emulsotron)	15 PPM
7	Diesel	800 ppm
8	DRA(Turboflo_H2O_270_)	Not available
9	DRA(Turbofio_SVX)	Not available
10	Fermsept -E	Not available
11	Flogard MS-6201 (corrosion inhibitor)	Not Determined
12	Flogard MS-6209 (corrosion inhibitor)	Not Determined
13	Gas Corrosion Inhibitor (R-2562,) Cortron	25 ppm
14	Gengard GN-7004(Dispersant)	Not Determined
15	H2S Scavenger (Multisweet MX 677-8)	6 ppm
16	Hydrochloric Acid	7 ppm
17	Monoethylene Glycol	50 ppm
18	Oil Corrosion Inhibitor (SRN-4665, Cortron)	400 ppm
19	Oxygen Scavenger(OS-2))	Not available

20	Penntreat 1400 (RO Antiscalant)	Not available
21	Penntreat 1509 (RO membrane cleaner)	Not available
22	Penntreat 1510 (RO membrane cleaner)	Not available
23	Penntreat 1699(Biocide)	Not available
24	Pour Point Depressant(SFM-6242, Flexoil)	50 ppm
25	Propane	1000 ppm
26	Scale Inhibitor(Gyptron-SA 4023)	Not available
27	Soda ash	10 mg/m3
28	Sodium HypoCholorite	2 mg/m3
29	Spectrus BD-1500	Not Determined
30	Spectrus NX-1100(Non Oxidising Biocide)	Not Determined
31	Spectrus NX-1103(Non Oxidising Biocide)	200ppm(propanal)
32	Triethylene glycol	Not Determined
33	Industrial -Urea	Not available
34	Water Clarifier - Mioversas	Not available
35	Water Clarifier Baker hughes	0.05 ppm
36	Water Corrosion Inhibitor (SRN-4665, Cortron)	400 ppm

Monitoring the implementation of control measures:

Engineering controls:

- Chemical handling i.e., crane-unloading of the barrels or toed tanks, shifting of the barrels from storage point to the utility point by fork lift. Manual rolling of the barrels is not an acceptable procedure. (Check for usage of the equipment)

Administrative controls:

- Fixing MSDS boards. (Check for the availability)
- Training to all the personnel (risk group) working in the chemical handling tasks on MSDS and Chemical hazards.

PPE:

- Chemical filter masks (Check for usage during chemical handling)
- Usage of PVC gloves, chemical splash goggles, helmets and shoes while handling chemicals.

Medical Surveillance:

Spirometry and chest x-ray shall be conducted to the risk group once in every year and once in three years respectively.

Records will be maintained by Manager Occupational & Community Health.

TEMPERATURE EXTREMES

There are no hot processes in Ravva Operations that radiates heat into the surroundings and affect adversely the health of the personnel working in the plant.

But when the high rates of gas flaring, operators are likely to receive heat radiation (not so excessive) while working at the knock out drum area. This is a very rare operational requirement and the time of exposure will not exceed 30-45 minutes.

During summer season, the ambient temperature will be recorded as high as 48 to 50 C, which shall be measured through the thermometers located outside the Control Room. Relative humidity is measured around 45%-50%. Necessary control measures shall be taken to prevent the overexposure of personnel to hot climatic conditions.

Records of daily observations will be maintained by Radio room.
The following control measures are recommended for adoption in Ravva Operations:

Administrative Control Measures:

- Information and Training: Heat Acclimatization Program & Heat Stress awareness program to all the employees. Program includes lecture session, video cassette show and evaluation.
- Provision of Electrolytes during Summer Season
- Planning indoor works during afternoon session during Summer Season(i.e. 1100 hours to 1600 hours)
- Provision of cool drinking water to the workforce.
- Supply of buttermilk & lemon water through pantries.

Records of training program will be maintained by Manager Occupational & Community Health

ERGONOMIC HAZARDS

Survey shall be conducted with the help of a Checklist (Annexure) biannually for all the occupations and whenever any new machinery or equipment or tools etc. are procured and put into operation.

This survey shall be conducted by Manager Occupational & Community Health with the concerned supervisors and the observations shall be analysed for corrective actions.

Records will be maintained by Manager Occupational & Community Health.

The following control measures are recommended for adoption in Ravva Operations:

- Design/Engineering control measures wherever possible.
- Administrative Controls

- Once in four years an external agency shall be assigned to carry out the Ergonomic survey.
- Awareness programs will be carried out for both employees and contract work force specifically to target groups.
- Records will be maintained by Manager Occupational & Community Health

ILLUMINATION HAZARD

Evaluation of lighting effectiveness is not just a question of quantity of light, but also of the quality of the lighting environment. Portable, contrast, rendered by lighting systems and visual display, battery powered instrument is available for measurement of general luminance, and luminance battery powered instrument is available for measurement of general luminance, and luminance contrast rendered by lighting systems.

Recommended (OEL) service illuminance for various classes of visual task as per OISD & Minimum average illumination for designated mine locations and activities as per IFC Guidelines

Class of Visual Task	Recommended Illuminance(Lux)	Typical examples	IFC Guidelines - Location / activity Illumination requirement (Lux)	Minimum Illumination (Lux)
Exceptionally difficult tasks	2400 or more	Inspection of minute work (e.g. very small instruments)	Emergency lighting	10
Very difficult	1600	Extra-fine bench and machine work, tool and die making (tolerances below 25 um); gauging and inspection of small or intricate parts	Outdoor non-working areas	20
	1200	Inspection, examining and hand finishing light goods.	Simple orientation and temporary visits (machine storage, garage, warehouse)	50
Difficult	800	Fine bench and machine work, inspection of fine	Workspace with occasional visual tasks only	100

		work (e.g. calibrated scales, precision mechanisms and instruments).	(Corridors, stairways, lobby, elevator, auditorium, etc.)	
Normal range of tasks and workplaces	600	Office work with poor contrast drawing Offices-boards, fine painting, spraying and computer rooms-input and output terminals.	Medium precision work (simple assembly, rough Machine works, welding, packing, etc.)	200
Moderately difficult	400	Medium bench and machine work, routine office work-typing, filing, reading, writing; inspection of medium work (e.g. "Go" and "No Go" gauges, machine work; structural steel fabrication-marking off; enquiry desks	Precision work (reading, moderately difficult assembly, sorting, checking, medium bench and Machine works, etc.), offices.	500
Ordinary	300	Training room, chalkboards and charts; pharmaceutical stores; kitchens - food preparation, cooking, washing up; staff canteens – counters.	High precision work (difficult assembly, sewing, color inspection, fine sorting etc.)	1,000 – 3,000
Simple	200	Rough bench and machine work , rough visual inspection, counting, rough checking of stock parts; structural steel fabrication-		

		general areas; entrance halls; waiting rooms; LPG Plants, POL Depots / Terminals, Staff canteens, General warehouses and bulk stores - Packing and dispatch.		
Rough intermittent tasks	100	Loading bays; office strong- Rooms, staff change rooms; locker rooms.		
Movement Areas	50	Corridors with heavy traffic; orientation indoor car parks (lanes); walkways and movement areas in industrial plant; stairs; rest rooms.		
	20	Corridors with light traffic		

The OISD RP 149 - recommends the following area specific minimum illumination levels in oil fields:

Areas	Minimum Illumination in Lux
Main roads (along process units, power houses, Workshops, etc.).	7-10
Secondary roads (along storage tanks settling basins etc.)	3-5
Tank Farm	10
Pump houses ,sheds	100
Main operation platforms &access stairs	60
Ordinary platforms	20
Process area , pipe racks , heat exchanger , heater , separators , cooling tower , columns , pig launching / receiving loading area, flare etc.	60
Switchgear building	150-200
Transformer bay	100

Battery room	150
Control room bldg/laboratory	400
Boiler house	150
Charger/UPS rooms	150-200
Cooling tower	60
Switchyard	
(i)operating area	100
(ii)other areas	50
Warehouse	100
Office	300
Compressor operating area	200
Watch room	100
Stairs	50
Corridors/lifts	70
Tube well, gate & watchman booth	100
Fire house , garage	100-150

Monitoring of illumination levels shall be done once in every year in the plant areas, control room, offices, workshops etc. with Lux Meter by Electrical department and. Manager Occupational & Community Health.

Observed levels are compared with the standards and areas of deficit illumination levels are recorded

Records of observations shall be forwarded to Electrical Department for arranging additional lighting for improving illumination.

As per CEIL Medical Policy, Periodical Medical Examination will be done to all the employees (once in 3 years for below 35 years age and once in every year for above 35 years age), in which vision test is included.

Records of medical examinations are maintained by Manager Occupational & Community Health..
The following control measures are recommended for adoption in Ravva Operations:

Design/Engineering control measures:

- Additional lighting facilities wherever deficient lighting observed during illumination survey
- Reorientation of light fittings at various locations in the plant for lighting improvement.
- Information and Training: Awareness program on Illumination to all the employees. Program includes lecture session, Video cassette show and evaluation

Records of medical examinations are maintained by Manager Occupational & Community Health.

RADIATION HAZARD (NORM)

The rem is a unit used to derive a quantity called equivalent dose. This relates the absorbed dose in human tissue to the effective biological damage of the radiation. Not all radiation has the same biological effect, even for the same amount of absorbed dose. Equivalent dose is often expressed in terms of thousandths of a rem, or mrem. To determine equivalent dose (rem), you multiply absorbed dose (rad) by a quality factor (Q) that is unique to the type of incident radiation.

1 Sv = 100 rem	1 rem = .01 Sv
1 mSv = 100 mR (mrem)	1 mR = .01 mSv
1 Gy = 100 rad	1 rad = .01 Gy
1mGy = 100 mrad	1 mrad = .01 mGy

Acceptable Effective Dose Limits for Workplace Radiological Hazards (As per IFC Guidelines)

Five consecutive years average – effective dose	20 mSv/year
Single year exposure – effective dose	50 mSv/year
Equivalent dose to the lens of the eye.	150 mSv/year
Equivalent dose to the Extremities (hands, feet) or the skin.	500 mSv/year

RB platform:

Multi-Phase Flow Meter was installed on the Oil line on RB, RC, RD, RE and RF platforms. The source of radioactive intensity is 0.1 mR. (TLV of radiation is 7mR.) Radiation measurements shall be taken around the meter at different distances with the Radioactive meter once in 6 months during platform scheduled inspections.

The Instruments Department will inform and rectify any abnormality noticed.

ON SHORE:

Other identified source of radiation is the radiography equipment mobilized into the site for weld-joint integrity checks. The equipment source intensity varies from 5 mill curie to 15MC.

Records of measurements shall be maintained by HSE Manager.

Design/Engineering control measures: The equipment is incorporated with design safety features to prevent radiation release into the surroundings.
Administrative control measures:

1. Storage pit: To store the equipment when not in use.
2. Works at night: All radiograph works shall be planned during night or in a isolated place where personnel moment is minimum.
3. Barricading the work area to a distance that depends upon the radiation source intensity.
4. The work shall be carried out through PTW.
5. Area operators have to monitor the radiation levels around barricading
6. Multi-Phase Flow Meter was installed on the Oil line on RB, RD, RE and RF platforms. The source of radioactivity intensity is 0.1 mR. (TLV of radiation is 7mR.). Radiation measurements shall be taken around the meter at different distances with the Radioactive meter once in 6 months during platforms scheduled inspections.
7. The Instruments Department will inform and rectify any abnormality noticed.
8. BARC certification to equipment and operators is essential
9. Records of measurements shall be maintained by HSE Manager.

DUST HAZARD

Dust monitoring shall be conducted once in four years by a third party with personal monitors to analyse the air borne respirable dust in the *blasting yard.*

Dust monitoring in some places of work area will be carried out once in a year by the external agency which is monitoring the dust in external and outside areas of plant regularly.

OEL / TLV of Silica is 0.1 mg / Metric cube to 0.2 mg /Metric cube and OEL / TLV –TWA of respirable dust is 3 mg /metric cube as specified in ACGIH (American conference of Governmental Industrial Hygienists)

Observations will be analysed by Manager Occupational & Community Health.

Administrative controls:

- Training to the personnel
- Regular preventive maintenance checks
- Information and Training: Awareness program to all the employees. Program includes lecture session, video cassette show and evaluation

PPE:

- Self-contained Breathing Air (Compressor connected) mask.
- Medical Surveillance: All the personnel working in the Blasting Area shall undergo Spirometry (Lung Function Test) and chest X-ray once in four years.
- Records of medical surveillance shall be maintained by Manager Occupational & Community Health

Vibration Hazard:

Permissible Dosage	Rems per calendar year
Whole body: Head and trunk, active blood forming organs, lens of eyes or gonads	5 rem
Hand and forearms, feet and ankles	75 rem
Skin of whole body	30 rem

NOTE: Rem (roentgen equivalent man)

- Vibration monitoring shall be done for the hand tools and equipment to check the user's exposure to vibration. Vibration may be transmitted to the entire body (Whole-body vibration) when the person stands on a vibrating platform or an equipment pedestal or only to the arm holding a vibration tool (Localized or segmental vibration).
- Portable Electrical Hand tools viz., Drills, grinders, etc. are in use in the plant. Vibration levels shall be checked and observations shall be analysed. Similarly, vibration levels of the equipment working platforms shall be monitored and recorded.
- Design/Engineering control measures: wherever possible.

STRESS-RELATED HAZARDS

- Physical, Mental & Emotional stress questionnaire or Work stressor questionnaire shall be circulated to all the employees and will be asked to submit and the records shall be maintained by Manager Occupational & Community Health.
- This data on stress related disorders will help to investigate the root causes & to take control measures. This exercise shall be repeated once in three years.
    - Administrative Controls: Medical Counselling, Recreation facilities at LQ, Shift-work rotation. Awareness programs.
    - Information and Training: Work place stress program to all the employees. Program includes lecture session, video cassette show and evaluation
    - Records shall be maintained by Manager Occupational & Community Health.
    - All the reports shall be reviewed and recommendations & corrective actions will be executed in association with Site Wellness Committee.
    - Stress buster programs shall be planned and executed through Wellness Committee

BIOLOGICAL HAZARDS

- Chemical laboratory & ETP deal with the *Sulphate Reducing Bacteria (SRB), General Anaerobic Bacteria (GAnB), both Planktonic and Sessile Bacteria* to test the existence of bacteria in injection water and produced water to assess the corrosion. These tests will be carried out every day.

- Hazard of bites by Mosquitoes & honey bees, bites by reptiles – Snake, Scorpion and Rat and bites by animals – Dogs, Cats and Foxes exists in the plant and LQ.
- Control measures ex. Housekeeping and necessary medications are maintained by Manager Occupational & Community Health.

Engineering Control Measures:

- Using non-absorbable work surface
- Use Sodium Hypo Chlorite as germicide for cleaning up of spills.
- Autoclaving the waste before disposal
- Housekeeping avoiding snakes, scorpions, rats, and other reptiles etc.
- Pest control programs to mitigate mosquito and insect problem

PPE:

- Use of Hand Gloves, shoes and other necessary PPE
- Use of Goggles, while handling SRB.
- Sufficient doses of Anti-venom have to be stored at OHC.

Chemical Lab keeps the records of SRB and other material of bacterial base that are in use. The work surfaces are non- absorbable. Lab keeps sufficient germicide to neutralize the spills.

Housekeeping has to be maintained in the plant to prevent snakes, scorpions, rats, insects and mosquitoes.

The pest control program shall be monitored for its efficacy and the Caterer keeps the records.

1. OCCUPATIONAL HEALTH AUDIT

1.1 PROCEDURE

It is essential for potential health hazards to be identified, evaluated and monitored the efficacy of control measures on regular basis to improve the system. Techniques to carry out the program shall include:

I. Site Survey – walk through survey in area wise.
II. All significant risk activities are to be observed to assess the existing control measures.
III. Identification of any other potential health hazards.

1.2 Health Hazards

The identified potential health hazards in Ravva Operations are:

A. Noise hazard
B. Chemical hazard
C. Temperature Extremes
D. Ergonomic hazard
E. Illumination hazard
F. Radiation hazard
G. Dust hazard
H. Vibration hazard
I. Stress-related hazard
J. Biological hazard

These hazards have to be prioritized based on the Risk Assessment Matrix of frequency of hazard Vs consequences of hazard. The basis for the assessment shall be task and area wise for each hazard identified.

1.3 Areas

Zone 1:

- Tank form area,
- Firewater Pumps
- Water Injection Pumps
- Chemical Storage area
- RO plant
- STP plant

Zone 2:

- CSU – Process area
- Gas Compressor area
- RSGDP
- ETP
- Terminal Area
- PWRI
- Gas Turbines area

Zone 3:

- Work shop
- Electrical substations
- Laboratory
- Offices
- Control Room

Zone 4:

- LQ – Ware house
- Helicopter operations
- Catering facilities

Zone 5

- Off shore Platforms

1.4 Audit Team

Audit team consists of 4 members.

- Occupational Health Physician
- HSE
- Manager Production
- Manager Maintenance

1.5 Audit schedule

Walk through survey will be carried out in all areas once in 6 months.

1.6 Audit Report & Circulation

All the findings are recorded and evaluated.
The action points are recorded in CAR / GAT and assigning both Corrective and Preventive actions to the concerned departments.
The action points will be discussed in monthly CAR, and HSE meetings.

2. HEALTH CARE SYSTEM

9.1 PROCEDURE

Health care systems are good technique for identifying physical problems of all employees on a regularly scheduled basis. Medical examinations should be considered early warning systems which can identify such items as weight changes, behavioural changes, altered general appearance, etc. and can therefore provide indicators to take preventive actions i.e. more detailed check-ups and proactive therapy.

9.2 Pre-Employment Medical Examination

All the new employees on joining shall undergo medical examination. This forms the base line health data of the person joining the company. This should cover all occupational health issues (Audiometry, spirometry etc.) and non-occupational or general medical parameters.

All contractors have to submit the medical details of the contract work force before undertaking the work.

The permanent contractors have to submit the medical records of their contract workforce before commencing the work.

Records shall be maintained by Manager Occupational & Community Health.

9.3. Periodical Medical Examination

As per CEIL medical policy, all the employees **below 35 years of age** shall undergo medical examination **once in 3 years** and those **above 35 years, once in a year.**

Perspective to Occupational health, the protocol includes Audiometry, Spirometry and Ophthalmic check-up.

Protocol of the tests also includes Lipid profile, TMT, Heart scan and HIV tests.

It also includes Mammography, Pap smear and Gynecological tests & consultation for Female employees.

Permanent contractors have to submit the medical records of their contract workforce once in five years.

The food handlers / Catering personnel have to submit their medical records once in a year

9.4 Health Records / files

Health files for all the employees shall be generated and maintained by Manager Occupational & Community Health, which contains medical history, medical check-up reports etc.

Review of PMC reports will be done and recorded in a format.

These files shall be updated in Documentum once in a year and confidentiality of this computerized data shall be maintained.

9.6. Health Facilities

OP services and round the clock emergency medical services are available to all employees.

FHPL (Family Health Plan Limited) Scheme through third party insurance extends to all the company employees.

FHPL (Family Health Plan Limited) Scheme through third party insurance extends to the entire Micro vendor contract work force.

9.7 Health assistance

Special health improvement programs shall be carried out in association with Site wellness Committee once in a year either internally by Manager Occupational & Community Health or through an external agency to ensure good health of the employees. These programs shall include:

- Stress Management
- Fitness & Yoga
- Alcohol addiction
- Risks in smoking etc.

Gymnasium facility is available in Living Quarters to improve the physical fitness of the employees.

9.8. Case Management

- Medical counselling (advice and information on the health problems) shall be conducted by Manager Occupational & Community Health on the general health improvement of the personnel absent from work due to ill health, injury or other reasons.
- Details of counselling are recorded and maintained by Manager Occupational & Community Health

9.9. Communication

- The review reports and other information & further advice are communicated personally and through personal e-mails for all Cairn employees.
- Review of PMC reports of permanent contractors will be done personally and the Xerox copies of the review report and the medical reports will be given to the individuals for implementation of recommendations.

9.9.1 Specific tests

- Annual Audiometry for O & M employees and contract workers and Security Personnel
- Annual Ophthalmic check for Drivers
- Annual Widal and Motion / stool examination for Catering crew (Food handlers)

Annexure 1: Pre-employment / PMC (Periodical medical check-up) - Protocol of tests for **Vedanta Cairn employees**

PROTOCOL OF TESTS

- Blood grouping & Rh typing
- Complete blood picture with ESR
- Blood urea
- Lipid profile
- Liver function tests
- PSA
- Sr.Creatinine
- Sr.Uric acid
- Urine routine
- VDRL
- Viral markers
- FBS & PPBS
- GTT or Hb 1 Ac
- Stool routine
- ECG
- 2D echo
- TMT
- X-ray Chest
- Ultra sound abdomen
- Audiometry
- Pulmonary function test (Spirometry)
- Ophthalmic checkup and Consultation by Ophthalmologist
- Gynecological Investigations and Consultations for Lady Employees
    - Pap-smear
- Consultation by ENT Specialist
- Consultation by Physician
- Consultation by Cardiologist
- Consultation by Dietician

Annexure 2: PMC - Protocol of tests for **Micro vendor contract workers / Other Contract workers**

- Blood group
- Hemoglobin

- TC,DC, ESR (CBC)
- Fasting Blood sugar
- Lipid Profile
- Blood Urea
- Serum Creatinine
- HIV marker
- Hepatitis B
- Urine routine
- ECG
- Ultrasound Scan Abdomen
- Chest X-ray
- Audiometry test
- Pulmonary function test (Spirometry)
- Ophthalmic checkup and Consultation by Ophthalmologist
- Physical examination
- Physician consultation and fitness certificate
- Gynecological consultation and PAP smear (Female workers).

Annexure 3: Medical check for contract workers of Catering Services (**Food handlers**)

- Blood group
- Hemoglobin
- TC,DC, ESR (CBC)
- Fasting Blood sugar
- Blood Urea
- Lipid profile
- Serum Creatinine
- Hepatitis B
- Urine routine
- Motion / Stool test (Every six months)
- Widal Test (Every six months)
- Chest X-ray (Every three years)
- ECG
- Physical examination
- Physician consultation and fitness certificate

Annex 9

Overview of the National and International Regulatory and Policy Framework applicable to this Project

1 OVERVIEW OF NATIONAL AND INTERNATIONAL REGULATORY AND POLICY FRAMEWORK APPLICABLE TO THIS PROJECT

This section provides an overview of the national and international regulatory framework, and Vedanta Ltd (Cairn Oil & Gas)'s corporate HSE requirements of relevance applicable to the proposed onshore and offshore oil and gas development programme as well as to the existing operations in the PKGM-1 Block.

1.1 VEDANTA LTD (CAIRN OIL & GAS)'S HSE HIERARCHY

Section 9 on Environmental and Social Management Plan (EIA Report Volume 1) covers Vedanta Ltd (Cairn Oil & Gas)'s HSE hierarchy as applicable to the proposed oil and gas development in the existing PKGM-1 Block.

1.2 APPLICABLE INSTITUTIONAL FRAMEWORK

This section covers following regulatory requirements:

- Constitutional provisions safeguarding individual rights and environment;
- Institutional Framework;
- Applicable Environmental Laws, Regulations and Policy;
- Social Laws, Regulations and Policy;
- Applicable Permits – Licenses, approvals and consents;
- Applicable Standards.

A brief description of the applicable requirements on the above aspects is presented in the following sub sections:

1.2.1 *Constitutional Provisions Safeguarding Individual Rights and Environmental Provisions*

In India environmental and community relations are governed by the 'intent of law' apart from specific acts and regulations. Any facility / business operations/ corporate/ private/ public sector units can be held accountable for its impact on the larger community based on the interpretation of certain constitutional safeguards and provisions. The Constitution of India guarantees every citizen the fundamental Right to Life and Personal Liberty. The fundamental *Right to Life* is guaranteed under *Article 21* that states "no person shall be deprived of his life or except according to the procedure established by law". *Article 21* has been used by the courts in a number of judgements, dealing with a range of social and environmental issues and has constantly progressed to include a number of rights, which interpret the "right to life". These include the 'right to food, water, clothing, environment, education, medical care and shelter.' The *Article 48-A* of the Constitution of India states that the State shall endeavour to protect and improve the environment and to safeguard the forest

and wild life of the country. At the same time, it shall be the fundamental duty of every citizen of India under *Article 51-A (g)* of the Constitution of India, to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures.

Judicial remedy under the Constitution of India through Public Interest Litigations

Public Interest Litigation (PIL) has become one of the most important tools of legal aid and has served to bring justice in cases involving social and environmental concerns. Under a PIL, any public-spirited individual or group can move the court of law (under *Article 226* of the Constitution for High Courts, and *Article 32* for the Supreme Court) in case of breach of any fundamental right, to seek judicial redress. PIL is a form of writ petition, which can be filed by anybody, even if he or she is not directly affected by the perceived injustice. This has enabled environmentally conscious, public-spirited individuals or groups, which are not an aggrieved party, to have easy access to the highest court of the nation. Indian courts are taking an increasingly aggressive stance towards defaulters and the legal system is moving towards the principle of 'polluter pays'.

1.2.2 Institutional Framework - Enforcement Agencies

A brief description of the key institutions, their functions and responsibilities and applicability to the proposed oil and gas development is presented in ***Table 1.1.***

Table 1.1 Applicable Institutions governing Environment Management for Ravva Field

SN	Institution	Functions & Responsibilities	Applicability for Cairn
1	**Ministry of Petroleum and Natural Gas (MoPNG) & Directorate General of Hydrocarbons (DGH)**	DGH was established in 1993 under the administrative control of Ministry of Petroleum & Natural Gas (MoPNG) with the objective to promote sound management of oil and natural gas resources with a balanced to the environment, safety, technological and economic aspects of the petroleum activity. DGH has been entrusted with several responsibilities like implementation of New Exploration Licensing Policy (NELP), matters concerning the **Production Sharing Contracts** for discovered fields and exploration blocks, promotion of investment in E&P Sector and monitoring of E&P activities including review of reservoir performance of producing fields. In addition, DGH is also engaged in opening up of new unexplored areas for future exploration and development of non-conventional hydrocarbon energy sources. DGH advises Government in laying safety norms and framing regulations on safety in oilfield operations.	The Ravva Field was discovered in 1988 by ONGC and Production Sharing Contract was signed on 28 October 1994 by Ravva JV Reportedly, Vedanta Ltd (Cairn Oil & Gas) abides by requirements as laid down in the PSC and periodically reports to DGH.

SN	Institution	Functions & Responsibilities	Applicability for Cairn
2	**Oil Industry Safety Directorate (OISD)**	OISD is a technical directorate under MoPNG that formulates and coordinates implementation of a series of self-regulatory measures aimed at enhancing the safety in the oil & gas industry in India. OISD has formulated Safety Standards (111 in nos.). OISD maintains a database of accidents taking place in the oil industry. OISD also investigates major incidents. OISD is responsible for ▪ operations pertaining to oil exploration & drilling, crude stabilization, gas processing & transportation; ▪ all refinery operations & petrochemical manufacturing; ▪ pipeline operations regarding Storage, Transportation and Distribution of Crude Oil & Petroleum products; ▪ marketing of Crude Oil & Petroleum products. ▪ meet requirement of Petroleum and Natural Gas (Safety in Offshore Operations) Rules, 2008, developed under the Oilfields (Regulation and Development) Act, 1948 (to be complied with safety and risk reduction for offshore oil and gas operations in India.	Vedanta Ltd (Cairn Oil & Gas) is to follow OISD guided safety related matters and also obtain Consent under PNGSOO Rules, 2008 for activities undertaken in offshore region. Vedanta Ltd (Cairn Oil & Gas) is reportedly complying with the OISD Standards and will also pursue Consent from OISD under PNGSOO Rules for the proposed oil and gas development activities in (Ravva Field) PKGM-1 Block.
3	**Ministry of Defence - Indian Coast Guards**	Coast Guard (CG) was set up as an Armed Force of the Union of India in 1978 under the Coast Guards Act, 1978 as amended in 2002 for preservation and protection of maritime zones of India (i.e. the territorial waters, the contiguous zone, the continental shelf, the exclusive economic zone or any other maritime zone of India). CG is responsible for keeping regular surveillance in order to prevent poaching/ smuggling, other illegal activities and pollution control at sea, search and rescue and protection of marine environment. Director General, Indian Coast Guard, at New Delhi is responsible for administrative control of CG with regional control from headquarters at Mumbai, Chennai and Port Blair. The entire coastline of India is covered by the 11 District HQs and 9 Coast Guard stations under respective Regional Headquarters. The primary duties of Indian Coast Guard are to: ▪ protect ocean and offshore wealth including Oil, Fish and Minerals; ▪ protect the artificial islands and off-shore installations; ▪ assist Mariners in distress and safeguard life and property at sea; ▪ enforce Maritime Laws with respect to sea, shipping, poaching, smuggling and narcotics; ▪ preserve marine environment and ecology and to protect rare species; ▪ collect scientific data; and ▪ assist Indian Navy during war situation. Indian Coast Guard is also implementing National Oil Spill Disaster Contingency Plan. As per the guidelines of the Indian Coast, every owner, operator of a port facility, oil installation, offshore installation is required to prepare and implement oil spill disaster contingency plan.	Vedanta Ltd (Cairn Oil & Gas) is also implementing Oil Spill Contingency Plan developed for the Ravva Asset.

SN	Institution	Functions & Responsibilities	Applicability for Cairn
4	**Ministry of Defence – Indian Navy: Flag Officer Offshore Defence Advisor Group (FODAG)**	FODAG functions as the nodal agency for all interaction with ONGC and other oil Exploration & Production (E&P) companies in matters relating to defence of offshore installations within the Maritime zones of India. The primary functions of FODAG includes the following: a) To advise the GoI including the Ministries of Defence, Petroleum & Natural Gas and Shipping and Civil Aviation through the Chief of the Naval Staff on planning and policy aspects of offshore security and defence covering territorial waters, the continental shelf, the exclusive economic zone and other Maritime zones of India as defined in the Maritime Zones Act, 1981. The aspects include:- (i) Coordination of functioning of offshore security arrangements; (ii) Identification of various threats to offshore installations and terminals; (iii) Identification and defining of military threats in situations short of war. b) Examination and proposing of appropriate security measures in respect of all entities engaged in offshore exploration and other measures necessary for the security of offshore installations and terminals c) Exercise command and control over mobile forces and static defences in defence of offshore installations, as directed by the respective Commander -in-Chiefs d) Monitor mercantile traffic for transit through recommended routes/ fairways in the vicinity of offshore areas, in coordination with the concerned civil authorities e) Inspect vessels engaged in offshore work, prior to their being deployed, for the purpose of ascertaining compliance with the security clearance accorded by competent authority FODAG is a member of Offshore Security Co-ordination Committee (OSCC), which manages offshore security. Flag Officer is also the chairman of the Joint Venture Offshore Protection Advisory Committee (JVOPAC) which is a sub-committee of the OSCC and a forum to facilitate the exchange of security and offshore issues between the OSCC and the offshore JV/ private oil companies, as Joint Venture. Private companies do not have representation in OSCC. For offshore oil and gas and related activities, defence clearance is required from Indian Navy.	All vessels deployed by Vedanta Ltd (Cairn Oil & Gas) are to undergo naval security inspection by concerned FODAG of concerned naval command in charge of the area with a minimum of one month in advance of such inspection and clearance. It is also important to note that prior to applying to FODAG, Cairn is required to obtain approval of Chief Hydrographer, Dehradun about the coordinates of the location where Rig or vessels will be deployed for the purpose of proposed oil and gas development in Ravva Field in PKGM-1 Block, based on which a marine Safety Warning will be issued by the Competent authorities Vedanta Ltd (Cairn Oil & Gas) is to ensure prior availability of naval clearance before start of any offshore activities and comply with the requirements
5	**Ministry of Shipping**	Within the Ministry, Department of Shipping encompasses regulations on shipping and ports sectors which include shipbuilding and ship-repair, major ports, national waterways, and inland water transport. Department of Shipping has been entrusted with the responsibility to formulate policies and programmes on these subjects and their implementation	Manages maritime navigation through state level Maritime Boards.

SN	Institution	Functions & Responsibilities	Applicability for Cairn
6	**Directorate General of Mines Safety (DGMS)**	DGMS is the governing body for safety in mines and oil fields in India. DGMS is the agency that has aim to continually improve safety and health standards, practices and performance in the mining industry and upstream petroleum industry. In the upstream petroleum industry the requirements are to be complied under the Oil Mines Regulations, 1984 promulgated under the Mines Act, 1952. The Oil Mines Regulations of 1984 are likely to be replaced with the 2011 regulations which are currently (as on June 2013) in draft form. The draft regulations also specifically include provisions related to offshore installation related safety.	Vedanta Ltd (Cairn Oil & Gas) is to comply with requirements of Oil Mines Regulations and ensure periodical reporting of its safety related information to DGMS
7	**Petroleum and Explosives Safety Organization (PESO)**	PESO is under the Department of Industrial Policy & Promotion, Ministry of Commerce & Industry, Government of India. The Chief Controller of explosives is responsible to deal with provisions of: ▪ The Explosives Act 1884 and Rules, 1983; ▪ The Petroleum Act 1934 and the Rules 2002; ▪ The Static and Mobile pressure vessels {Unfired} Rules, 1981 and amendment 2000, 2004; ▪ The Gas Cylinder Rules, 2004; and ▪ Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 and amendment, 2000.	Vedanta Ltd (Cairn Oil & Gas) is to ensure compliance under Acts and Rules related to petroleum safety related requirements is taken up at the Ravva Terminal. Prior licences are required for storage of crude and petroleum products.
8	**Ministry of Environment and Forests and Climate Change (MoEFCC)**	MoEFCC is responsible for the environment management at Union of India level by implementation and enforcement of the Environment Protection Act, 1986, and Rules issued under the Act, including the EIA notification. Under sections 3 and 5 of the EP Act, 1986, it retains enormous powers to issue directions in the interests of environment protection. The specific functions of MoEFCC are as follows: ▪ Environmental policy planning; ▪ Effective implementation of legislation; ▪ Monitoring and control of pollution; ▪ Environmental clearance for industrial and development projects; ▪ Promotion of environmental education, training and awareness; and ▪ Forest conservation, development, and wildlife protection. MoEFCC is the responsible agency to issue prior Environmental Clearance (EC) as per the requirement of the EIA Notification 2006 as amended to date. For projects falling within the ambit of Coastal Regulation Zone Notification, 2011, MoEFCC approves CRZ Clearance after appraisal of the Project and recommendation for CRZ Clearance by the State Level Coastal Zone Management Authority i.e. APCZMA in this case. MoEFCC, through its eight regional offices monitors the conditions stipulated in the Environmental Clearance issued to various projects including upstream and downstream Oil and Gas projects.	Requirement of prior Environmental Clearance as per the terms of reference approved by Expert Appraisal Committee of MoEFCC will be applicable for the proposed oil and gas development in Ravva Field. Vedanta Ltd (Cairn Oil & Gas) is also required to submit compliance status of the EC conditions as issued for the Project. Six monthly compliance status submissions to MoEFCC regional office is also mandatory.
9	**Andhra Pradesh Coastal Zone Management Authority (AP CZMA)**	For coastal zone management, National and State level Coastal Zone Regulatory Authorities (created under the CRZ Notification, 1991, 2011 and 2019) report to MoEFCC. Under the CRZ Notifications, area from coast to 12 nautical miles constitute coastal regulation zone. Any activity within CRZ area requires prior approval (CRZ Clearance) from respective state CZMA. Upon recommendation of APCZMA, CRZ Clearance will be granted by MoEFCC	Vedanta Ltd (Cairn Oil & Gas) is to ensure CRZ Clearance from MoEFCC after obtaining recommendations for the same from APCZMA

SN	Institution	Functions & Responsibilities	Applicability for Cairn
10	**Central Pollution Control Board (CPCB)**	CPCB was established in September 1974 for implementing provisions of the Water (Prevention and Control of Pollution) Act, 1974. CPCB has a mandate for control of water, air and noise pollution, land degradation and hazardous substances and waste management. It has responsibilities for the industrial pollution prevention and control is primarily executed by the CPCB at the Central level, which is a statutory body, attached to the MoEFCC. Specific functions of CPCB include: ▪ Prevent pollution of streams and wells; ▪ Advise the Central Government on matters concerning prevention, control and abatement of water and air pollution; ▪ Co-ordinate activities of SPCB's and provide them with technical and research assistance; ▪ Establish and keep under review quality standards for surface and groundwater and for air quality; and ▪ Planning and execution of national programme for prevention, control and abatement of pollution through the Water and Air Acts.	No approval is required from CPCB however the agency, being attached to MoEFCC, may provide technical support in pertinent environmental related.
11	**Department of Fisheries of Andhra Pradesh**	The department has been set up in 1959. The department has the following objectives: ▪ Increase of fish production and ensure sustainable development ▪ Development of fisheries value chain and boost exports. ▪ Promote investment to create infrastructure. ▪ Promote welfare of fishers. ▪ Set up institutions to build skills. The department also supports utilization of land not utilized for agriculture, for Aqua culture to get additional fish and prawn production specifically in West Godavari, Krishna and East Godavari Districts.	Vedanta Ltd (Cairn Oil & Gas) is to ensure effective environmental management of its operations for sustainable development.
12	**Andhra Pradesh Pollution Control Board (APPCB)**	APPCB is a statutory authority entrusted to implement environmental laws and rules within the jurisdiction of the State of Andhra Pradesh, India. APPCB was constituted in 1976 under the Water (Prevention and Control of Water Pollution) Act, 1974. The Board is responsible for implementing a series of environmental Acts and Rules, either directly or indirectly of 1) the Water Act, 1974, 2) the Air Act, 1981; 3) the Environment (Protection) Act, 1980, 4) the Hazardous and Other Wastes (Management, Handling and Trans boundary Movement) Rules, 2016, 5) the Bio Medical Waste (Management and Handling) Rules, 2016 and amendment Rules 2018, 6) the Solid Waste (Management and Handling) Rules , 2016, 7) the Plastic Management Rules, 2016; 8) the Batteries (Management and Handling) Rules, 2010, 9) e-Wastes (Management) Rules, 2016 as amended in 2018, and the Manufacture, Import and Storage of Hazardous Chemical Rules, 1989 as amended in 2000. APPCB functions through its head office at Hyderabad and 5 zonal offices and 19 regional offices. The key functions of the board include planning and execution of annual action plans to implement the provisions of various Acts and Rules; consent management; environmental awareness, ensure legal action against defaulters; and APPCB deals with projects related to onshore and territorial waters (within 4.8 km from coast) under the jurisdiction of the Water (Prevention and Control of Pollution) Act, 1974.	Consent for Establishment and Consent for Operation will be required for activities related within 4.8 km from coast. The agency may look into any marine pollution caused due to offshore activities within 4.8 km from coast.

SN	Institution	Functions & Responsibilities	Applicability for Cairn
13	**Department of Ports of Andhra Pradesh**	Andhra Pradesh has 14 notified non-major ports and one major port (Vizag) along its 996 km coastline. The 14 notified non-major ports are Bhavanapadu, Meghavaram, Kalingapatnam, Bheemunipatnam, Gangavaram, Nakkapalli, Kakinada SEZ, Kakinada, S.Yanam, Narsapur, Machilipatnam, Nizampatnam, Vadarevu and Krishnapatnam. Ravva (at S> Yanam) in East Godavari District was declared as a Minor Port through G.O.Ms.No.19 TR&B (P) Dept., dated 30-1-96. It is an offshore single buoy mooring [i.e. Single Point Mooring (SPM)] system established about 11 km from S Yanam for collecting offshore oil from oil rigs of 6 Nos., on the Ravva Basin to pump the same into the oil tankers for transporting to other Ports. The location of the SPM facility is at:- (A) Lat : 16º 24′05′′ N; Long : 81º 57 ′30′′ E. (B) Lat : 16º 34′55′′ N; Long : 82º 17 ′55′′ E. (C) Lat : 16º 18′25′′ N; Long : 82º 17 ′55′′ E. (D) Lat : 16º 18′25′′ N; Long : 81º 57 ′30′′ E. Port Conservancy powers are vested with The Port Officer, Kakinada Port. Vedanta Ltd (Cairn Oil & Gas) is responsible for safe operation of SByM at Ravva Port and handling Crude Oil transportation to HPCL's Oil Refinery at Visakhapatnam and Haldia under private sector. The above facility is used for handling Oil transportation and deriving revenue to the Government.	Vedanta Ltd (Cairn Oil & Gas) is to ensure safety of the SPM and also comply with navigation safety requirements of the vessels
14	**Environment, Forests, Science and Technology of Andhra Pradesh**	The Environment, Forests, Science and Technology Department is headed by the Principal Secretary, and is divided into nine sections. The Department primarily deals with: ▪ Proposals relating to forest lands, mining leases, encroachments on forest lands, forest Conservation Act 1980, use of forest land for non-forest purposes, soil conservation ▪ Issues relating to Podu cultivation, forest settlement, forest survey and mapping ▪ Protection of forests and related notifications ▪ Issues relating to destruction of forests ▪ Budget planning and Non-Plan schemes ▪ Research and development/monitoring and evaluation ▪ Social forestry programmes ▪ Development of waste land, and so on The Department also has set up Environment Protection Training and Research Institute (EPTRI) an autonomous institution registered as a society to provide training, consultancy, applied research services and advocacy in the area of environment protection to industry, regulatory bodies, Government, NGOs etc. The Forest Department implements three major acts - Andhra Pradesh Forest Act, 1967, the Indian Wildlife (Protection) Act 1972 and the Forest (Conservation) Act 1980. The Principal Chief Conservator of Forests (PCCFs), CCFs and CFs are in the administrative charge of forest circles or special circles and are responsible within their respective areas for the general direction and supervision of all forest works, control of establishment, expenditure, sales and supplies and general management of forests. The PCCF (Wildlife) and Chief Wildlife Warden is responsible for implementing the program of wildlife conservation sponsored by the State or Central government and deals with the national parks, wildlife sanctuaries, zoos etc. The Divisional Forest Officers (DFOs) are responsible for the general management and protection of forests situated in their division.	Vedanta Ltd (Cairn Oil & Gas) is to ensure that the protected areas are duly protected from any potential oil spill.

SN	Institution	Functions & Responsibilities	Applicability for Cairn
15	Central Ground Water Authority (CGWA) and Central Ground Water Board (CGWB)	Central Ground Water Authority (CGWA), constituted under the Environmental (Protection) Act, 1986 is responsible for activities related to regulation and control of ground water development and management in the country. The Authority is entrusted with powers of i) To resort to penal provisions contained in sections 15 to 21 of the said Act. ii) To regulate and control, management and development of ground water in the country and to issue necessary regulatory directions for the purpose. iii) Exercise of powers under section 4 of the Environment (Protection) Act, 1986 for the appointment officers CGWA is regulating withdrawal of ground water by industries/ projects. Construction of new ground water structures is prohibited in the notified areas. Permission of drilling tube wells is being granted only to the Govt. agencies responsible for drinking water supply. CGWA has notified following areas in Andhra Pradesh as the notified areas within which withdrawal of groundwater is prohibited. The notified areas include Tirupathi (Rural) in Chittor District; Vempalli in Cuddapah District; Midjil in Mahabubnagar District; Chimathur in Anantpur District; Narpala(NC) in Anantpur District; Vailpoor (NC) in Nizamabad District; Giddaluru in Prakasam District. CGWA has published guidelines /criteria for evaluating proposals/requests for groundwater abstraction (with effect from 15/11/ 2012). As per the guidelines, for non-notified areas, NOC for Ground Water withdrawal will be considered for Industries/Infrastructure projects which are either NEW or under EXPANSION as per select criteria given in the notification. For the proposed Project falling in safe category NOC is required for groundwater withdrawal if quantity of groundwater abstraction exceeds 100m^3/day. **Central Ground Water Board (CGWB)** established in 1970, is the National Apex Agency entrusted with the responsibilities of providing scientific inputs for management, exploration, monitoring, assessment, augmentation and regulation of ground water resources of the country. Andhra Pradesh Water, Land and Trees Authority is created for regulation of ground water resource.	Ravva Field is located in non-prohibited East Godavari District. Vedanta Ltd (Cairn Oil & Gas) is withdrawing groundwater of 9,570 m^3/day through six nos. of old deep wells reportedly drilled prior to 1998 as per approval dated 3 Jan 2018 from APWALTA for withdrawal of 10,413 m^3/day valid for two years. For additional water withdrawal, Vedanta Ltd (Cairn Oil & Gas) will obtain prior approval (NOC) for the same.
16	**National Green Tribunal (NGT)**	The National Green Tribunal (NGT) established under the National Green Tribunal Act, 2010 has mandate to decide cases related to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto. The NGT is guided by principles of natural justice. New Delhi is the principal place of sitting of the NGT while Bhopal, Pune, Kolkata and Chennai are other four places of sitting of the NGT.	NGT may be involved for any case pertaining to the environment as and when arises.

SN	Institution	Functions & Responsibilities	Applicability for Cairn
17	**Atomic Energy Regulatory Board, India**	The Atomic Energy Regulatory Board (AERB) was constituted in 1983 as per powers of the Atomic Energy Act to carry out certain regulatory and safety functions under the Act. The regulatory authority of AERB is derived from rules and notifications promulgated under the Atomic Energy Act and the Environment (Protection) Act, 1986. AERB grants the regulatory consent in accordance with the provisions of Sections 16 & 17 of the Atomic Energy Act, 1962 and the Rule: 3 of the Atomic Energy (Radiation Protection) Rules, 2004 for handling radiation sources. Consent is granted in the form of a licence, an authorisation, a registration, an approval and a type approval depending upon the hazard potential associated with the different radiation sources. A licence is applicable to the high hazard radiation sources and registration to low hazard sources, while the practices and devices having very small quantities of radioactive materials are exempted from Regulatory Consent for example of consumer products. Well logging activity will require radioactive materials, the handling, storage and use shall be as per the Atomic Energy (Radiation Protection) Rules 2004.	Vedanta Ltd (Cairn Oil & Gas) is to ensure that prior licence is obtained by the concerned contractor engaged for well logging activity using radioactive source.
18	**Directorate General of Civil Aviation (DGCA)**	DGCA is a directorate under the Ministry of Civil Aviation. DGCA is the regulatory body in the field of Civil Aviation primarily dealing with safety issues. It is responsible for regulation of air transport services to/from/within India and for enforcement of civil air regulations, air safety and airworthiness standards. It also co-ordinates all regulatory functions with International Civil Aviation Organization. Its headquarters are located in New Delhi with regional offices in the various parts of India. It has 14 regional airworthiness offices located at Delhi, Mumbai, Chennai, Kolkata, Bangalore, Hyderabad, Trivandrum, Bhopal, Lucknow, Patna, Bhubaneshwar, Kanpur, Guwahati and Patiala. It also has 5 regional air safety offices located in Delhi, Mumbai, Chennai, Kolkata and Hyderabad. It's Regional Research and Development Office is located in Bangalore and the Gliding Centre in Pune. India is participated in ICAO by the Representative of India. Prior approvals are required for flights and operation of helipads. Air emissions through elevated chimneys of higher than 30 m also require prior approval from DGCA.	Helipad facilities have been provided on unmanned RA to RH offshore platforms and at the Living Quarters All on-going manpower transportation through helicopters from Helipad at Ravva Living Quarters and unmanned platforms within Ravva Field are subject to prior approval of DGCA. Vedanta Ltd (Cairn Oil & Gas) has reportedly obtained Civil Aviation Clearance and Defence Clearance for aviation related facilities

1.2.3 Applicable Pieces of Environment & Safety Legislation

A list of issues and applicable pieces of environment and safety legislation are described in ***Table 1.2.***

Table 1.2 Applicable Legislations

Issues	Applicable Legislation	Approval/Standards Requirement	Enforcement Agency
Oil and Gas Exploration & Exploitation	Constitution of India ▪ Fundamental Rights ▪ Fundamental Duties ▪ Refer to Section 3.3.1	Through various regulatory provisions	Government of India and State Governments

Issues	Applicable Legislation	Approval/Standards Requirement	Enforcement Agency
	▪ The Petroleum and Natural Gas Rules 1989 - regulate the grant of the exploration licenses and its conservation and development; recommend efforts to be taken to prevent any escape of petroleum. ▪ Protection of Environment under Article 14 of PSC	Prior approval on requirements of the PSC	MoPNG – DGH
EIA, Public Consultation and Environmental and CRZ Clearance	The Environment Protection Act, 1986, Rules and Notifications including Environmental Impact Assessment (EIA) Notification [S.O. 1533 (14/1/2006)] and CRZ Notification, 2011	1) The Project falls under the Category 'A' in the Schedule to the EIA Notification and requires prior Environmental Clearance for proposed oil and gas development in Ravva Field. 2) Public Consultation	Ministry of Environment Forest and Climate Change (MoEFCC) APPCB
	Coastal Regulation Zone Notification 2011 (promulgated under the Environment (Protection) Act, 1986). It regulates activities in the coastal areas within 500 m from high tide line (HTL) on the landward side and up to low tide line (LTL) on seaward side. Four types of Costal Regulation Zones have been identified in the Notification. The proposed oil and gas developmental Project will be completed in the offshore region beyond 4 km from shoreline. No developmental activities proposed in the coastal/onshore region. The Project falls within CRZ IV i.e. within 12 NM from shoreline as per classification of CRZ Notification, 2011. Also refer to *Section 3.2.5*	3) The Project falls within CRZ area. within 12 NM from shoreline and proposes activities within CRZ, therefore requires CRZ Clearance under the CRZ Notification, 2011.	MoEFCC & AP CZMA
Forest and Wildlife	The Forest (Conservation) Act, 1980	4) As no diversion of forestland for non-forest purposes is expected and no wildlife protected area is located within 10km from the block. No Forest Clearance would be required.	Department of Forests through Principal Chief Conservator of Forests & MoEFCC
	The Wildlife (Protection) Act (WPA) 1972, 2002 and Rules 2003 and amendments	5) No wildlife sanctuary or national park is located within 10 km radius from the Ravva Field. The nearest Coringa Wildlife Sanctuary is located at around 18 km from the PKGM-1 Block. No prior approval is required. 6) Compliance of provisions of the WPA. Vedanta Ltd (Cairn Oil & Gas) is to ensure compliance of the provisions of the WPA for any scheduled fauna observed within and surrounding the Ravva Field.	Chief Wildlife Warden and Department of Forests

Issues	Applicable Legislation	Approval/Standards Requirement	Enforcement Agency
Safety Management System for offshore drilling activities	Petroleum and Natural Gas (Safety in Offshore Operations) Rules, 2008 [PNGSOO Rules], developed under the Oilfields (Regulation and Development) Act, 1948 (53 of 1948), are to comply with safety and risk reduction for offshore oil and gas operations in offshore waters of India. As per the requirement of Schedule IV of the Petroleum and Natural Gas (Safety in Offshore Operations) Rules, 2008, Vedanta Ltd (Cairn Oil & Gas) is required to submit an application for Consent for Mobile Offshore Installation prior to drilling of wells. One of the requirements under the application is to develop Safety Management System	7) Consent for Mobile Offshore Installation as per Schedule IV of the PNGSOO Rules for the proposed offshore drilling in Ravva Field	OISD
Drilling related – Movement of Jack up Rig and support vessels to the Drilling location	▪ Maritime Zones Act 1976: Describes various zones such as territorial waters, EEZ, continental shelf etc. ▪ The Merchant Shipping (Amendment) Act 1987: Control of pollution from ships and off-shore platforms.	8) Approval from DGH under Article 14 of the PSC 9) Authority letter from Central Government prior to commencement of drilling activities for defence clearance. 10) All the regulations are applicable for the Exploration in offshore area.	Department of Port of Andhra Pradesh
Drilling of wells – Movement of Jack up Rig and support vessels to the Drilling location	Fishing and Fish Conservation ▪ Indian Fisheries Act, 1897 ▪ Marine Fishing Regulation Act, 1978	11) Offers protection to fisheries. 12) A model act, which provides guidelines to the maritime states to enact laws for protection to marine fisheries by regulating fishing in the territorial waters. The measures include: regulation of mesh size and gear, reservation of zones for various fishing sectors and also declaration of closed seasons. Laws framed and amended from time to time by different maritime states. Coastal states ban fishing during closed season. Different closure period for different states.	MoEFCC, DoE, Department of Fisheries
Air Emissions and Ambient Air	The Air (Prevention and Control of Pollution) Act, 1981, amended in 1987	13) Consent to Establish or NOC 14) Consent to Operate	APPCB (Any discharge within 4.8 km from shore line will require prior approval from APPCB)
Water and Wastewater	The Water (Prevention and Control of Pollution) Act, 1974, amended in 1988	15) Consent to Establish or NOC 16) Consent to Operate	APPCB

Issues	Applicable Legislation	Approval/Standards Requirement	Enforcement Agency
Groundwater usage	The Central Guidelines/ Criteria for evaluation of proposal/ request for groundwater abstraction (with effect from 15/11/ 2012). Projects located in non-notified areas require NOC for Ground Water withdrawal for industrial projects which are either NEW or under EXPANSION as per the criteria given for safe category of NOC is permitted with mandatory recycling reuse of water for groundwater withdrawal if quantity of groundwater abstraction exceeds 100 m^3/day. The proposed Project has reportedly groundwater abstraction through bore wells installed prior to 1998. There are four categories of groundwater usage status, namely – 'Safe', 'Semi-critical', 'Critical' and 'Overexploited' areas. The proposed Project in East Godavari District falls in Safe Category in non- notified area, hence the proposed expansion i.e. additional oil and gas development will require NOC from CGWA.	17) No Objection Certificate (NOC).	CGWA
	Andhra Pradesh Water, Land and Trees Act, 2002 ▪ An Act to Promote Water Conservation, and Tree Cover and Regulate the Exploitation and Use of Ground and Surface Water for Protection and Conservation of Water Sources, Land and Environment and Matters, Connected Therewith or Incidental Thereto	18) No Objection Certificate (NOC)	Andhra Pradesh Water, Land and Trees Act Authority
Sewage discharge	▪ Merchant Shipping Act, 1958, Merchant Shipping (Amendment) Act 2003 ▪ MARPOL Convention	19) Movement of ships and boats; 20) Control of pollution from ships and off-shore platforms. 21) Discharge of sewage will be as per the requirement of MARPOL.	Department of Ports APPCB (within territorial water of 4.8 km)
Environment Protection	The Environment (Protection) Second Amendment Rules, 2002 – Emission/Discharge Standards	22) Project to comply with these standards. 23) Filing of annual Environmental Statement under prescribed format of Rule 14 of EPA Rules 24) For the proposed oil and gas development in existing Ravva Field – Vedanta Ltd (Cairn Oil & Gas) is required to obtain certificate of compliance of conditions of Environmental Clearance	APPCB Regional Office of MoEFCC

Issues	Applicable Legislation	Approval/Standards Requirement	Enforcement Agency
Impact on Wildlife	Wildlife Protection Act, 1972 ▪ The Act offers protection to marine biota. Creates conditions favourable for in situ conservation of fauna and flora. Covers several species of fish, corals, sea cucumbers and sea shells, olive Ridley turtles in Schedule I and III.	25) Requires protection of marine scheduled fauna	MoEFCC, DoE
Hazardous Substances & Wastes	The Environment (Protection) Act, 1986, and Rules framed there under a) Hazardous and Other Wastes (Management, Handling and Trans boundary Movement) Rules, 2016;	26) Authorisation for collection, reception, storage, transportation and disposal of hazardous wastes 27) Filing of annual return under Form 4 to the rules 28) Other compliance under the rules 29) Labelling of vehicles carrying hazardous substances (Transport Emergency - TREM card). 30) Liability of the occupier, transporter and operator of a facility: 31) The occupier, transporter and operator of a facility shall be liable for damages caused to the environment resulting due to improper handling and disposal of hazardous waste listed in its schedules; 32) The occupier and operator of a facility shall also be liable to reinstate or restore damaged or destroyed elements of the environment; 33) The occupier and operator of a facility shall be liable to pay a fine as levied by the State Pollution Control Board with the approval of the Central Pollution Control Board for any violation of the provisions under these rules.	APPCB CPCB DGMS MoEFCC and other agencies
	Drilling Wastes b) The Environment Protection Act, 1986 - Standards for liquid discharge by Oil Drilling and Gas Extraction industry as notified under Environment (Protection) Rules, 1986.	34) Project to comply with these standards.	APPCB

Issues	Applicable Legislation	Approval/Standards Requirement	Enforcement Agency
	Hazardous Substances c) Manufacture Storage and Import of Hazardous Chemicals 1989 and amendment Rules 2000	35) Identification of Major Accident Hazard under Rule 4 36) All hazardous chemicals would be properly classified and properly label 37) Preparation of Onsite and Offsite Emergency Control Plan under Rules 13 & 14 38) Collection, Development and Dissemination of information including Do's and Don'ts and labelling for hazardous substances handled onsite under Rule 17 39) Notification of accident to authorities under Schedule 5 and Rules 2b and 3 40) Site Notification and Safety Reporting.	APPCB CPCB MoEFCC District Collector, PESO - Chief Controller of Explosives. DGMS
	Medical & infected waste d) The Bio-Medical Waste Management Rules 2016;	41) All biomedical wastes are required to be properly labelled, handled and disposed off. Compliance including reporting, labelling etc. as applicable under the BMWM Rules, 2016. 42) Every occupier handling bio-medical waste, irrespective of the quantity shall make an application the prescribed authority i.e. concerned SPCB and seek authorisation under BMWM Rules, 2016	APPCB
Vehicular Movement	Motor Vehicles Act, 1988 and Rules, 1989	43) Project to follow up CMV rules for transportation of diesel, or any other hazardous substance.	Local Transportation Authority
Petroleum Handling	The Petroleum Act, 1934	44) Approval / licence required for storing Class A, B, C petroleum above the thresholds.	Petroleum and Explosives Safety Organisation, Hyderabad
Noise	The Environment (Protection) Second Amendment Rules, 2002 (Noise Limits for New Generator Sets)	45) Project to comply with the prescribed standards.	APPCB
	The Noise (Regulation & Control) Rules, 2000	46) Project to comply with the prescribed standards.	APPCB
Use of well logging tool containing sealed radioactive material	The Atomic Energy Act, 1962 The Atomic Energy (Radiation Protection) Rules, 2004	47) Project to ensure that the contractor engaged for well logging has prior approval from Atomic Energy Regulatory Board, India for use and handling of radioactive material for well logging tool.	Atomic Energy Regulatory Board, India
Safety and Protection against Pollution of Environment	Oil Mines Regulations, 1984	48) Various provisions of the OMR including measures specified for safety, health and protection against pollution of environment would be followed.	DGMS

Issues	Applicable Legislation	Approval/Standards Requirement	Enforcement Agency
Safe management of Lead acid batteries	The Batteries (Management and Handling) Rules 2001, as amended in May 2010;	49) Filing of Half Yearly return by bulk consumers and auctioneers of batteries to State Pollution Control Board as per Form 8 and 9 under Rules10 (2) (ii) and 11 (ii) respectively	APPCB and Ministry of Environment and Forests
Safety and Other related regulations	The Gas Cylinders Rules 2004	50) Licence for possession of gas cylinders containing 100 kg of more of pressurised gas; 51) Safe storage and Labelling of Gas cylinders 52) Filing of annual returns 53) Compliance under the rules	PESO - Chief Controller of Explosives
Storage of Petroleum products	The Petroleum Act 1934, as amended in August 197 The Petroleum Rules 1976, as amended in March 2002.	54) Licence for possession of petroleum products (for Class A with flash point less than 23 ^{o}C above 30 litres; Class B with flash point from 23 to 65^{o}C above 2500 litres; and Class C with flash point from 65 to 93^{o}C above 45000 litres) 55) Provision of enclosure and safety measures for safe storage 56) Labelling of vessels containing petroleum products; 57) Compliance under the rules and as stipulated in the licence	PESO - Chief Controller of Explosives
Power Generation	Electricity Act 2003, as amended in May 2007 and Electricity Rules 2005	58) A prior certificate of power generation (through Diesel generators) is required.	AP State Electricity Department
Helicopter movement	The Aircraft Act, 1934 and Rules, 1937	59) DGCA Approval for Helicopter movement from Ravva Terminal to offshore platforms.	DGCA

A brief summary of the legislations and their specific application (*provided in italics*) for the proposed oil and gas development in Ravva Field is given in the following subsections.

1.2.4 The EIA Notification, 2006 promulgated under the Environment (Protection) Act, 1986

1) Project categorization

As per the EIA Notification SO no. 1533 dated 14 September 2006 issued by Ministry of Environment and Forests, any project or activity including ***Offshore and Onshore Oil and Gas Exploration, Development and Production**** (which falls under projects or activities listed under category A in the Schedule), requires prior Environmental Clearance from Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India.

The proposed oil and gas development Project in already operating Ravva Field falls under Category A and requires prior Environmental Clearance from MoEFCC.

2) Scoping

The proposed Project (of Category A under EIA Notification) requires appraisal of EIA study prepared based on Terms of Reference (TOR) as approved by Expert Appraisal Committee (EAC) of MoEFCC.

This EIA report has been prepared as per the approved terms of reference forms the basis for appraisal of the Project for prior Environmental Clearance under the EIA Notification 2006.

3) Public Consultation

All projects or activities under Category A (and B1) of EIA Notification, 2006 requires Public Consultations except for exemptions made for certain kind of projects. Public Consultations normally covers two components i.e. a) public hearing at the district level, conducted by the State Pollution Control Board; and b) SPCB receiving responses in writing from concerned persons with stakes in the project.

As per the terms of reference for EIA study as approved by MoEFCC, Public Hearing under 7 (ii) of EIA Notification, 2006 is required. Based on EIA study and Cairn's responses to the oral and written representations received during the Public Consultation process, the EAC of MoEFCC would appraise the Project for prior Environmental Clearance.

4) Appraisal

EAC at MoEFCC will undertake appraisal of the Project based on

- Application for Environmental Clearance;
- Final EIA report; and
- Outcome of public consultations.

The appraisal is generally completed within 60 days of the receipt of the application and final EIA report.

1.2.5 The Coastal Regulation Zone Notification, 2011

The CRZ, Notification, 2011 classifies coastal regulation zone in four type i.e. CRZ-I (ecological sensitive), CRZ-II (built-up area), CRZ-III (Rural area) and CRZ-IV (water area). First three types are similar to those given under CRZ Notification, 1991, the fourth class i.e. CRZ-IV includes the water areas up to the territorial waters and the tidal influenced water bodies. List of areas included in CRZ-I include:

i) Ecologically sensitive areas and the geomorphological features that play a primary role in maintaining the integrity of the coast.
   - Mangroves, in case mangrove area is more than 1000 sq. m, a buffer area of 50 m shall be provided;
   - Corals and coral reefs and associated biodiversity;
   - Sand Dunes;
   - Mudflats which are biologically active;

- National parks, marine parks, sanctuaries, reserve forests, wildlife habitats; and other protected areas under the provisions of Wild Life (Protection) Act, 1972 (53 of 1972), the Forest (Conservation) Act, 1980 (69 of 1980) or Environment (Protection) Act, 1986 (29 of 1986); including Biosphere Reserves encompassing;
  - ~ Salt Marshes;
  - ~ Turtle nesting grounds;
  - ~ Horse shoe crabs habitats;
  - ~ Sea grass beds;
  - ~ Nesting grounds of birds;
- ~ Areas or structures of archaeological importance & heritage sites;

ii) The area between Low Tide Line and High Tide Line.

The proposed project for expansion of oil & gas exploration, development & production in existing Ravva field will involve activities in the CRZ hence CRZ Clearance is required under the CRZ Notification, 2011.

Presently a draft CRZ Notification 2018 has also been issued by MoEFCC on 18th April, 2018. The aforesaid draft notification is available in the public domain in the Ministry's website for seeking feedback and comments from all concerned. It is understood that based of feedback from concerned stakeholder the Notification is expected to be possibly finalised and issued toward the latter half of 2018.

1.2.6 OM from MoEFCC on Corporate Environment Responsibility

Office Memorandum (OM) from MoEFCC on Corporate Environmental Responsibility (CER) dated 1st May, 2018. In order to have transparency and uniformity while recommending CER by Expert Appraisal Committee (EAC) / State level Expert Appraisal Committee (SEAC) / District level Expert Appraisal Committee (DEAC), the following guidelines are issued:

I. The cost of CER is to be in addition to the cost envisaged for the implementation of the EIA/EMP which includes the measures for the pollution control, environmental protection and conservation, R&R, wildlife and forest conservation/protection measures including the NPV and Compensatory Aforestation, required, if any, and any other activities, to be derived as part of the EIA process.

II. The fund allocation for the CER shall be deliberated in the EAC or SEAC or DEAC, as the case may be, with a due diligence subject to maximum percentage as prescribed in the OM. ***For brownfield projects, CER has been capped at 0.25% of additional capital investment for any additional capital investment between 1000 to 10,000 crores (in the present case cost of the project is estimated to be ~ INR 7,924 Crores)***

III. The activities proposed under CER shall be worked out based on the issues raised during the public hearing, social need assessment, R&R plan, EMP, etc.

IV. The proposed activities shall be restricted to the affected area around the project.

V. Some of the activities which can be carried out in CER, are infrastructure creation for drinking water supply, sanitation, health, education, skill development, roads, cross drains, electrification including solar power, solid waste management facilities, scientific support and awareness to local farmers to increase yield of crop and fodder, rain water harvesting, soil moisture conservation works, avenue plantation, plantation in community areas, etc.

VI. The entire activities proposed under the CER shall be treated as project and shall be monitored. The monitoring report shall be submitted to the regional office as a part of half-yearly compliance report, and to the District Collector. It should be posted on the website of the project proponent.

VII. The District Collector may add or delete the activities as per the requirement of the District.

VIII. The EAC can vary the above percentage of CER subject to proper diligence, quantification and justification. The EAC based on appraisal, should clearly suggest the activities to be carried out under CER.

IX. This CER is not applicable in name change, transfer and amendment involving no additional project investment. In case of amendment in EC involving additional expenditure, CER will be applicable only on the additional expenditure as specified in the OM.

1.2.7 The Wild Life (Protection) Act, 1972 as amended in 2002 and 2006

Endangered marine animals have been accorded special protection under the Wild Life (Protection) Act, 1972 as amended to date [WPA] wherever they occur in Indian territories. These include all species of Cetaceans such as whales and 11 dolphins, dolphins, dugongs, reptiles such as Salt water or Estuarine crocodile and sea turtles such as Green Sea, Hawksbill, Leatherback, Olive Ridley turtles, hard corals, some fishes specially shark species, sea cucumbers, certain molluscs etc. Other marine animals get full protection within the Protected Areas (PAs), such as National Parks and Sanctuaries, which are constituted under the WPA.

At present in Andhra Pradesh there is no National Parks but has 16 wild life sanctuaries. The coastal areas of Andhra Pradesh are joined by that of Orissa to NE and by Tamil Nadu to SE. The protected areas located along East Coast of India in the states of Andhra Pradesh, Orissa and Tamil Nadu is as described in ***Table 1.3.***

Table 1.3 Protected Areas along East Coast of India within Andhra Pradesh, Orissa and Tamil Nadu States

S.N.	Protected Area	Approx. Distance & Bearing from PKGM-1 Block
A	**Andhra Pradesh**	
1	Coringa Wildlife Sanctuary in AP	18 km to NE from Apex Point D of PKGM-1 Block
2	Kolleru Wildlife Sanctuary in AP	~ 80 km to WNW
3	Pulicate Lake Wildlife Sanctuary in AP	~ 360 km to SW
B	**Orissa**	

S.N.	Protected Area	Approx. Distance & Bearing from PKGM-1 Block
4	Balukhand Wildlife Sanctuary near Chilika Lake in Orissa	~ 520 km to NE
5	Bittarkanika Wildlife Sanctuary in the estuary of Brahmani River in Orissa	~ 425 km to NE
6	Chandaka Wildlife Sanctuary in Eastern Ghats, Puri District in Orissa	~ 555 km to NE
7	Lakhari Valley Wildlife Sanctuary in Eastern Ghats in Orissa	~ 425 km to NE
C	**Tamil Nadu**	
8	Gulf of Mannar Biosphere Reserve in southern Tamil Nadu	~ 845 km to SSW
9	Point Calimere Wildlife Sanctuary in Tamil Nadu	~ 710 km to SSW

All the protected areas are to be protected and conserved of their natural heritage. These areas are primarily no commercial extractive use zones and are to be avoided for locating any drilling vessel or setting up of any logistics base. However, navigational pathway for a Rig and supply vessels is not restricted in marine national parks, sanctuaries declared under WPA, 1972.

Within the PKGM-1 Block, no notified protected area exists to date. However, any endangered marine species as listed in Schedule to the WPA, 1972 are required to be protected if seen within the Block, by either relocating drilling site or specific mitigation measures are adopted to avoid any adverse impact on such species during drilling activities.

1.2.8 The Forest (Conservation) Act, 1980

The Forest (Conservation) Act (FCA), 1980 as amended in 1988 and revised Rules made there under in 2003 (in suppression of FC Rules of 1981) provide for prevention of diversion of any forestland for non-forest purposes. In all such cases, prior Forest Clearance is required from Central and State Government depending upon type and extent of forestland required for non-forest purposes. Under the Act, an Advisory Committee advises GoI for grant of approval and other matters connected with the conservation of forests.

The proposed oil and gas development does not require any forestland for non-forest purposes under this legislation.

1.2.9 The Air (Prevention and Control of Pollution) Act, 1981 Including Rules 1982, 1983 and 1987 (the Air Act)

For setting up a new project or for expansion in production capacity or for a new activity, prior Consent to Establish (CTE) or No Objection Certificate (NOC) is required under the Air Act as per the prescribed format for the application and applicable fees. Before operational phase of a project, there is requirement of Consent to Operate (CTO).

For the proposed oil and gas development in Ravva Field, prior CTE/NOC and CTO under the Air Act is required from APPCB.

1.2.10 *The Water (Prevention and Control of Pollution), Act, 1974 including Rules, 1975 (as amended up to 1988)*

This Act provides for the prevention and control of water pollution and maintaining or restoring good water quality for any establishment. For setting up a new project or expansion of existing production capacity, or new activity, prior Consent to Establish (CTE) or No Objection Certificate (NOC) is required under Water Act as per the prescribed format for the application and applicable fees. Before operational phase of a project, there is requirement of Consent to Operate (CTO).

For the proposed oil and gas development Project, prior CTE/NOC and CTO under the Water Act would be required from APPCB.

1.2.11 *Manufacture Storage & Import of Hazardous Chemicals (MSIHC) Rules 1989 and amendment 2000*

These rules apply to the activities, which involve handling, storage and import of hazardous chemicals as specified in Part 2 of Schedule 1 of the Rules. The indicative criteria are specified in the Part 1 of the same schedule. The rule also applies to the industrial activity involving isolated storage in the quantities mentioned in Schedule 2. The information on various requirements and clearances under the MSIHC Rules will have to be furnished to the SPCB office.

The MSIHC Rules also require provision for the proper storage and handling of chemicals. Definition and classification of the chemicals as dangerous/hazardous is specified under the MSIHC Rules and listed in Schedules 1, 2 & 3.

For the oil development within Ravva Field in PKGM-1 Block, the handling of hazardous chemicals including drilling chemicals, crude oil, other flammable liquid and natural gases which are covered under these rules will be properly classified, labelled, handled and stored. For classification the indicative criteria refers to the acute toxicity, flammable or explosive characteristics of the chemical. Under the Rules, Vedanta Ltd (Cairn Oil & Gas) is responsible to classify and properly label all the hazardous substances being handled at its existing (RA to RH). The classification codes used for labelling purpose should include corrosive, explosive, reactive, flammable or toxic. Necessary approvals have also been reportedly obtained from Petroleum Explosives Safety Organization (PESO) (erstwhile Chief Controller of Explosives) for storages of hazardous chemicals/petroleum upstream & downstream hydrocarbons. Onsite and offsite Emergency Response Plans are to be available with necessary notifications to various agencies under the Rules.

1.2.12 *The Hazardous and Other Wastes (Management and Trans boundary Movement Rules), 2016*

The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 were promulgated under Environment (Protection) Act 1986 and in supersession of the earlier Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008.

The rules define hazardous wastes to be any waste which by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances, and will include any of hazardous processes generating wastes (as listed in Schedule I) or concentration of hazardous contents in such wastes (as listed in Schedule II) or import or export of hazardous wastes (as listed in Schedule III). Import and export norms for the hazardous wastes have been provided in conformance with the Basel Convention, to which India is a signatory.

The rules define responsibility of hazardous wastes generators, defines procedures for management of hazardous and other wastes, require safe handling practices and also maintenance of manifest system during transport of hazardous waste. The rules cover liabilities of occupier, transporter and operator of a facility for any damages caused due to improper handling and disposal of hazardous wastes by reinstating or restoring environmental damages caused.

The drilling mud and other drilling wastes are considered as hazardous. However, based on sampling and analysis carried out through a recognized laboratory, if it is proved that the drilling mud and other drilling wastes do not contain any of the constituents mentioned in Schedule II to the extent of concentration limits specified therein, the wastes may not be treated as hazardous, will be disposed offshore as per MoEFCC criteria.

*For the proposed oil and gas development Project, prior authorisation has been obtained from APPCB for collection, storage and disposal of hazardous wastes as covered under the HW Rules. Vedanta Ltd (*Cairn *Oil & Gas) has also obtained membership of CHWTSDF for disposal of hazardous chemicals in secured landfills.*

1.2.13 The Central Motor Vehicles Act, 1988 and Rules, 1989

For transportation of dangerous substances (including flammables) the Central Motor Vehicle (CMV) Rules 1988 specifies proper labelling system. There are specific signs and symbols for identifying hazardous chemicals and their manner of display is also mentioned in these Rules.

Vedanta Ltd (Cairn Oil & Gas) is reportedly following up CMV rules for transportation of diesel or any other hazardous substance at Ravva Terminal as per the requirement of CMV Rules.

1.2.14 The Petroleum Act, 1934 and the Petroleum Rules, 1976

This Act and Rules provide procedures and safety measures to be taken up for handling, storage and transportation of petroleum products. The Rules define the quantity and class of petroleum for which prior permission from the

concerned authorities are required. The storage requiring prior licence is as following:

- Petroleum class A (having flash point less than 23°C) not intended for sale of the total quantity in possession does not exceed 30 litres. Petroleum Act, 1934, Section 8);
- Petroleum class B (having flash point from 23 to 65°C) if the total quantity in possession at any one place does not exceed 2,500 litres and none of it is contained in a receptacle exceeding 1,000 litres; (Petroleum Act, 1934, Section 7);
- Petroleum class C (having flash point above 65 to 93°C) if the total quantity in possession at any one place does not exceed 45,000 litres (Petroleum Act, 1934, Section 7).

Vedanta Ltd (Cairn Oil & Gas) is procuring High Speed Diesel (Class B petroleum) to run emergency power diesel generator. The company has reportedly obtained approval from Petroleum and Explosives Safety Organisation, Nagpur and is following up of safety measures for the storage of diesel (petroleum products) and crude oil under the Rules.

1.2.15 The Oilfields (Regulation and Development) Act, 1948 (ORDA), Petroleum and Natural Gas Rules, 1959 (PNGR)

The provisions of above legislations require regulation of petroleum operations and grant of Licenses and Leases for exploration, development and production of Petroleum in India. The provisions of the Production Sharing Contract signed between Government of India and Ravva JV have to be complied with the requirements of the ORDA and PNGR through Vedanta Ltd (Cairn Oil & Gas) being operator of the Block for Ravva JV.

Under the Article 14 of the Production Sharing Contract, Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) reports are required to be submitted by Vedanta Ltd (Cairn Oil & Gas) to Directorate General of Hydrocarbons (DGH) of Ministry of Petroleum and Natural Gas (MoPNG).

1.2.16 The Petroleum and Natural Gas (Safety in Offshore Operations) Rules, 2008 (PNGSOOR)

As per the requirement of PNGSOO Rules, Vedanta Ltd (Cairn Oil & Gas) will require prior Consent from OISD by furnishing application in duly prescribed Format as required under Schedule IV to the Rules. The application for the Consent requires following key information:

- *Safety Management Systems of the Company (Cairn) and Contractor (rig engaged);*
- *Detail description of emergency response plans (covering all identified major hazards), pursuant to the rules under Chapter X on emergency response system; and*
- *Particulars of any combined operations which may involve the installation, including summary of the arrangements in place for coordinating the safety management systems (SMS) and joint review of the safety aspects by the operator and other participants, involved in combined operations.*

The rules also prescribe guidance Safety of the Facilities covering the following requirements:

1) Risk & Emergency

Under the PNGSOO Rules, the operator of an offshore facility shall select technical, operational, human resources and organizational solutions in a manner that will reduce the risk to humans, assets and the environment involved in the activities and in the probability of failures or situations of hazard and accident through a barrier based system. Barriers shall be established in a way that reduces the probability of accidents and also limit possible damage that may arise as a result. The PNGSOO Rules focuses on the safety aspects of offshore oil and gas operations and lays down requirements for an overall safety management framework in order to ensure safety performance of offshore operations and putting in place an effective emergency management setup.

A systematic risk assessment is required in order to provide the necessary basis for taking decisions to give due consideration to health, safety and the environment. The risk assessment should be undertaken using industry recognized models, methods and techniques as appropriate for the purpose and the best available data shall be used for the purpose. The acceptance criteria for major accident risk and environmental risk shall be specified and OISD may stipulate risk acceptance criteria for the proposed oil and gas development related activities in Ravva Field.

2) Safety Management System

According to the PNGSOO Rules, Vedanta Ltd (Cairn Oil & Gas) should put in place a formal Safety Management System (SMS) which will be applicable for all activities to be undertaken as a part of the drilling program. The SMS should consider the following:

- ensure that the management of health, safety and environment comprises the activities, resources, processes and the organization including trained manpower necessary to ensure safe activities;
- ensure that authorities and responsibilities of personnel at various management levels are clearly defined in the safety management system;
- prepare the necessary steering documents and establish reporting lines;
- establish objectives in relation to health, safety and environment and set internal requirements in concrete terms, which will contribute to achieving these objectives and if the internal requirements are expressed functionally, criteria of fulfillment shall be established;
- ensure that situations of hazard and accident shall be investigated, analyzed and documented by the operator.
- establish monitoring parameters within his areas of activity in order to monitor matters of significance to health, safety and environment, including the degree of achieving objectives.

- The operator shall establish indicators to monitor changes and trends in major accident risk.
- Emergency response plans prepared as per guidelines provided in the PNGSOO Rules

3) Emergency Response Planning

Clause 14.7 under Article 14 of PSC requires Vedanta Ltd (Cairn Oil & Gas) to prepare Contingency Plans and Emergency Operations for dealing with oil spills, fires, accidents and emergencies designed to achieve rapid and effective emergency response. In addition, the PNGSOO Rules specify detailed requirements for setting up an emergency response system based on performance criteria of barriers set in the risk assessment and should include:

- Emergency response organization;
- Emergency preparedness plans;
- Coordination and cooperation for emergency preparedness;
- Emergency communication;
- Means of evacuation and arrangements for rescue and recovery;
- Equipment for rescue, standby vessels, etc.

4) Oil Spill Preparedness & Response

The PSC required Vedanta Ltd (Cairn Oil & Gas) to prepare a contingency plan to deal with oil spills, designed to achieve a rapid and effective emergency response. This plan shall be approved by the government and in the event of an oil spill affecting the environment it should be notified and the relevant contingency plan should be promptly implemented and site restoration as may be necessary be carried out in accordance with modern oilfield and petroleum industry practices.

India is a signatory to the International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 which provides a global framework international cooperation in combating major incidents, threats of marine pollution. A National Oil Spill Disaster Contingency Plan (NOS-DCP) exists for India, which was last updated in March 2006. The Director General Coast Guard is designated as the Central Coordinating Authority (CCA) to implement the Plan, and coordinate response activities in the event of an oil spill at sea. The Ministry of Shipping, the Department of Ocean Development, the Ministry of Petroleum and Natural Gas, Oil companies, Port authorities, and maritime states are the other stakeholders who will act independently or in co-ordination with the Coast Guard in an oil response scenario in the maritime zones of India.

The regional commander of Coast Guard is responsible for combating oil spills in this region and has a regional contingency plan. Cairn's OSCP has to be in tandem with these local contingency plans. The response capabilities are internationally classified based on tiers, depending on the size of spill and response capabilities.

5) Oil Spill Liability

Liability for pollution caused by oil spills is not very strong as per Indian regulatory framework. The Public Liability Insurance Act of 1991 imposes on the owner of industrial activities the liability to provide immediate relief in respect of death or injury to any person or damage to property resulting from an accident while handling a notified hazardous chemical and require the owner to contribute a premium to the Central Government's emergency relief fund. However, the law appears to be relevant only to industries operating with the Indian landmass and there is no previous precedence of its being applied to an oil spill at sea. At international level, the International Convention on Civil Liability for Oil Pollution Damage (CLC), 1992 (1992 Liability Convention) has been adopted to ensure that adequate compensation is available to persons who suffer oil pollution damage resulting from maritime casualties involving oil-carrying ships/vessels. The liability for such damage rests on the owner of the ship from which the polluting oil escaped or was discharged during an accidental event. The Convention applies to all seagoing vessels carrying oil in bulk as cargo with ships/vessels carrying more than 2,000 tonnes of oil requiring a certificate of insurance or other financial security with respect to the 1992 Liability Convention. As the Jack up rig to be engaged will be storing about 600 tonnes of fuel, as per the relevant provisions of the Convention, liability of oil pollution damage arising from any spills occurring from the Rig will be borne by Cairn. In addition, the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1992 involves the establishment of international oil pollution compensation fund to provide compensation for pollution damage to the extent that the protection afforded by the 1992 Liability Convention is inadequate. As per Article 4 of this Convention, any oil pollution damage caused as a result of any maritime casualty with respect to the proposed oil and gas development in the block will be compensated by Fund established under the auspices of the 1992 Fund Convention. Compensation will be granted only when the damage exceeds Cairn's liability under the 1992 Liability Convention.

6) Decommissioning

Pursuant to Clause 14.9 of the PSC, on expiry/or termination of contract or relinquishment of part of the contract area, the contractor (Ravva JV) shall remove all equipment and installations from the relinquished area as per agreed abandonment plan and perform all necessary site restoration activities in accordance with good international petroleum industry practice and take all other action necessary to prevent hazards to human life or to the property of others or the environment.

1.2.17 Merchant Shipping (Amendment) Act 2003 Art 356(A to H)

The Act lays down that no Indian oil tanker or other Indian ship to which Annex IV of the (MARPOL) convention applies shall proceed to sea except with a certificate issued by the Central Government, to be called an International Sewage Pollution Prevention Certificate. The certificate is issued for such duration and subject to such conditions as may be prescribed or a valid International Pollution Prevention Certificate issued in respect of an oil tanker

or a ship, other than an Indian ship, by the Government of the country to which the ship belongs shall, subject to such rules as the Central Government may make in this behalf, have the same effect in India as the corresponding certificate issued in respect of an Indian ship.

The vessels engaged are required an international sewage pollution prevention certificate prior to commencement of any activities in the Indian waters.

Vedanta Ltd (Cairn Oil & Gas) is to ensure sewage pollution prevention certificate from vessels engaged for the oil and gas development activities in Ravva Field.

1.2.18 The Territorial Waters, Continental Shelf, Exclusive Economic Zone and other Maritime Zones Act, 1976

The Territorial Waters, Continental Shelf, Exclusive Economic Zone and other Maritime Zones Act, 1976 recognizes the sovereign rights to conservation and management of living resources and protection of the marine environment in the Indian water.

No person (including a foreign Government) shall, except under, and in accordance with, the terms of any agreement with the Central Government or of a licence or a letter of authority granted by the Central Government, explore or exploit any resources of the exclusive economic zone or carry out any research or excavation or conduct any research within the exclusive economic zone or drill therein or construct, maintain or operate any artificial island, off-shore terminal, installation or other structure or device therein for any purpose whatsoever.

Vedanta Ltd (Cairn Oil & Gas) requires a letter of authority granted by the Central Government prior to commencement of proposed oil and gas development activities in Ravva Field.

1.2.19 The Ancient Monuments and Archaeological Sites and Remains Act, 1958

The Act covers provisions for protection of any underwater cultural heritage sites by Archaeological Survey of India (ASI).

1.3 APPLICABLE ENVIRONMENTAL STANDARDS

MoEFCC has the overall responsibility to set policy and standards for the protection of environment in association with the CPCB. The relevant standards for Oil Drilling and Gas Extraction industry as notified under the Environment (Protection) Rules, 1986 and amendments are divided into three sections:

- Section A: Standards for liquid effluent;
- Section B: Guidelines for discharge of gaseous emissions; and
- Section C: Guidelines for disposal of solid/hazardous waste.

1.3.1 *Standards for Liquid Effluent Discharge for Onshore Facilities (for Marine Disposal)*

Following standards are to be complied with for marine disposal:

Table 1.4 Discharge Standards for Liquid Effluent for Marine Disposal

SN	Parameter	Limits
1	pH	5.5. to 9.0
2	Oil & Grease	10 mg/l
3	Suspended solids	100 mg/l
4	BOD (3 days at 27°C)	30 mg/l

Note: For onshore discharge of effluents, in addition to the standards prescribed above, proper marine outfall has to be provided to achieve the individual pollutants concentration level in sea water below their toxicity limits as given below, within a distance of 50 m from discharge point, in order to protect the marine aquatic life:

Table 1.5 Toxicity Limits prescribed for Discharges through Marine Outfall

S.N	Parameter	Toxicity Limit, mg/l
1	Chromium as Cr	0.1
2	Copper, as Cu	0.05
3	Cyanide, as CN	0.005
4	Fluoride, as F	1.5
5	Lead, as Pb	0.05
6	Mercury, as Hg	0.01
7	Nickel, as Ni	0.1
8	Zinc, as Zn	0.1

For offshore facilities the discharge of effluents, the oil content of treated effluent without dilution shall not exceed 40 mg/litre for 95% of the observation and shall never exceed 100 mg/litre. Three 8 hourly grab samples are required to be collected daily and the average value of oil and grease content of three samples shall comply with these standards.

1.3.2 *Guidelines for Discharge of Gaseous Emissions*

a) Diesel Generators

DG sets at Ravva Terminal and offshore unmanned platforms are required to conform to the norms notified under the Environment (Protection) Act, 1986. Emission limits for diesel generators (up to 800 KW) are presented in ***Table 1.6.***

Table 1.6 Emission Limits for New Generator Sets

Capacity	Emission Limits (g/kw-hr)		
	Hydrocarbons (HC) + Oxides of Nitrogen (NO_x)	Carbon monoxide (CO)	Particulate Matter (PM)
Up to 19 kW	7.5	3.5	0.3
19 kW up to 75 kW	4.7	3.5	0.3
> 75 kW up to 800 kW	4.0	3.5	0.2

Source: Environment (Protection) Second Amendment Rules. The above standards are applicable from 2014.

a3) Emissions from Generators (>800 KW)

Emission limits for diesel engines more than 800 kW) for power plant, diesel generator applications and other requirements are presented in ***Table 1.7.***

Table 1.7 Emission Standard for Diesel Engines (more than 800 KW)

Parameter	Standards
▪ NO_x as NO_2 (for category A) - Engine Rating up to 75 MW	710 ppm at 15% O_2, dry basis
▪ NMHC (as C) (for category A & B)	100 mg/Nm^3 (at 15% O_2)
▪ PM Diesel Fuels - HSD & LDO (for category A & B)	75 mg/Nm^3(at 15% O_2)
▪ PM, Furnace Oils - LSHS & FO (for category A & B)	100 mg/Nm^3(at 15% O_2)
▪ CO (for category A & B)	150 mg/Nm^3(at 15% O_2)
▪ Stack height (for diesel generators commissioned after 1/7/2003)	Maximum Stack height of the following, in meter: i) 14 $Q^{0.3}$, where Q = Total SO_2 emission from the plant in kg/hr ii) Minimum 6 m above the building where generator is installed. iii) 30 m

Source: G.S.R.489 (E), [9/7/2002] - The Environment (Protection) Third Amendment Rules, 2002
Note : Category A: Areas within the municipal limits of towns/cities having population more than 1 million and also up to 5 km beyond the municipal limits of such towns/cities; Category B: Areas not covered by category A.
*Note : * for category Class B Area; and for up to 75 MW Generator set*

At Ravva Terminal, the emissions from a 1000 KVA Diesel Generator are only meant for emergency power supply.

b) Flaring

As per the guidelines cold venting shall never be resorted to and all the gaseous emissions are to be flared. The guidelines on flaring are mainly related to onshore activities.

No cold venting is proposed and flaring will be resorted for the exploratory drilling of wells. For the existing operations of high pressure and low pressure gases are flared through elevated flaring at Ravva Terminal.

1.3.3 Guidelines for Disposal of Solid Waste, Drill Cutting and Drilling Fluids for Offshore and Onshore Drilling Operations

MoEFCC has promulgated guidelines for disposal of solid waste, drill cutting and drilling fluids for offshore and onshore drilling operations under Environment Protection Rules, 1986 through notification GSR 546 (E) dated 30 August 2005. The guidelines for offshore drilling include the following:

i) Disposal of Drill Cutting and Drilling Fluids for Offshore Installations:

a) Use of diesel base mud is prohibited. Only Water based Mud (WBM) is permitted for offshore drilling. If the operator intend to use low toxicity Oil Based Mud (OBM) or Synthetic Base Mud (SBM) to mitigate specific hole problem in the formulation, it should be intimated to MoEFCC/SPCB (APPCB in this case). The low toxicity OBM should have aromatic content of <1%

b) The toxicity of chemical additives used in the drilling fluid (DF) (WBM or OBM or SBM) should be biodegradable (mainly organic constituents) and should have toxicity of 96 hours LC50 value of > 30,000 mg/litre as per mysid toxicity or toxicity test conducted on locally available sensitive sea species;
c) Hexavalent chromium compound should not be used in drilling fluid. Alternative chemical in place of chrome lignosulfonate should be used in drilling fluid. In case, chrome compound is used, the drilling fluid/drill cutting should not be disposed offshore;
d) Bulk discharge of drilling fluid in offshore is prohibited except in emergency situations;
e) WBM/OBM/SBM should be recycled to a maximum extent. Unusable portion of OBM should not be discharged into sea and shall be brought to onshore for treatment and disposal in an impervious waste disposal pit;
f) Thoroughly washed drill cutting separated from WBM/SBM and unusable portion of WBM /SBM having toxicity of 96 hour LC 50 > 30,000 mg/litre shall be discharged offshore into sea intermittently, at an average rate of 50 bbl/hour/well from a platform so as to have proper dilution and dispersion without any adverse impact on marine environment.
g) Drill cutting of any composition should not be discharged in sensitive areas notified by the Ministry of Environment and Forests;
h) In case of specific hole problem, use of OBM will be restricted with zero discharge of drill cutting. Zero discharge would include re-injection of the drill cutting into a suitable formation or to bring to shore for proper disposal. In such a case, use of OBM for re-injection should be recorded and made available to the regulatory agency. Such low toxic OBM having aromatic content <1% should be made available at the installation.
i) In case, drill cutting is associated with high oil content from hydrocarbon bearing formation, then disposal of drill cutting should not have oil content >10 g/kg;
j) The drill cutting wash wastewater should be treated to confirm limits notified under the EPA, before disposal into Sea. The treated effluent should be monitored regularly;
k) Discharge of drill cutting from the installation located within 5 km away from shore should ensure that there is no adverse impact on marine Eco-system and on the shore. If adverse impact is observed, then the industries have to bring the drill cutting onshore for disposal in an impervious waste disposal pit;
l) If any, environmental friendly technology emerges for substitution of drilling fluid and disposal technology, it may be brought to the notice of MoEFCC and regulatory agencies. If the operator desires to adopt such environment friendly technology a prior approval from MoEFCC is required;
m) Barite used in preparation of Drilling Fluid shall not contain Hg> 1 mg/kg & Cd> 3mg/kg;
n) Oil drilling operators are required to record daily discharge of drilling fluid and drill cutting to offshore and also to monitor daily the effluent quality and submit the compliance report once every six monthly to MoEFCC.

1.3.4 Hazardous and Other Wastes (Management and Transboundary Movement), Rules, 2016

As per item nos. 2.1, 2.2 and 2.3 of Schedule 1 to the Rules, following wastes generated from drilling operations will be considered hazardous:

- Drill cuttings excluding those from water based mud
- Sludge containing oil
- Drilling mud containing oil

For any hazardous wastes, Vedanta Ltd (Cairn Oil & Gas) is to arrange disposal onshore CHWTSDF in Andhra Pradesh.

1.3.5 Environmental Standards for Gas based Thermal Power Plants

Vedanta Ltd (Cairn Oil & Gas) is maintaining 10 MW captive power generation through four gas turbines each of 2500 KW capacity. Following standards (***Table 1.8***) have been prescribed under the Environmental (Protection) Rules, 1986.

Table 1.8 Emission Standards for Gas based Thermal Power Plant

S.N.	Description	Emission Limit
1	For the plants burning gas in a conventional boiler	100 ppm

Source: Serial no. 82 of Schedule 1 of Environment (Protection) Rules, 1986

1.3.6 Water Quality Standards for Inland Waterbodies and Estuaries

The CPCB water quality criteria for determining the designated best us of inland surface water bodies are presented in ***Table 1.9***.

Table 1.9 CPCB Water Quality Criteria for Surface Water

Designated Best Use	Class	Criteria
Drinking Water Source without conventional treatment but after disinfection	**A**	▪ Total Coliforms Organism MPN/100ml shall be 50 or less ▪ pH between 6.5 and 8.5 ▪ Dissolved Oxygen 6mg/l or more ▪ Biochemical Oxygen Demand 5 days 20°C 2 mg/l or less
Outdoor bathing (Organised)	**B**	▪ Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more ▪ Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	**C**	▪ Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more ▪ Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	**D**	▪ pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more ▪ Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	**E**	▪ pH between 6.0 to 8.5 ▪ Electrical Conductivity at 25°C micro mhos/cm Max.2250 ▪ Sodium absorption Ratio Max. 26 ▪ Boron Max. 2mg/l

As the Project area lies near the Godavari Estuary, hence *Criteria for Controlling Pollution of Marine Coastal Areas* as specified in IS 7967-1976 (reaffirmed 2009) has been provided below in ***Table 1.10***.

Table 1.10 Water Quality Criteria for Estuary

S.N.	Characteristics	Tolerance limits for Bathing, Recreation, Shell Fish & Commercial Fish Culture, and Salt Manufacture	Tolerance Limit for Harbour Water
1	Colour and odour	No noticeable colour or offensive odour	No noticeable colour or offensive odour
2	Floating material	No visible floating material of sewage or industrial waste origin	No visible floating matter
3	Suspended Solids	No visible suspended solids of sewage or industrial waste origin	-
4	pH	6.5 to 8.5	6.5 to 9.0
5	Free Ammonia (as N), mg/l, *Max*.	1.2	-
6	Phenolic compounds (as C_2H_5OH), mg/l, *Max*.	0.1	-
7	Dissolved Oxygen, *Min.*	40 percent saturation value or 3mg/l, whichever is higher	3 mg/l
8	Pesticides (chlorinated hydrocarbons) (as Cl), mg/l, *Max*.	0.002	-
9	Arsenic (as As), mg/l, Max.	0.2	-
10	Mercury (as Hg), mg/l, *Max*.	0.0003	-
11	Oil and greasy substances (sampled in 30 cm surface layer), mg/l, *Max.*	0.1	10
12	Biochemical oxygen demand (5 days at 20°C), mg/l, *Max.*	5	5
13	Coliform bacteria, MPN index per 100ml, *Max.*	1000	2500
14	Bio-assay test	Not less than 90 percent of test animals shall survive in 96-hour test	-

Source: IS 7967-1976 (reaffirmed 2009)

1.3.7 Applicable General Standards for Discharge of Environmental Pollutants

Part A: Effluents

The general standards for discharge are as prescribed under the Environment Protection Rules, 1986 and amendments. The Project aims to comply with the standards given in ***Table 1.4 & Table 1.5*** however, in absence of any other parameters General Standards of Discharge (***Table 1.11***) may be referred to. Vedanta Ltd (Cairn Oil & Gas) will comply with specific APPCB prescribed standards if they are stringent than the General Standards.

Table 1.11 Applicable General Standards for Discharge of Environmental Pollutants

S N	Parameter	Standards for discharge on Land for Irrigation	Standards for Marine Coastal Areas
1.	Colour and odour	All efforts shall be made to remove colour and unpleasant odour as far as practicable*	
2	Suspended solids mg/l, max.	200	100
5	pH value	5.5 to 9.0	5.5 to 9.0
6	Temperature ^{o}C	Shall not exceed 5^{o}C above receiving water temperature	Shall not exceed 5^{o}C above receiving water temperature
7	Oil and grease, mg/l max,	10	20
8	Total Residual Chlorine (as Cl_2), mg/l	-	1.0
9	Ammonia Cal Nitrogen (as N), mg/l	-	50
10	Total Kjeldahl Nitrogen (as NH3), mg/l	-	100
11	Free Ammonia, (as NH3), mg/l	-	5.0
12	Biochemical oxygen demand (3 days at 27^{0} C), mg/l max	100	100
13	Chemical Oxygen Demand	-	250
14	Arsenic (as As)	0.2	0.2
15	Mercury (as Hg), mg/l	-	0.01
16	Lead, (as Pb), mg/l	-	2.0
17	Cadmium (as Cd), mg/l	-	2.0
18	Hexavelent Chromium (as Cr+6), mg/l	-	1.0
19	Total Chromium (as Cr), mg/l	-	2.0
20	Copper (as Cu), mg/l	-	3.0
21	Zinc (as Zn), mg/l	-	15
22	Selenium (as Se), mg/l	-	0.05
23	Nickel (as Ni), mg/l	-	5.0
27	Cyanide (as CN) mg/1,max	0.2	0.2
32	Sulphide (as S), mg/l	-	5.0
33	Phenolic compounds (as C_6H_5OH), mg/l	-	5.0
34	Radioactive materials: (a) Alpha emitters micro curie /ml,max (b)Beta emitters micro curie /m1	 10^{-8} 10^{-7}	 10^{-7} 10^{-6}
35	Bio-assay test	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent
36	Manganese (as Mn), mg/l	-	2.0
37	Iron (as Fe)	-	3
38	Vanadium (as V), mg/l	-	0.2
39	Nitrate Nitrogen, mg/l	-	20

Note: * as per annexure 6 of the General Standards

General Emission Standards

Different emission standards are notified from time to time for different set of industries. In case of non-specific standards, General Emissions Standards are as given in the ***Table 1.12.***

Table 1.12 General Emission Standards

S.N.	Parameter	Standard mg/Nm^3
1	Particulate matter (PM)	150
2	Carbon monoxide	1% max. (v/v)

Source: Schedule VI Environment (Protection) Rules, 1986
General Emission Standards Part D: Concentration based standards

1.3.8 Ambient Air Quality

The National Ambient Air Quality Standard (NAAQS) is presented in the ***Table 1.13.***

Table 1.13 Applicable National Ambient Air Quality Standards

SN	Pollutant	Time Weighted Avg	Concentration in Ambient Air for Industrial, Residential, Rural & Other Areas
1	Sulphur dioxide (µg/m^3)	Annual Avg*	50
		24 Hours**	80
2	Oxides of Nitrogen (µg/m^3)	Annual Avg*	40
		24 Hours**	80
3	Particulate matter (PM_{10}) (µg/m^3)	Annual Avg*	60
		24 Hours**	100
4	Particulate matter ($PM_{2.5}$) (µg/m^3)	Annual Avg*	40
		24 Hours**	60
5	Ozone (O3) (µg/m^3)	8 hours**	100
		1 hour**	180
6	Lead (Pb) (µg/m^3)	Annual Avg*	0.5
		24 Hours**	1.0
7	Carbon monoxide (CO) (µg/m^3)	8 Hours	2000
		1 Hour**	4000
8	Ammonia (µg/m^3)	Annual Avg*	100
		24 Hours**	400
9	Benzene (µg/m^3)	Annual Avg*	5
10	Benzo-a-pyrene particulate phase (ng/m^3)	Annual Avg*	1
11	Arsenic ((ng/m^3)	Annual Avg*	6
12	Nickel (ng/m^3)	Annual Avg*	20

Note: * Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval. ** 24 hourly/8 hourly values should be met 98% of the time in a year. However 2% of the time, it may exceed but not on two consecutive days. Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

6) Ambient Noise Standards for Onshore industrial facilities

Ambient noise standards are to be maintained as land use of an area as specified in ***Table 1.14.***

Table 1.14 Ambient Noise Standards

Area Code	Category of Area	Limits in dB(A) Leq	
		Day time*	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone**	50	40

Note:*Day time is from 6 am to 10 pm, Night time is10.00 pm to 6.00 am;**Silence zone is defined as area up to 100 meters around premises of hospitals, educational institutions and courts. Use of vehicle horns, loud speakers and bursting of crackers are banned in these zones. As per Schedule III of the E (P) A Rules, 1986

1.3.9 Noise Limits and Guidelines for Diesel Generators

- Noise from a diesel generator (DG) set shall be controlled by providing an acoustic enclosure or by treating the room acoustically, at the users end;

- The acoustic enclosure or acoustic treatment of the room shall be designed for minimum 25 dB (A) insertion loss or for meeting the ambient noise standards, whichever is on the higher side (if the actual ambient noise is on the higher side, it may not be possible to check the performance of the acoustic enclosure/acoustic treatment. Under such circumstances the performance may be checked for noise reduction up to actual ambient noise level, preferably, in the night time). The measurement for Insertion Loss may be done at different points at 0.5 m from the acoustic enclosure/room, and then averaged;
- These limits shall be regulated by the State Pollution Control Boards and the State Pollution Control Committees;
- The manufacturer shall offer to the user a standard acoustic enclosure of 25 dB (A) insertion loss and also a suitable exhaust muffler with insertion loss of 25 dB (A);
- The user shall make efforts to bring down the noise levels due to the DG set, outside his premises, within the ambient noise requirements by proper siting and control measures;
- Installation of a DG set must be strictly in compliance with the recommendations of the DG set manufacturer; and
- A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

Vedanta Ltd (Cairn Oil & Gas) is reportedly following noise limits as stipulated for diesel generators by providing acoustically enclosed diesel generators and maintaining ambient noise levels within the prescribed limits outside the Ravva Terminal site.

1.4 RELEVANT INTERNATIONAL CONVENTIONS

Following section describes International Conventions of relevance to offshore activities and to which India is a party.

1.4.1 International Conventions to which India is a Party

India is signatory to various international conventions related to protection of fauna and flora and environment through conventions as listed in ***Table 1.15.***

Table 1.15 International Conventions to which India is a Party that relates to Protection of the Environment

S.N.	Year	Convention
1	1946	International Convention for the Regulation of Whaling
2	1960	Radiation Protection Convention, 1960
3	1969	International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties
4	1969	Protocol to the International Convention on Civil Liability for Oil Pollution Damage
5	1971	Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)
6	1971	Protocol to the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage of 18 December 1971
7	1972	The International Regulations for Preventing Collisions at Sea 1972
8	1973	International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)
9	1973	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
10	1976	International Convention for the Safety of Life at Sea (SOLAS) of 1974
11	1975	Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention)
12	1976	Merchant Shipping (Minimum Standards) Convention, 1976

S.N.	Year	Convention
13	1978	Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships of 2 November 1973, as amended
14	1980	Convention on the Conservation of Antarctic Marine Living Resources, also Commission on the Conservation of Antarctic Marine Living Resources, and CCAMLR
15	1982	United Nations Convention on the Law of the Sea (UNCLOS). Under the convention, India claims right within 12 nautical miles of territorial water and 200 nautical miles as Exclusive Economic Zone (EEZ) from its coastal areas;
16	1983	Convention on the Conservation of Migratory Species of Wild Animals (CMS) also called Bonn Convention of 1979
17	1983	Antarctic treaty and related agreements of 1959
18	1985	Vienna Convention for the Protection of the Ozone Layer
19	1987	Montreal Protocol on Substances that Deplete the Ozone Layer
20	1988	Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation (SUA)
21	1989	Basel Convention for the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention) ratified in 1992
22	1992	Rio Declaration on Environment and Development – MoU signed by US EPA and MoEFCC
23	1992	Convention on Biological Diversity (CBD/Biodiversity Convention)
24	1992	United Nations Framework Convention on Climate Change (UNFCCC)
25	1997	Kyoto Protocol to the United Nations Framework Convention on Climate Change
26	1998	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
27	1998	Memorandum of Understanding (MoU) Concerning Conservation Measures for the Siberian Crane of 1993
28	2001	Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia
29	2005	Protocol for the Suppression of Unlawful Acts against the Safety of Fixed Platforms Located on the Continental Shelf

In addition, India has signed several "Memorandum of Understanding" with various countries as a commitment towards the protection of its rich and unique biodiversity has assumed added significance. As it is clear, sufficient legal measures exists both at the national and international level which can provide effective protection to the endangered marine animals and critical ecosystems of coastal and marine water.

Specific provisions for prevention of pollution are as per the following conventions:

1) International Convention for the Prevention of Pollution from Ships, 1973 as modified by the protocol of 1978 (MARPOL73/78)

This instrument is a combination of two treaties adopted in 1973 and 1978 respectively. It covers all the technical aspects of pollution from ships, except the disposal of waste into the sea by dumping, and offshore exploration activities.

The Convention has two Protocols dealing respectively with Reports on Incidents involving Harmful Substances and Arbitration; and five Annexes, which contain regulations for the prevention of various forms of pollution:

- *Annex I deals with pollution by oil;*
- *Annex II deals with pollution by noxious liquid substances carried in bulk;*
- *Annex III deals with: pollution by harmful substances carried in packages, portable tanks, freight containers, or road or rail tank wagons, etc.;*
- *Annex IV deals with pollution by sewage from ships; and*

- *Annex V deals with pollution by garbage from ships.*

India has ratified MARPOL 73/78, Annexes I, II, IV & V. The area of Bay of Bengal is not included in the IMO's list of Special Areas. A summary of MARPOL discharge standards as applicable to Indian water is given in ***Table 1.16.***

Table 1.16 Summary of MARPOL Discharge Standards

Pollutant Type	Sub-Category	Where/When discharge permitted
Oil (Annex I)	Oily waste from cargo tanks of oil tankers	▪ More than 50 nautical miles from the nearest land; ▪ Tanker is proceeding en route; ▪ Instantaneous rate of discharge < 30 litres per nautical mile; ▪ Total quantity discharge does not exceed 1/15,000 or 1/30,000 of the total cargo (depending on the age of the vessel); and ▪ Oil discharge monitoring and control system and slop tank arrangement to be operating.
	Machinery space bilges for vessels >= 400 gross tons	▪ Oil and all oily mixtures retain on-board for on shore disposal; or ▪ Proceeding en route; ▪ Oil content less than 15 parts per million; and ▪ Oil discharge monitoring and control system and oil filtering equipment to be operating;
	Machinery space bilges for vessels <400 gross tons	▪ Proceeding en route; and ▪ Has in operation equipment of a design approved by the administration that ensures oil content less than 15 parts per million.
Noxious Liquid Substances (Annex II)	Category X	▪ Tanks to be prewashed before leaving unloading port, residues to be pumped ashore until the concentration of the substance in the effluent is 0.1% by weight or less, as indicated by analysis of samples of the effluent taken by an AMSA marine surveyor. When the required concentration level has been achieved, remaining tank washings to be discharged to the reception facility until the tank is empty. Appropriate entries to be made in the Cargo Record Book and endorsed by the AMSA marine surveyor. Any water subsequently added may be discharged if: ▪ Ship is proceeding en route at a speed of at least 7 knots; and ▪ Discharge below the waterline; and ▪ Ship is > 12 nm from nearest land and depth of water is >25m.
	High-viscosity or solidifying Category Y	▪ Prewash in accordance with Convention, residues to be pumped ashore until tank is empty. Any water subsequently added may be discharged if: ▪ Ship is proceeding en route at a speed of at least 7 knots; and ▪ Discharge below the waterline; and ▪ Ship is > 12 nm from nearest land and depth of water is >25m.
	Category Y Category Z	▪ Ship is proceeding en route at a speed of at least 7 knots; and ▪ Concentration of substance in wake of ship < 1 part per million; and ▪ Amount not to exceed 1m3 or 1/3,000 of tank capacity, whichever is greater; and ▪ Discharge below the waterline; and ▪ Ship is > 12 nm from nearest land and depth of water is >25m.
Harmful Packaged Substances (Annex III)		Jettisoning prohibited.

<table>
<tr><th>Pollutant Type</th><th>Sub-Category</th><th colspan="2">Where/When discharge permitted</th></tr>
<tr><td rowspan="4">Sewage (Annex IV)</td><td>Comminute and disinfected sewage using an approved system</td><td colspan="2">> 3 nm from nearest land.</td></tr>
<tr><td>Untreated sewage stored in holding tank</td><td colspan="2">> 12 nm from nearest land; and
discharged at a moderate rate; and
Ship proceeding en route at a speed of at least 4 knots.</td></tr>
<tr><td>Sewage from an IMO approved sewage treatment plant</td><td colspan="2">Effluent not to produce visible floating solids nor cause discolouration of the surrounding water.</td></tr>
<tr><td></td><td colspan="2"><table><tr><th>Parameter</th><th>Permissible Value on or after January 2010</th></tr><tr><td>Faecal Coliform</td><td>Not specified</td></tr><tr><td>Thermo tolerant Coliform</td><td>100/100 ml</td></tr><tr><td>Suspended Solids</td><td>Onshore: 35 mg/l
On-board Ship: 35 mg/l above the suspended solids content of ambient water used for flushing purposes</td></tr><tr><td>BOD_5</td><td>25 mg/l</td></tr><tr><td>COD</td><td>125 mg/l</td></tr><tr><td>pH</td><td>6-8.5</td></tr></table></td></tr>
<tr><td rowspan="4">Garbage (Annex V)</td><td>Plastics, including synthetic ropes,synthetic fishing nets, plastic garbage bags and incinerator ashes from plastic products</td><td colspan="2">Prohibited.</td></tr>
<tr><td>Dunn age, lining and packing materials which will float</td><td colspan="2">> 25 nm from nearest land.</td></tr>
<tr><td>Food wastes and all other garbage including cargo residues and incinerator ashes (except from plastic products)</td><td colspan="2">> 12 nm from nearest land.</td></tr>
<tr><td>Garbage that has been ground or comminute to particles < 25mm</td><td colspan="2">> 3 nm from nearest land.</td></tr>
</table>

Source: Developed from MARPOL standards; Note: nm = nautical mile; NS – Not Specified

MARPOL has also demarcated several marine areas as sensitive from ecological standpoint and has identified following three levels of sensitivities:

- Areas to be avoided;
- Particularly Sensitive Areas; and
- Special Areas.

Within the above three sensitive areas marine traffic and anchorage is regulated by MARPOL. These areas have not been identified within Bay of Bengal by MARPOL. Indian Coast Guard is helping in protection of Protected Areas along the Indian coasts as Particularly Sensitive Areas.

2) Other International Guidelines

International Finance Corporation (IFC) provides Environment, Health and Safety guidelines for Oil and Gas development (Offshore) projects. The guidelines are similar to the MARPOL norms for marine areas.

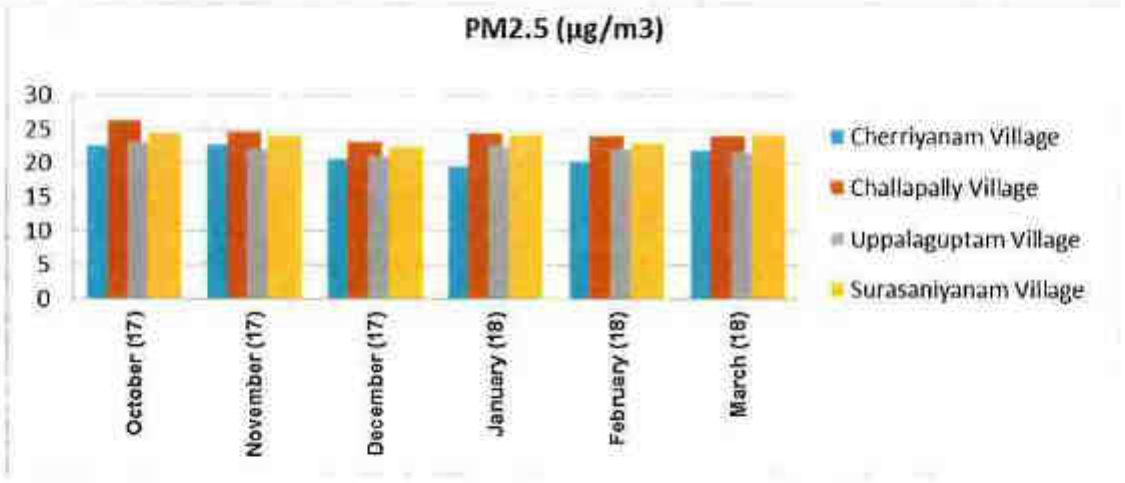
Annex 10

Trends in Environmental Monitoring Results (Submitted to MoEFCC on 25 April, 2018 as part of the Report against compliance to the conditions stated in the environmental clearances)

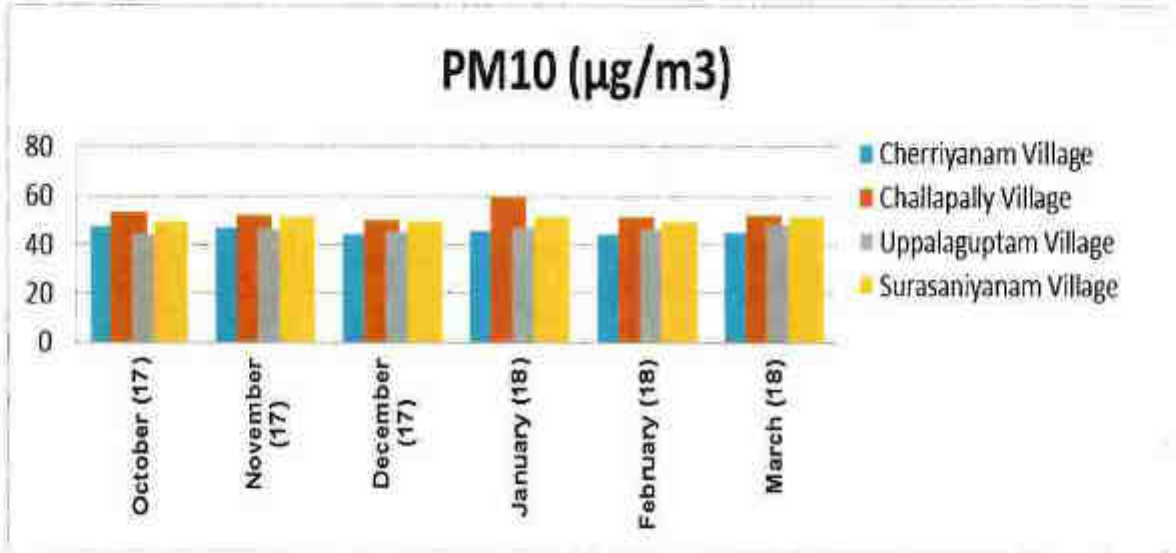
Annexure-1: Trends in Environmental Monitoring Results

1. Ambient Air Quality

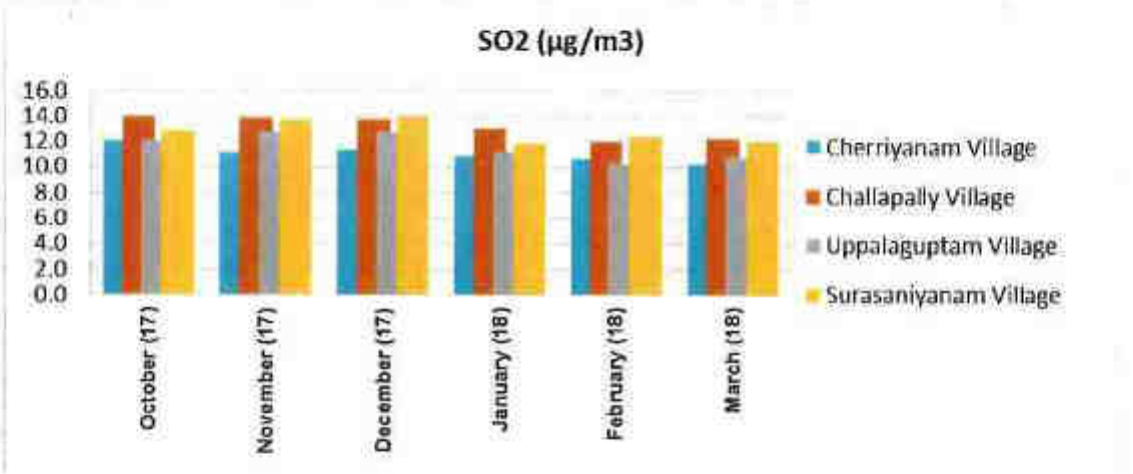
PM 2.5:



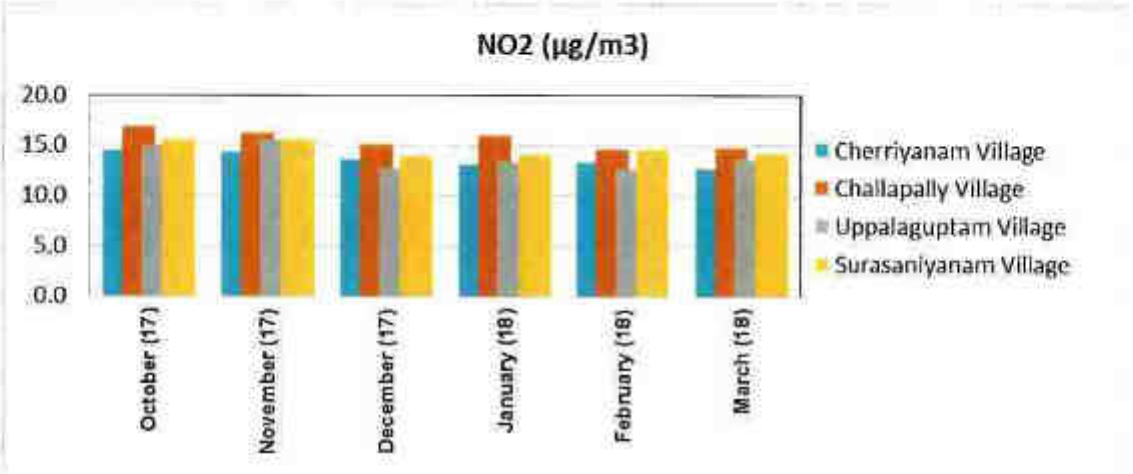
PM10:



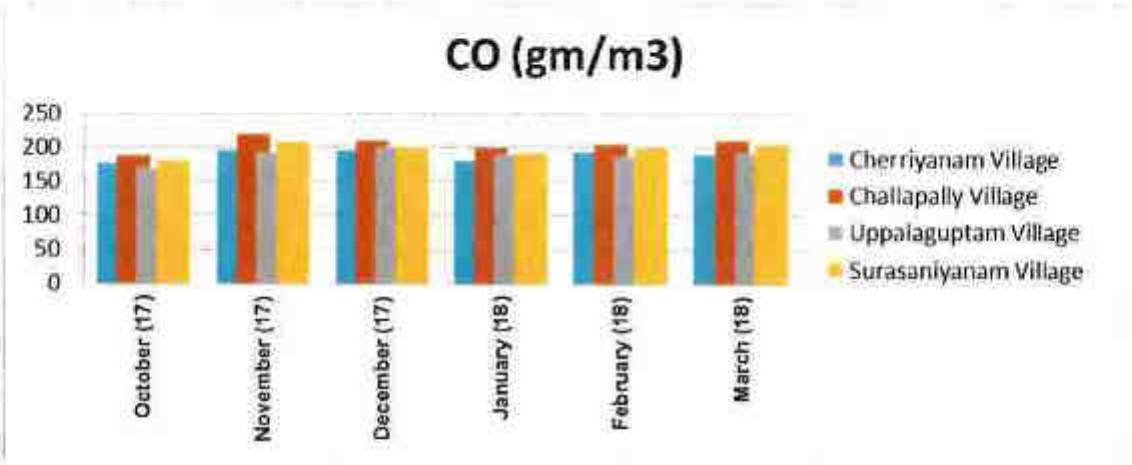
SO2:


SO2 (µg/m3)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
October (17)
November (17)
December (17)
January (18)
February (18)
March (18)
Cherriyanam Village
Challapally Village
Uppalaguptam Village
Surasaniyanam Village

NO2:


NO2 (µg/m3)
20.0
15.0
10.0
5.0
0.0
October (17)
November (17)
December (17)
January (18)
February (18)
March (18)
Cherriyanam Village
Challapally Village
Uppalaguptam Village
Surasaniyanam Village

CO:



NH3, C6H6, and BaP: Found to be below detectable limits at all four monitoring locations.

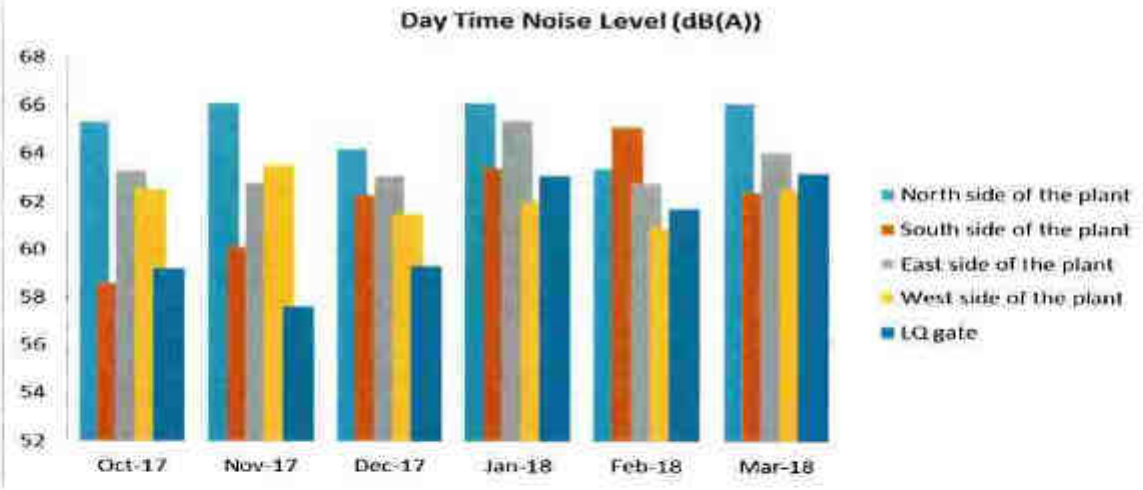
O3: Found to be within limits at all four monitoring locations.

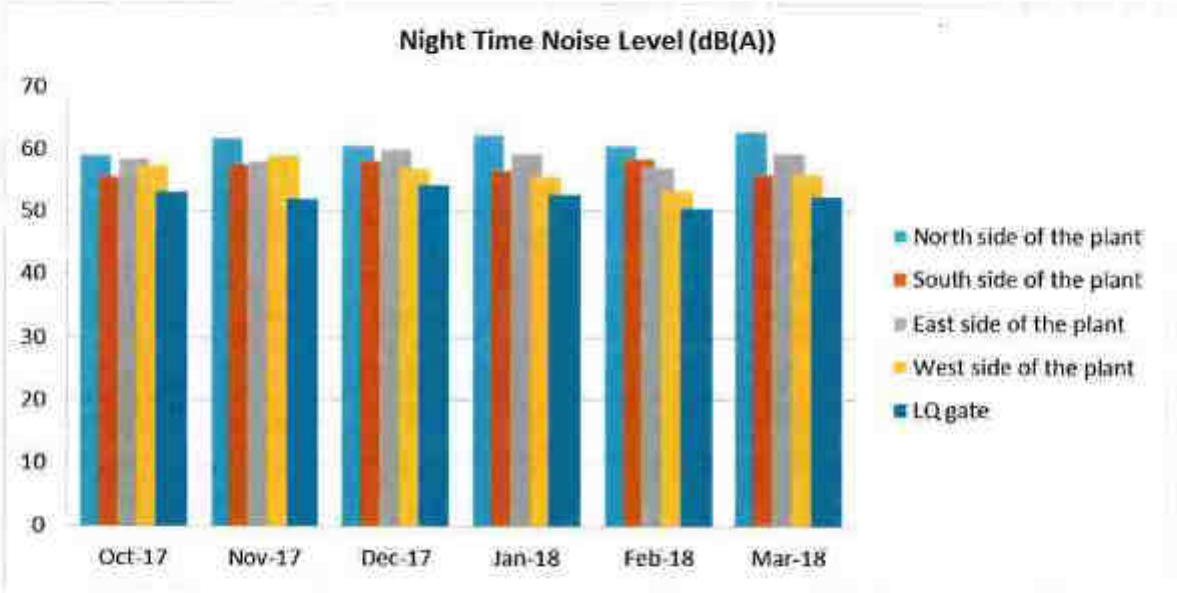
As: Found to be less than 1.0 ng/m3 at all four monitoring locations.

Ni: Found to be less than 1.0 ng/m3 at all four monitoring locations.

Pb: Found to be less than 1.0 ng/m3 at all four monitoring locations.

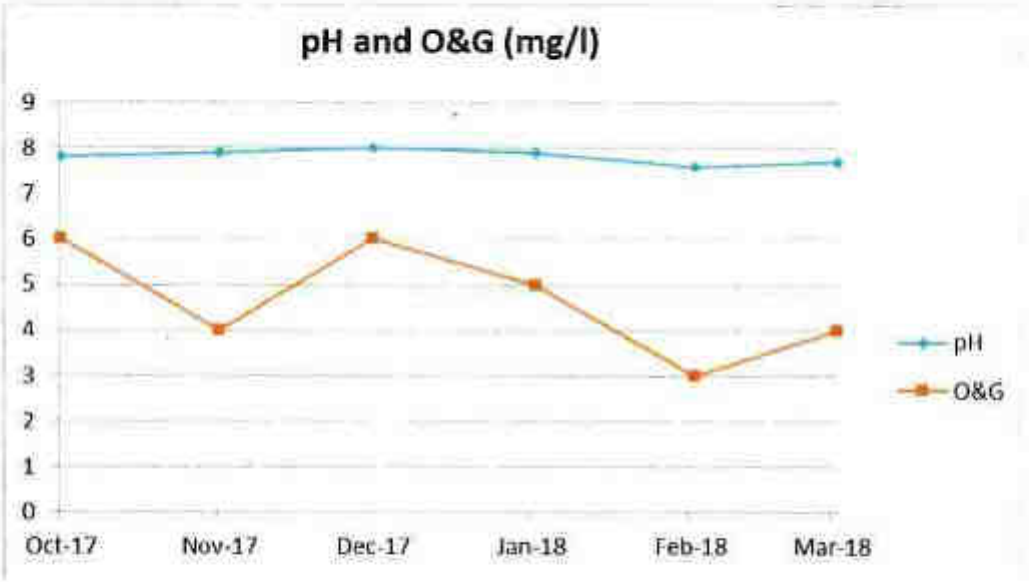
2. Ambient Noise Level:



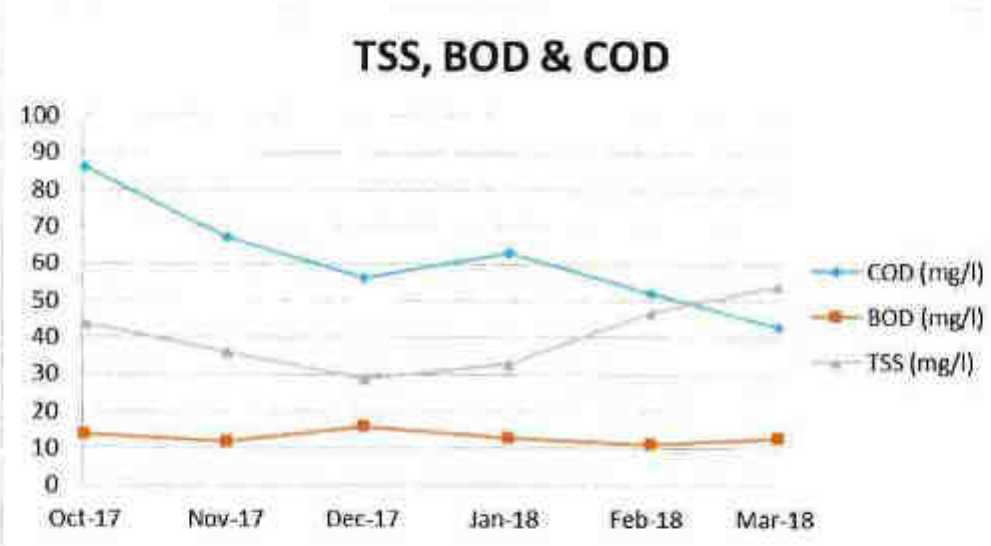


3. Treated Effluent Quality:

pH and O&G:



TSS, BOD & COD:



Cr (6), Cr (total), Pb, Cu, Ni, Zn, Hg, Sulphide, CN, and Phenol: Are monitored and analyzed and are found to be within the limits

4. **Air Emission from Stacks attached to Gas Turbine Generators (GTGs):**

PM, SO2, NO2, CO, HC: Are monitored and analyzed and are found to be within the limits.

****

Annex 11

Certified Copy of EC Compliance Report, Andhra Pradesh Pollution Control Board, Regional Office, Kakinada, 31.01.2019

Dilip Kumar Bera

From: Pankaj Jain
Sent: Friday, March 1, 2019 1:10 PM
To: Thomas Christopher J; K K Nayak; Dilip Kumar Bera; YNM-Installation Manager
Subject: FW: APPCB-RO-KKD – Request of M/s. Vedanta Limited (Cairn Oil & Gas), S.Yanam Village, Uppalaguptam Mandal, East Godavari District for issuance of certified Environmental Clearance(EC) compliance for obtaining EC & CRZ Clearance for the proposed expan...
Attachments: Vedanta Limited (Cairn Oil & Gas) - EC compliance.pdf

FYI

From: SECRETARIAT, SEIAA A.P. [mailto:apseiaasecretariat@gmail.com]
Sent: Friday, March 1, 2019 12:46 PM
To: Pankaj Jain
Cc: Appikonda Ramarao Naidu; Satish V
Subject: Fwd: APPCB-RO-KKD – Request of M/s. Vedanta Limited (Cairn Oil & Gas), S.Yanam Village, Uppalaguptam Mandal, East Godavari District for issuance of certified Environmental Clearance(EC) compliance for obtaining EC & CRZ Clearance for the proposed expan...

External Sender: Use caution with links/attachments

Sir,
Please find attached the certified copy of the compliance report of EC order of M/s .Vedanta Limited (Cairn Oil & Gas)., for information.
With Regards,
EC Section,
APPCB.

---------- Forwarded message ---------
From: **A.Ramarao Naidu EE** <rokkd-ee1@appcb.gov.in>
Date: Fri, Feb 1, 2019 at 1:33 PM
Subject: APPCB-RO-KKD – Request of M/s. Vedanta Limited (Cairn Oil & Gas), S.Yanam Village, Uppalaguptam Mandal, East Godavari District for issuance of certified Environmental Clearance(EC) compliance for obtaining EC & CRZ Clearance for the proposed expansion of Offshore & Onshrore Oil & Gas exploration, development and production within the existing Ravva (PKGM – I) offshore block – Compliance report - Submitted – Regarding.
To: <apseiaasecretariat@gmail.com>

Sir,

Please find enclosed the EC compliance report of M/s. Vedanta Limited (Cairn Oil & Gas), S.Yanam Village, Uppalaguptam Mandal, East Godavari District for issuance of certified Environmental Clearance(EC) compliance for obtaining EC & CRZ Clearance for the proposed expansion of Offshore & Onshrore Oil & Gas exploration, development and production within the existing Ravva (PKGM – I) offshore block for kind information.

Submitted.

Yours faithfully
EE/RO/KKD

ANDHRA PRADESH POLLUTION CONTROL BOARD
REGIONAL OFFICE
Plot No.2, IDA, Ramanayyapet, KAKINADA-533005

A.Ramarao Naidu
Environmental Engineer.

Ph: 0884-2374006
E-mail:rokkd-ee1@appcb.gov.in

Lr.No.14-R-1040/APPCB/RO/KKD/2019-1913 Date:31.01.2019

To
The Member Secretary,
A.P. Pollution Control Board,
Board Office,
VIJAYAWADA.

Sir,

Sub: APPCB-RO-KKD – Request of M/s. Vedanta Limited (Cairn Oil & Gas), S.Yanam Village, Uppalaguptam Mandal, East Godavari District for issuance of certified Environmental Clearance(EC) compliance for obtaining EC & CRZ Clearance for the proposed expansion of Offshore & Onshrore Oil & Gas exploration, development and production within the existing Ravva (PKGM – I) offshore block – Compliance report - Submitted – Regarding

Ref: E-mail received from EC Section on 22.12.2018, enclosing the letter of M/s.Vedanta Limited (Cairn Oil & Gas) requesting for certified EC compliance.

* * * *

With reference to the above, it is to submit that the MoEF&CC, GoI issued the following ECs/CRZ in-connection with Ravva PKGM Block – I since its inception.

S.No.	EC order No. & Date	Activity
1.	EC Order No.J - 11011/11/90-IA-II dated 30th July, 1990 (preliminary clearance).	The EC is for development of oil/ gas fields, installation of onshore oil & gas processing terminal and production of oil & gas by drilling 32 wells.
2.	EC Order No.J - 11011/6/91-IA dated 19th December 1991 (final clearance).	
3.	EC Order No.J-11012/59/95-1A-II (I) dated 03.07.1996	The EC is for the development of one Single Point Mooring (SPM) and laying of one crude oil export pipeline.
4.	EC Order No.J-11011/84/2000-IA II dated 30th January 2001	The EC is for the drilling, development of facilities both at offshore and onshore for Gas production.
5.	EC Order No.J-11011/50/2001-IA II dated September 17, 2001	The EC is for oil and gas exploratory drilling of eight (08) nos. of well in offshore.
6.	EC Order No.J - 11011/207/2004-IA (II) I dated 4th August 2005	The EC is for drilling of fifteen (15) nos. of additional infill (development) wells in offshore to sustain the production.
7.	EC Order No.10-28/2004-IA-III dated 31st March, 2006	The EC is for Exploratory drilling in onshore area of PKGM-1 Block for drilling of 2 Nos. of Wells.
8.	EC Order No.J-11011/81/2013-IA II (I) dated 23rd February, 2015	The EC is for Oil and Gas Development in existing Ravva Off-shore Field, PKGM-1 Block by drilling 20 + 6 development / exploratory wells, one new platform and subsea pipeline
9.	CRZ F. No. 11-20/2015-IA.III dated 25th May, 2017	CRZ Clearance for Expansion of Oil & Gas Development facilities in existing Ravva Off-shore Field, PKGM-1 Block by drilling 20 + 6 development / exploratory wells, one new platform and subsea pipeline.

In this connection, it is submitted that the undersigned along with AEE of this office inspected the project area and its surroundings on 28.12.2018 & 18.01.2019 to verify the compliance status for each EC/CRZ issued above.

The compliance status of the facility with the conditions stipulated in each EC / CRZ orders mentioned above is herewith submitted for favour of ready reference and for further course of action.

Submitted.

Yours faithfully

31/01/19

ENVIRONMENTAL ENGINEER

Encl: a/a

Compliance Report

Subject: Environmental Clearance for oil production from Godavari off-Shore field and onshore field terminal facility at Surasaniyanam.

Reference: J - 11011/11/90-IA-II dated 30th July, 1990 (preliminary clearance).

Present Status of the Project:

This EC is for development of oil/ gas fields, installation of onshore oil & gas processing terminal and production of oil & gas. The offshore facilities developed: Seven nos. of offshore platforms (RA, RB, RC, RD, RE, RF and RG) and subsea pipelines. On-shore oil and gas processing terminal with facilities has been installed with the following capacity:

Plant fluid handling – 90,000 BLPD;

Crude oil production – 50,000 BOPD;

Associated gas production – 1.42 MMSCMD;

Non-associated gas Production – 0.9 MMSCMD.

Permission obtained to drill 32 nos. of wells of oil and gas. Out of that 31 nos. of wells were drilled. Currently, ten (10) nos. of wells are producing oil and four (04) nos. of wells are being used as water injector wells.

Details of the facilities developed at offshore and onshore and wells drilled are given as **Appendix-1**.

<table>
<tr><th>S. No.</th><th>CONDITIONS</th><th>COMPLIANCE STATUS / REMARKS BY APPCB</th></tr>
<tr><td>i)</td><td>The Project Authority must submit the comprehensive EIA report for the development of oil/ gas fields for this project within a period of 9 months before commencement of the production.</td><td>No information available with project authorities and hence, could not be verified. The Project Authorities informed that they have taken over the O & M of the facility from ONGC in the year 1994. The authorities also informed that only after submitting comprehensive EIA report, final clearance issued in this regard.</td></tr>
<tr><td>(ii)</td><td>The Project Authority must strictly adhere to the stipulations made by the Central Government as part of any international conventions or Merchant Shipping Act.</td><td>The project authorities have been obtaining permission from time to time as per Merchant Shipping Act. At present, the project authorities obtained permission for Mahananda Ship which is valid upto 17.02.2019, vide certificate dated 22.07.2014.
Being complied.</td></tr>
<tr><td>(iii)</td><td>The crude and gas distribution network should be made in such a manner that the handling terminals need not expand their capacity to excessively high levels.</td><td>As per the production records the average production against installed capacity is as follows:
<table>
<tr><th>Parameter</th><th>Units</th><th>Installed Capacity</th><th>Present Avg. Production</th></tr>
<tr><td>Plant fluid handling capacity</td><td>BLPD</td><td>90,000</td><td>67,600</td></tr>
<tr><td>Crude production</td><td>BOPD</td><td>50,000</td><td>22,000</td></tr>
<tr><td>Associated gas production</td><td>MMSCMD</td><td>1.42</td><td>0.474</td></tr>
<tr><td>Non-associated gas production</td><td>MMSCMD</td><td>0.9</td><td>0.58</td></tr>
</table>
Complied.</td></tr>
<tr><td>(iv)</td><td>The Project Authority must (a) collect all constructions wastes in ships for on-shore disposal (b) control and remove any pollution or contamination which originated above the surface of the sea from negligence, spills of wells, lubricants, ballast and garbages within the project proponent's possession and</td><td>No construction activities are being carried out at present. No incidents of oil spill or accidental discharges recorded. Small quantities of garbage and waste generated at offshore platforms are being brought to the onshore terminal by vessels and there are no unused objects or sunken plant structures are left in the Project area.
Being complied.</td></tr>
</table>

S. No.	CONDITIONS	COMPLIANCE STATUS / REMARKS BY APPCB
	control and (c) raise and remove all sunken plant structures or objects arising from the proposed activities.	
(v)	The Project Authority must shut down the system to provide primary protection by pressure control instrumentation, to prevent or minimise the escape of crude oil or gas.	Provided with Emergency Remote Shut off facilities. **Being Complied.**
(vi)	The Project Authority must use such type of chemicals which are permissible and information regarding the type of chemicals used and toxicity must be made available to this Ministry regularly, changes in the use of any type of chemicals in addition to the above should be informed to this Ministry along with their quantity, consumption and toxicity levels. Any Chemicals which have accumulative property in benthos or sediments should be avoided or their use restricted to the minimum. They should monitor their concentration levels in sediments fauna, flora and fish tissues.	A list of production and treatment chemicals used are as follows. MSDS of all hazardous chemicals are maintained at site. PPD — Scale Inhibitor - De-emulsifier — Sodium Hypochlorite Oil Corrosion Inhibitor — Glycol Water Corrosion Inhibitor — Therminol 55 Biocide-1 — Propane Biocide-2 — Gas Phase Corrosion Inhibitor Biocide -3 — Drag Reducing Agent Oxygen Scavenger Monitoring of water quality, sediment characteristics, plankton diversity and concentration of heavy metals in fish tissues has been conducting under offshore environmental monitoring by Andhra University and submitting the reports along with EC compliance. **Being Complied.**
(vii)	The Project Authority should monitor the population of marine biota around the proposed exploration area and within a radius of 5 kms. The recorded data should be furnished once in six months to this Ministry. Any major changes observed should be reviewed carefully.	At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted on 24.04.2018. **Complied.**
(viii)	The Project Authority must provide ear muffs/ any other hearing protection measures to the employees at the time of their duty to mitigate the effect of noise.	The employees working in high noise areas are provided with personnel protective equipment (PPE) including hearing protection devices like ear muffs, ear plugs etc. **Complied.**
(ix)	Releases containing pathogenic bacteria, viruses and parasites that survive in marine life must be completely, precluded by adequate treatment measures on the platforms.	Offshore platforms are unmanned with no accommodation facilities. Only maintenance staff visits the platform when required. **Not applicable.**
(x)	The Project Authority must undertake adequate measures to minimize the burning of gas in flares and for smoke reduction at all the offshore installations. The flare should be non-luminous at all stages of operations. This will reduce the buildup of particulate matter in the environment. They should measure hydrocarbon emissions at regular intervals.	No flaring has been carrying at offshore installations and the onshore terminals has provided 3Nos. of flare stacks of 30mtrs., height. **Complied.**
(xi)	The Project Authority must strictly adhere to the regulations made by MARPOL Conventions 1973/1978, for setting limits, for discharges from offshore oil-gas exploration and production activities.	The facility has been obtaining permission from statutory departments. **Being Complied.**
(xii)	The Project Authority must perform Static Sheen Test of any other approved test for the drilling fluids, drill cuttings that are discharged into the sea.	No drilling activities carried out at present. The project authorities informed that they regularly analyzed the characteristics of solid waste and discharged after conforming standards into Sea. **Complied.**

S. No.	CONDITIONS	COMPLIANCE STATUS / REMARKS BY APPCB
(xiii)	The Project Authority must establish oil spill control centres at vulnerable areas with high pollution potential. The Project Authority must prepare contingency plan for (a) blow-out, (b) major fire (c) oil spill and (d) hydrogen Sulphide emissions.	Provided with 2000 M Boom Reel, Power packs, 2 Skimmers, Oil Spill Dispersant and others as per Oil Spill Contingency plan for offshore operations of Ravva field, East Coast of India and latest updated oil spill contiagency plan submitted to Indian Coast Guard Services, Kakinada on 04.10.2016. **Complied.**
(xiv)	The Project Authority must regularly analyse the characteristics of solid wastes before they are discharged into the sea from drilling rigs and process platform including kitchen wastes.	No drilling activities carried out at present. The project authorities informed that they regularly analyzed the characteristics of solid waste and discharged after conforming standards into Sea. **Complied.**
(xv)	The Project Authority must ensure that the liquid/ solid wastes would not disturb the marine ecosystem. The recorded data or analysis should be furnished to this Ministry / State pollution control Board once in six months.	At present the Facility has been monitoring marine environment and ecology through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted on 24.04.2018. **Complied.**
(xvi)	The Project Authority must set up adequate number of monitoring stations for sampling and analysis of various parameters including objectionable chemicals, in water, sediments, fish and other biological materials for heavy metals.	At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted on 24.04.2018. **Complied.**
(xvii)	The Project Authority must establish their own laboratory facility for sampling and analysis of various parameters under the supervision of competent person.	In-house laboratory facilities provided at onshore facility for analysis of effluents. The in-house laboratory has capability to monitor parameters like O&G, TSS, BOD, COD, pH etc. External approved agency has also been engaged to conduct regular monitoring of ambient air quality, effluent, stack emissions and noise. **Complied.**
(xviii)	The Project Authority must prepare a safety audit system and mock rehearsal must be carried out regularly to test the responsiveness of the concerned.	Mock drills are being conducted regularly for various emergency scenarios to test the responsiveness. **Bing complied.**
(xix)	The integrated disaster management plan on the basis of risk analysis duly approved by Nodal Agency must be submitted to this ministry along with the comprehensive EIA report for review. This should cover detailed analysis of the explosion, fire and their cascading effect with respect to pressure wave radiation and fire borne impacts etc.	Prepared and updated Onsite and Offsite Emergency Plans submitted in August, 2018. **Complied.**
(xx)	The Project Authority must widen and strengthen the existing road for transporting the crude at their own cost and in consultation with the State Government, till the proposed pipeline for transportation of crude is ready.	At present, the facility has been exporting the Crude oil through Single Point Mooring (SPM). **Not applicable.**
(xxi)	The Project Authority should perform by bioassay test with suitable phytoplankton.	At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted 24.04.2018. **Complied.**
(xxii)	The flaring of gas should be kept as minimum as possible.	No flaring has been carrying at offshore installations and the onshore terminals has provided 3Nos. of flare stacks of 30mtrs., height. **Being Complied.**

S. No.	CONDITIONS	COMPLIANCE STATUS / REMARKS BY APPCB
(xxiii)	The reclamation at on-shore facility should be done without indiscriminate quarrying of fill material. The Project Authorities may explore the possibility of using drill cuttings as landfill material.	No earth filling of the land was required in the Onshore Terminal. **Not applicable.**
(xxiv)	A separate environment management cell with suitably qualified technical personnel to carry out various functions related to environmental management to be set up under the control of senior technical personnel who will directly report to the Chief Executive.	Separate Environment Management Cell is established with competent technical personnel headed by Head – HSEQ and reporting to Chief Executive Officer (CEO) of Cairn Oil & Gas directly. **Complied.**
(xxv)	Adequate fund provision (capital and recurring expr.) must be made for environmental control measures and the fund so provided should not be diverted for any other purposes.	The expenditure incurred for O&M of ETP, and Environmental Monitoring for the last 6 years as follows: 2012-13: 1,82,41,911 INR 2013-14: 1,84,13,482 INR 2014-15: 4,93,67,015 INR 2015-16: 1,64,75,766 INR 2016-17: 3,25,28,350 INR 2017-18: 1,34,02,539 INR **Assured to comply.**
(xxvi)	The Ministry may add any other stipulations after review of comprehensive EIA report, for development of oil-gas fields of ONGC's offshore basin.	Additional conditions stipulated in Final Clearance issued by MoEF&CC and compliance report is submitted as enclosure.
(xxvii)	The Project Authority must not start commercial production at the proposed sites before getting final clearance from environmental angle.	Obtained final permission on 19.12.1991 to drill 32Nos. of wells of oil & gas. Out of which 31Nos. of wells were drilled and currently 10Nos. of wells are producing oil and 4Nos. of wells are being used as water injector wells. **Being Complied.**

ENVIRONMENTAL ENGINEER

Compliance Report

Subject: Environmental Clearance for Oil/ Gas Production from Ravva off-Shore Field in Godavari Basin and On-Shore Terminal Facility at Surasaniyanam

Reference: J - 11011/6/91-IA dated 19th December 1991 (final clearance)

S. No.	CONDITIONS	COMPLIANCE STATUS / REMARKS BY APPCB
(i)	Environment statement should be submitted to this Ministry once every year.	Latest Form-V submitted on November, 2018. **Being complied**
(ii)	A detailed study on the impacts (short term and long term) of laying sub-sea pipeline (at the time of laying) should be carried out and a report submitted within 6 months to this Ministry.	The Export Pipe line of 20 inch Diameter was laid from onshore terminal to Sea fall point underground with length 1.5 KM and from Sea Fall Point to Single Buoy Mooring (SBM) on sea bed with length of about 15 KM. **Complied.**
(iii)	A detailed report on the impact of the proposed project on mangroves and steps taken to reduce the adverse impact should be submitted to this Ministry within six months.	The project authorities informed that study report submitted to MoEF in time by M/s. ONGC. **Being complied.**
(iv)	Facilities to tackle disaster in case of accidental oil spill or blow-out should be developed before commencement of the project.	Provided with 2000 M Boom Reel, Power packs, 2 Skimmers, Oil Spill Dispersant and others as per Oil Spill Contingency plan for offshore operations of Ravva field, East Coast of India and latest updated oil spill contingency plan submitted to Indian Coast Guard Services, Kakinada on 04.10.2016. **Assured to comply.**
(v)	The stack height of both bath-heater & flare should be increased to appropriate lengths in consultation with Andhra Pradesh State Pollution Control Board.	Provided Stack height of 30 m to bath heater and 3 nos of flare stack. **Complied.**
(vi)	The flare should be of 60-m. height with steam injection facilities.	Provided stack height of 30mts., to flare stack only. **Not complied.**
(vii)	Ground water near the solid waste disposal site should be regularly monitored.	No solid waste disposal facility within Ravva facility. However, the facility has been carrying out the ground water quality quarterly by 3rd party agency. **Complied.**
(viii)	The project authority should prepare a well-defined scheme for disposal of sludge generated in the treatment plant. The site for disposal of solid waste should be identified based on scientific study. The plan for disposal should be submitted to the ministry within one year.	The sludge generated from ETP is being disposed of to TSDF / Co-processing in Cement Kilns **Complied.**
(ix)	The proposed post-project monitoring should be strictly implemented and a report submitted to this Ministry every six months. The location and frequency of monitoring for the proposed environmental parameters should be identified on scientific basis in consultation with Andhra Pradesh State Pollution Control Board.	At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted on 24.04.2018. The in-house laboratory has capability to monitor parameters like O&G, TSS, BOD, COD, pH etc. External approved agency has also been engaged to conduct regular monitoring of ambient air quality, effluent, stack emissions and noise. **Being complied.**
(x)	The storage tanks and spheres must conform to the stipulations made by Chief Inspectorate of Factories, Controller of Explosive etc. wherever required.	Total Capacity of 1,70,015 KL approved by Chief Controller of Explosives vide dated 31.05.2018. **Complied.**

S. No.	CONDITIONS	COMPLIANCE STATUS / REMARKS BY APPCB
(xi)	A report on status of implementation of conditions stipulated by this Ministry should be submitted to this Ministry every year from date of issue of this letter.	Submitting Half Yearly EC compliance. Submitted Latest on 29.11.2018. **Being Complied.**

ENVIRONMENTAL ENGINEER

Appendix-1: Details of present status of the project
Offshore Structures Installed:

Offshore Platform	Easting	Northing
RA	620738.000	1813336.000
RC	620793.893	1813365.606
RB	627395.490	1821906.660
RD	621331.391	1815820.092
RE	623597.442	1818795.685
RF	625654.820	1820439.983
RG	626945.433	1820513.551

The Surface location coordinates of wells drilled:

S. No	Well Name	Easting (m)	Northing (m)	Remarks
1.	RA-1	620731.36	1813339.32	Wells drilled by M/s. ONGC
2.	RB-1	627388.90	1821900.90	
3.	RD-1	621332.06	1815825.73	
4.	RA-2	620737.72	1813339.05	
5.	RB-2	627388.90	1821900.90	
1.	RC-1	620800.24	1813367.61	Against EC approval for 27 wells, 26 nos. have been drilled.
2.	RG-1	626950.80	1820518.90	
3.	RD-2	621338.00	1815825.60	
4.	RD-3	621334.62	1815825.22	
5.	RE-1	623603.40	1818801.20	
6.	RC-2	620796.64	1813370.48	
7.	RD-4	621336.26	1815827.11	
8.	RF-1	625656.00	1820442.70	
9.	RF-2	625653.15	1820444.15	
10.	RG-2	626947.63	1820518.61	
11.	RE-2	623601.67	1818802.71	
12.	RF-3	625656.80	1820441.30	
13.	RX-1	625747.55	1822285.30	
14.	RH-1	620010.44	1818261.08	
15.	RF-4	625654.69	1820446.12	
16.	RE-3	623601.77	1818799.31	
17.	RD-5	621330.74	1815824.09	
18.	RD-6	621338.00	1815822.00	
19.	RX-3	629050.00	1823349.35	
20.	RX-4	626357.55	1818348.00	
21.	RC-3	620799.70	1813370.90	
22.	RX-5	622820.28	1814043.98	
23.	RX-6	629048.76	1823350.88	
24.	RF-5	625658.31	1820443.28	
25.	RC-8	620797.5	1813373.91	
26.	RC-4	620800.93	1813369.45	

Pipelines:

Sub-sea pipelines of around 150 Kms. (inter platform pipelines, pipelines from platforms to onshore terminal) as detailed below:

S. No.	Nominal Size (inch)	Pipeline Designation – from > to	Service	Pipeline Length (km)
1.	10.000	RT-RC(2)	Oil	10.44
2.	12.000	RB > RT	Oil	11.39
3.	4.000	RD > RC	Gas Lift	5.15
4.	8.000	RD > RC	Water Injection	5.00
5.	8.000	RD > RE	Oil	5.93
6.	6.000	RD > RE	Oil	5.75
7.	10.000	RE > RD	Water Injection	5.58
8.	4.000	RE > RF	Gas Lift	4.29
9.	8.000	RE > RF	Water Injection	4.18
10.	12.000	RE > RT	Oil	8.57
11.	4.000	RF > RB	Gas Lift	5.55
12.	8.000	RF > RB	Oil	6.04
13.	6.000	RF > RB	Water Injection	5.78
14.	8.000	RG > RT	Gas Line	11.29
15.	6.000	RT > RE	Gas Lift	8.42
16.	12.000	RT > RE	Water Injection	8.51
17.	20.000	RT > SEA	Effluent	1.79
18.	10.000	RT>RC	Water Injection	10.74
19.	14.000	RD>RT	Oil	10.49
20.	14.000	RT>RD	Water Injection	10.64
21.	8.000	RE>RF	Water Injection	3.15

Oil and Gas Processing Terminal - Major units installed:

a. Three Stage crude stabilization units-3
b. Crude oil storage tanks
c. Gas Recovery compressors and treatment plant
d. Produced water treatment system
e. Water Injection Facilities
f. Effluent Treatment plant

Compliance Report

Subject: Development of the Ravva Oil and Gas field located near the Godavari Basin, A. P. by M/s. Command Petroleum (India) Pvt. Ltd. Joint Venture with ONGC – Environmental Clearance.

Reference: J-11012/59/95-1A-II (I), dated 03.07.96

Present Status of the Project:

This EC is for the development of one Single Point Mooring (SPM) and laying of one crude oil export pipeline. The following have been developed and presently in operation:

- One SPM for crude oil loading to marine vessels.
- One 20" Export Pipeline from Onshore Terminal to PLEM (Pipeline End Manifold) for transfer of crude oil to SPM.

A) Onshore facilities:

S. No.	CONDITIONS	Compliance Status / Remarks by APPCB
1.	The Project Authorities must strictly adhere to the stipulation made by the Andhra Pradesh State Pollution Control Board for the onshore terminal facilities.	Treated wastewater samples are conforming to the Board's discharge standards and submitting Environment Monitoring reports monthly. **Being Complied.**
2.	Onsite and Offsite Emergency Preparedness Plan required under Rules 13 and 14 of the Management, Storage and Import of Hazardous Chemicals Rules, 1989 should be prepared and approved by the nodal agency.	Prepared and Updated Onsite and Offsite Emergency Plans submitted latest on 12.07.2017 **Complied.**
3.	The project proponent should take appropriate measure to store the oily sludge in the crude tanks until a long-term plan for disposal of oily sludge has been finalised in consultation with the SPCB. A report on the proposed disposal plan should be submitted to this Ministry for review within six months. The feasibility of recovering oil from the oily sludges should also be considered.	At present, the oil sludge generated from the storage tanks is being disposed of to TSDF / Co-processing in Cement Kilns. **Being Complied.**
4.	Efforts should be made by the project proponent to reduce the flaring in the existing platform to the maximum extent possible. As indicated in the EMP, an indair flare stack with scrubbers should be provided. The height of the stack should be as per guidelines of the Central Pollution Control Board.	3Nos. of flare stacks of 30 m height provided at Onshore Terminal. **Being Complied.**
5.	For facilities proposed within 500 Mts. of the high tide line, necessary approvals under CRZ notification should be obtained.	No other facilities existing within 500mtrs., except laying of the Export Pipe line of 20 inch Diameter from onshore terminal to Sea fall point underground with length 1.5 KM and From Sea Fall Point to Single Buoy Mooring (SBM) on sea bed only with length of about 15 KM. **Complied.**
B. Offshore facilities		
1.	The Project Authority must strictly adhere to the stipulations made by the Central Government as part of any International Convention(s) or Merchant Shipping Act.	The project authorities have been obtaining permission from time to time as per Merchant Shipping Act. At present, the project authorities obtained permission for Mahananda Ship which is valid upto 17.02.2019, vide certificate dated 22.07.2014. **Being Complied.**

<table>
<tr><th>S. No.</th><th>CONDITIONS</th><th>Compliance Status / Remarks by APPCB</th></tr>
<tr><td>2.</td><td>The Project Authority must (a) dispose off construction wastes (b) control and remove any pollution or contamination of the sea due to spills of oil from the wells, lubricants, ballast and garbage resulting from the project activities and (c) raise and remove all sunken plant structures or objects arising from the proposed activities in accordance with MARPOL convention 1973/1978.</td><td>Provided with the Following
2000 M Boom Reel, Power packs, 2 Skimmers, Oil Spill Dispersant and others as per Oil Spill Contingency plan for offshore operations of Ravva field.

No construction activities are being carried out at present. No incidents of oil spill or accidental discharges recorded. Small quantities of garbage and waste generated at offshore platforms are being brought to the onshore terminal by vessels and there are no unused objects or sunken plant structures are left in the Project area.

Being complied.</td></tr>
<tr><td>3.</td><td>The Project Authority must use such chemicals which are permissible and information regarding the type of chemicals used and toxicity must be made available to this Ministry along with their quantity, composition and toxicity level chemicals which have accumulative property in benthos or sediments should be avoided or their use restricted to the minimum. The concentration levels of chemical specially heavy metals in sediments, fauna, flora and fish tissues should be monitored at regular intervals.</td><td>A list of production and treatment chemicals used are as follows. MSDS of all hazardous chemicals are maintained at site.
<table>
<tr><td>PPD</td><td>Scale Inhibitor -</td></tr>
<tr><td>De-emulsifier</td><td>Sodium Hypochlorite</td></tr>
<tr><td>Oil Corrosion Inhibitor</td><td>Glycol</td></tr>
<tr><td>Water Corrosion Inhibitor</td><td>Therminol 55</td></tr>
<tr><td>Biocide-1</td><td>Propane</td></tr>
<tr><td>Biocide-2</td><td>Gas Phase Corrosion Inhibitor</td></tr>
<tr><td>Biocide -3</td><td>Drag Reducing Agent</td></tr>
<tr><td>Oxygen Scavenger</td><td></td></tr>
</table>
Monitoring of water quality, sediment characteristics, plankton diversity and concentration of heavy metals in fish tissues has been conducting under offshore environmental monitoring by Andhra University and submitting the reports along with EC compliance.

Being complied.</td></tr>
<tr><td>4.</td><td>The project proponent should provide barium recovery facilities.</td><td>Not Provided barium recovery facility.

Not complied.</td></tr>
<tr><td>5.</td><td>Only water based drilling mud and cutting having a low toxicity should be used for drilling operation. The drilling fluids should be reused to the maximum extent possible and should be discharged into the ocean only when not suitable for further drilling. Adequate solids control and fluid handling system should be provided to ensure minimum losses to the ocean.</td><td>No drilling activity is being carried out at present.

The project authorities assured to comply.</td></tr>
<tr><td>6.</td><td>Horizontal Direction Drilling (HDD) technique should be adopted during the laying of the export pipeline.</td><td>The Export Pipe line of 20 inch Diameter was laid from onshore terminal to Sea fall point underground with length 1.5 KM and From Sea Fall Point to Single Buoy Mooring (SBM) on sea bed only with length of about 15 KM.

Not applicable.</td></tr>
<tr><td>7.</td><td>The pigging chemicals used for cleaning the interfield pipelines should not be discharged into the ocean but collected after use and returned to the gas and condensate export line. To minimise accidental release / contain oil spill the pigging chemicals should be stored in defined bunded areas.</td><td>No chemicals are being used in the pigging of lines. The material collected during pigging is re-circulated into the process streams. No marine discharge is made during the process of pigging.

Being Complied.</td></tr>
<tr><td>8.</td><td>Release containing pathogens bacteria, viruses and parasites which survive in marine life must be completely precluded by adequate treatment measures on the platform.</td><td>Offshore platforms are unmanned with no accommodation facilities. Only maintenance staff visits the platform when required.

Not applicable.</td></tr>
</table>

S. No.	CONDITIONS	Compliance Status / Remarks by APPCB
9.	The Project Authority must strictly adhere to the regulations made by MARPOL convention 1973 / 1978 for setting limits, for discharge from off-shore oil / gas exploration and production activities.	The facility has been obtaining permission from statutory departments. **Being Complied.**
10.	The Project Authority must perform static sheen test or any other approved test for the drilling fluids and drill cuttings that are discharged into the sea to ensure that there is no discharge of free oil in the sea. Strict compliance with the CPCB discharge standard of 40 ppm oil should be ensured.	No drilling activities carried out at present. The project authorities informed that they regularly analyzed the characteristics of solid waste and discharged after conforming standards into Sea. **Complied.**
11.	The Project Authority must set up adequate number of monitoring stations within an area of 400 M radius around the drilling rigs, processing platforms, the point of discharge of drilling mud and drilling fluids. The monitoring should cover oil and grease in produced water, hydrocarbon in deck drainage etc.	At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra University, Visakhapatnam and last report submitted on 24.04.2018. **Complied.**
12.	The Project Authority must analyse relevant parameters including chemicals, hydrocarbons and heavy metals in water, sediments and their concentration levels in sediments on fauna, flora and fish tissues and should furnish the data to this Ministry.	At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra University, Visakhapatnam and last report submitted on 24.04.2018. **Complied.**
13.	The Project Authority should monitor the population of marine biota including fishes for the effects of these drilling operations preferably within a radius of 7 kms. The recorded data should be furnished once in six months to this Ministry. Any major change observed should be reviewed carefully and necessary preventive measures should be taken immediately.	At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted on 24.04.2018. **Complied.**
14.	The Project Authority must provide ear plugs / muffs as protection measures to the employees at the time of their duty to mitigate the effect of noise.	All the employees are provided with PPEs including hearing protection devices like ear muffs, ear plugs etc., **Complied.**
15.	The Project Authority must prepare a safety audit system and mock rehearsal must be carried out regularly to test the responsiveness.	The project authorities obtained ISO 14001 & OHSAS 18000 standards certificates and carrying mock drills regularly. **Being Complied.**
16.	The Project Authority must establish oil spill control centres at vulnerable area with high pollution potential. The project authorities should upgrade the existing oil spill control capabilities to the maximum extent possible. The project authorities should also create an all weather capability for rescue operation.	Provided with the Following 2000 M Boom Reel, Power packs, 2 Skimmers, Oil Spill Dispersant and others as per Oil Spill Contingency plan for offshore operations of Ravva field. **Complied.**
17.	Adequate infrastructural facilities should be provided near the offshore installations so that booms, skimmers, chemicals dispersants could be deployed immediately in case of oil leakage from the installations. Efforts should be made to curtail the oil slick within 500 meters of the installation and accordingly an action plan and facilities to check the oil slick beyond 500 metres should be provided.	Provided with the Following 2000 M Boom Reel, Power packs, 2 Skimmers, Oil Spill Dispersant and others as per Oil Spill Contingency plan for offshore operations of Ravva field. **Complied.**
18.	Facilities existing with the Coast Guard are also required to be strengthened with respect to deployment of booms, oil skimmers etc. The project proponent may consider to provide necessary funds for strengthening such facilities.	Provided with the Following 2000 M Boom Reel, Power packs, 2 Skimmers, Oil Spill Dispersant and others as per Oil Spill Contingency plan for offshore operations of Ravva field. **Complied.**

S. No.	CONDITIONS	Compliance Status / Remarks by APPCB
19.	A separate Environment Management Cell with suitably qualified technical personnel to carry out various functional related to environmental management should be set up under the control of a senior technical personnel who will directly report to the Chief Executive.	Separate Environment Management Cell is established with competent technical personnel headed by Head – HSEQ and reporting to Chief Executive Officer (CEO) of Cairn Oil & Gas directly. **Complied.**
20.	Adequate fund provision (capital and recurring expenditure) must be made for environmental control measures and upgradation of facilities for major oil spill control and the fund so provided should not be diverted for any other purpose. The fund provision should be clearly reflected in their proposal for financial approvals to the competent authority.	The expenditure incurred for O&M of ETP, and Environmental Monitoring for the last 6 years as follows: 2012-13: 1,82,41,911 INR 2013-14: 1,84,13,482 INR 2014-15: 4,93,67,015 INR 2015-16: 1,64,75,766 INR 2016-17: 3,25,28,350 INR 2017-18: 1,34,02,539 INR **Assured to comply.**
21.	The project would be monitored by Ministry's Regional Office, Bangalore and status report on compliance of conditions stipulated by the MOEF should be submitted to this Ministry and Regional Office, Bangalore every six months for review.	Submitting Half Yearly EC compliance. Submitted Latest on 29.11.2018. **Being Complied.**

ENVIRONMENTAL ENGINEER

Compliance Report

Subject: Ravva Gas Development Project in the Bay of Bengal, Andhra Pradesh Coast by M/s. Cairn Energy India Pvt. Ltd. – Environmental Clearance Reg.

Reference: J-11011/84/2000-IA II dated 30th January 2001.

Present Status of the Project:

This EC is for the drilling, development of facilities both at offshore and onshore for Gas production.

Offshore facilities installed: one offshore platform (RH), laying of interconnecting subsea pipelines between the platforms (RF & RG and RD & RH), RH platform to the onshore terminal. Permission obtained to drill one well. One well (RH2) has been drilled and currently producing gas.

Onshore facilities installed: Gas Handling and Compression Facilities, Gas Dehydration Facilities, Gas Metering and Control.

S. No.	Conditions	Compliance Status / Remarks by APPCB
	Specific Conditions:	
1.	The Schedule for commencement by the drilling operation should be intimated at least one month in advance to the Wildlife Warden having jurisdiction over the nearest coastal area so as to enable him to monitor its impact, if any, as on the wild life.	The project authorities informed that they have intimated to Wildlife Warden, Rajahmundry while drilling was carried out.
2.	Approval from DG Shipping under the Merchant Shipping Act prior to commencement of the drilling operations should be obtained. At least 30 days prior to the commencement of drilling, the exact location should be intimated to the Director General of Shipping, Mumbai and the Company should abide by any direction he may issue with respect to ensuring the safety of navigation in the area.	Certificates for Vessels obtained from Indian Register of Shipping. Intimation had been sent to D.G. Shipping prior to the drilling. **Complied.**
3.	As reflected in the EMP the drilling fluid should be reused/ recycled. As per the norms stipulated under EPA, efforts should be made not to discharge drilling fluid/mud/cuttings into sea. The drill cuttings/mud should be disposed off onshore in a secured landfill site approved by the Andhra Pradesh SPCB. In case disposal on land is not feasible, Ministry hereby grants provisional permission for one-year for disposal of the residual water based drilling fluids and drill cuttings after proper washing into sea subject to following conditions: • The project authority should ensure that only low toxicity chemical additive shall be used for preparation of drilling fluids. • The disposal point should be located at least 5 KM away from the shoreline and ecologically sensitive areas. • At the disposal point, the seabed currents should have a minimum velocity of 60cm/sec and sea depth of 50 meter minimum must be available for proper dilution and dispersion. • The drill cuttings should be discharged intermittently to avoid turbidity and reduction in transmittance. • Company should submit well-wise data on the quantity of water based muds / cuttings used/generated along with slurry volume and properties (particle size distribution etc.) • Company should monitor the sea surface	No drilling activities carried out at present. The project authorities informed that they regularly analyzed the characteristics of solid waste and discharged after conforming standards/guidelines of MoEF&CC into Sea. **Being complied.**

S. No.	Conditions	Compliance Status / Remarks by APPCB
	water quality in terms of oil content around the well and submit reports to the Ministry on a monthly basis during the period of drilling operations.	
4.	The company should monitor the heavy metal concentration in the marine fish species before taking up the drilling activities and subsequently thereafter on a yearly basis.	At present, the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted 24.04.2018. **Complied.**
5.	Even though the proposed site is not part of National Park or wild life sanctuary, it is seen that degraded mangrove forests exists in the region. The company should submit a plan/scheme for mangrove regeneration/compensatory development in consultation with the local Forest/Wildlife office. About 25% of the land acquired for the onshore terminal should be developed as green belt.	Out of 223 acres of land, acquired for onshore Terminal, 78.8 acres green belt developed. **Complied.**
6.	Adequate infrastructural facilities should be provided in offshore installations so that booms skimmers chemical dispersants could be deployed immediately in case of oil leakage from the installations such that the oil slick if any, is contained within 500 meters of the installation and accordingly, action plan and facilities to check the oil slick beyond 500 meters should be provided.	Provided with the following: 2000 M Boom Reel, Power packs, 2 Skimmers, Oil Spill Dispersant and others as per Oil Spill Contingency plan for offshore operations of Ravva field, East Coast of India. **Complied.**
7.	The project proponent shall also comply with the environmental protection measure and safeguards recommended in the EIA/EMP/Risk Analysis report as well as the recommendations of the Public Hearing Panel.	The project authorities obtained ISO 14001 & OHSAS 18000 standards certificates and carrying mock drills regularly. **Being Complied.**
	General Conditions:	
1.	The project authority must strictly adhere to the stipulations made by the Central Government as part of any International Convention(s) or Merchant Shipping Act.	The project authorities have been obtaining permission from time to time as per Merchant Shipping Act. At present, the project authorities obtained permission for Mahananda Ship which is valid upto 17.02.2019, vide certificate dated 22.07.2014. **Being Complied.**
2.	The project authorities must strictly adhere to the stipulations made by the Andhra Pradesh State Pollution Control Board and the State Government.	At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted on 24.04.2018. The in-house laboratory has capability to monitor parameters like O&G, TSS, BOD, COD, pH etc. External approved agency has also been engaged to conduct regular monitoring of ambient air quality, effluent, stack emissions and noise. **Being complied.**
3.	No further expansion or modifications in the proposal should be carried out without prior approval of MoEF. In case of deviations or alterations in the project proposal from those submitted to this Ministry for clearance, a fresh reference should be made to the Ministry to assess the adequacy of conditions imposed and to add additional environmental protection measures required, if any	**The project authorities agreed to comply.**
4.	The project must strictly adhere to the regulations made by MARPOL convention 1973/1978 for setting limits, for discharges from offshore oil/gas exploration and production activities.	The project authorities have been obtaining permission from time to time as per Merchant Shipping Act. At present, the project authorities obtained permission for Mahananda Ship which is valid upto 17.02.2019, vide certificate dated 22.07.2014. **Being Complied.**

S. No.	Conditions	Compliance Status / Remarks by APPCB
5.	The project authorities must strictly comply with the rules and regulations under Manufacture, Storage and Import of Hazardous chemicals Rules, 1989 as amended on 3rd October 1994. Prior approvals from Chief Inspectorate of Factories, Chief Controller of Explosives, Fire Safety Inspectorate etc. must be obtained wherever applicable.	Total Capacity of 1,70,015 Kl. approved by Chief Controller of Explosives vide dated 31.05.2018. **Complied.**
6.	The project authorities must strictly comply with rules and regulations with regard to handling and disposal of hazardous wastes in accordance with the Hazardous Wastes (Management & Handling) Rules, 1989 wherever applicable. Authorization from the State Pollution Control Board must be obtained for collections/treatment/storage/disposal of hazardous wastes.	CFO & HW authorization issued by APPCB is valid upto 31.10.2021. **Complied.**
7.	The overall noise levels in and around the rig area should be kept well within the standards (85 dBA) by providing noise control measures including acoustic hoods, silencers, enclosures etc. on all sources of noise generation. The ambient noise levels should conform to the standards prescribed under EPA rules, 1989 viz. 75 dB(A) (daytime) and 70 dB(A) (night-time).	Noise Monitoring has been conducting in and around onshore facility on monthly basis. **Complied.**
8.	A separate environmental management cell equipped with full fledged laboratory facilities must be set up to carry out the environmental management and monitoring functions.	Separate Environment Management Cell is established with competent technical personnel headed by Head – HSEQ and reporting to Chief Executive Officer (CEO) of Cairn Oil & Gas directly. **Complied.**
9.	The project authorities will provide adequate funds both recurring and non recurring to implement the conditions stipulated by the MoEF as well as the State Government along with the implementation schedule for all the conditions stipulated herein. The funds so provided should not be diverted for any other purpose.	The expenditure incurred for O&M of ETP, and Environmental Monitoring for the last 6 years as follows: 2012-13: 1,82,41,911 INR 2013-14: 1,84,13,482 INR 2014-15: 4,93,67,015 INR 2015-16: 1,64,75,766 INR 2016-17: 3,25,28,350 INR 2017-18: 1,34,02,539 INR **Assured to comply.**
10.	The implementation of the project vis-à-vis environmental action plans will be monitored by Ministry's Regional Office at Bangalore, State Pollution Control Board/ CPCB. Six monthly compliance status report should be submitted to the monitoring agencies.	Submitting Half Yearly EC compliance. Submitted Latest on 29.11.2018. **Being Complied.**
11.	The Project Proponent should inform the public that the project has been accorded environmental clearance by the Ministry and copies of the clearance letter are available with the State Pollution Control Board/Committee and may also be seen at Website of the Ministry and Forests at http:/www.envfor.nic.in. This should be advertised in at least two local newspapers that are widely circulated in the region of which one shall be in the vernacular language of the locality concerned.	Advertised in the local newspapers on 5th February 2001. **Complied.**

ENVIRONMENTAL ENGINEER

Compliance Report

Subject: Exploratory Drilling of 8 wells for oil and gas in the PKGM-1 offshore block in East coast of India in the Bay of Bengal, by M/s. Cairn Energy India Pvt. Limited.

Reference: J-11011/50/2001-IA II dated September 17, 2001.

Present Status of the Project: This project is for oil and gas exploratory drilling of eight (08) nos. of well in offshore. Out of that, seven (07) nos. of exploratory wells have been drilled. Presently, none of these wells are producing. The details are provided as **Appendix-5**

A. Specific Conditions:

S. No.	Conditions	Compliance Status / Remarks by APPCB
i.	The Schedule for commencement by the drilling operation should be intimated at least one month in advance to the Wildlife Warden having jurisdiction over the nearest coastal area so as to enable him to monitor its impact, if any, on the wild life.	The project authorities informed that they have intimated to Wildlife Warden, Rajahmundry while drilling was carried out.
ii.	Approval from DG Shipping under the Merchant Shipping Act prior to commencement of the drilling operations should be obtained. At-least 30 days prior to the commencement of drilling, the exact location should be intimated to the Director General of Shipping, Mumbai and the company should abide by any direction he may issue regarding ensuring the safety of navigation in the area.	Certificates for Vessels obtained from Indian Register of Shipping. Intimation had been sent to D.G. Shipping prior to the drilling. **Complied.**
iii.	Only water based drilling fluids/ mud should be used for the drilling operation. Ministry hereby grants provisional permission for one-year for disposal of the residual water based drilling fluids and drill cuttings after proper washing subject to following conditions.	Recently no drilling activities were undertaken. The project authorities informed that water based mud was used while drilling the initial sections after which synthetic based mud was used. While preparation of mud it was ensured that its properties meet the MoEF&CC requirements specified under G. S. R. 546 (E) notification. **Assured to comply.**
	The water based muds must have low toxicity (i.e 96 LC50 value > 30,000 ppm). The project authority should ensure that only low toxicity chemical additives shall be used for preparation of drilling fluids.	Recently no drilling activities were undertaken. The project authorities informed that water based mud was used while drilling the initial sections after which synthetic based mud was used. While preparation of mud it was ensured that its properties meet the MoEF&CC requirements specified under G. S. R. 546 (E) notification. **Assured to comply.**
	The disposal point should be atleast 5 Km away from the shoreline and ecologically sensitive areas.	The wells drilled had been beyond 5 km distance and thus disposal point was also the same. **Complied.**
	At disposal point, the sea bed currents should have a minimum velocity of 60 Cm/second sea depth of 50 m minimum must be available for proper dilution and dispersion.	The project authorities informed that the turbulence and sea bed currents are reported high in the Bay of Bengal and thus there is proper dilution and dispersion. **Complied.**
	The drill cuttings should be discharged intermittently to avoid turbidity and reduction in transmittance.	The project authorities informed that the during drilling campaign the drill cuttings are separated from the drilling mud mechanically by using shale shakers and centrifuges and then discharged into sea intermittently. **Being complied.**
	Company should submit well-wise data on the quantity of water based muds used/ cuttings generated along the slurry volume and properties.	The project authorities informed that the during the drilling operations daily data was monitored on quantity and type of drilling mud used, quantity of drilling mud generated. **Complied.**

S. No.	Conditions	Compliance Status / Remarks by APPCB
	Company should monitor the sea surface water quality in terms of oil content around the well and submit reports to the Ministry on a monthly basis during the period of drilling operations.	At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted 24.04.2018. **Complied.**
iv.	The Company should monitor the Petroleum hydro carbons and heavy metal concentrations in the marine fish species regularly and submit report to the Ministry	At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted 24.04.2018. **Complied.**
v.	In case the commercial viability of the project is established, the company will prepare a detailed plan for development of oil and gas fields in PKGM -1 in the Bay of Bengal and obtain fresh clearance from Ministry.	Prepared a detailed plan for development of Oil and gas fields and obtained EC for infill well drilling (Development Wells) and obtained EC vide dated 04.08.2005. **Assured to comply.**
vi.	Adequate infrastructural facilities should be provided near the offshore installations, so that booms, skimmers and chemical dispersants could be deployed immediately in case of oil leakage from the installations. Efforts should be made to curtail the oil slick within 500 m of the installation and accordingly, action plan and facilities to check the oil slick beyond 500 m should be provided.	Provided with the following: 2000 M Boom Reel, Power packs, 2 Skimmers, Oil Spill Dispersant and others as per Oil Spill Contingency plan for offshore operations of Ravva field, East Coast of India. **Complied.**
vii.	The project proponent shall also comply with the environmental protection measures and safeguards recommended in the EIA/EMP report as well as the recommendations of the public hearing panel.	The project authorities obtained ISO 14001 & OHSAS 18000 standards certificates and carrying mock drills regularly. **Being Complied.**
General conditions:		
i.	The project authority must strictly adhere to the stipulations made by the Central Government as part of the international conventions and Merchant Shipping Act.	The project authorities have been obtaining permission from time to time as per Merchant Shipping Act. At present, the project authorities obtained permission for Mahananda Ship which is valid upto 17.02.2019, vide certificate dated 22.07.2014. **Being Complied.**
ii.	The project authorities must strictly adhere to the stipulations made by the Andhra Pradesh State Pollution Control Board and the State Government.	At present, the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted 24.04.2018. **Complied.**
iii.	No further expansion or modifications in the plant should be carried out without prior approval of the Ministry of Environment and Forests. In case of deviations or alterations in the project proposal from those submitted to this Ministry for clearance, a fresh reference should be made to the Ministry to assess the adequacy of conditions imposed and to add additional environmental protection measures required if any.	**Agreed to Comply.**
iv.	The project authorities must strictly comply with the rules and regulations under Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 as amended on 3rd October, 1994. Prior approvals from Chief Inspectorate of Factories, Chief Controller of Explosives, Fire Safety Inspectorate etc, must be obtained	Total Capacity of 1,70,015 Kl. approved by Chief Controller of Explosives vide dated 31.05.2018. **Complied.**

S. No.	Conditions	Compliance Status / Remarks by APPCB
	where ever applicable.	
v.	The project authorities must comply with the rules and regulations with regard to handling and disposal of hazardous wastes in accordance with the Hazardous Wastes (Management & Handling) Rules, 1989 wherever applicable. Authorization from the State Pollution Control Board must be obtained for collection/treatment/storage/disposal of hazardous wastes.	CFO & HW authorization issued by APPCB is valid upto 31.10.2021. **Complied.**
vi.	The overall noise levels in and around the rig area should be kept well within the standards (85 dB(A)) by providing noise control measures including acoustic hoods, silencers, enclosures etc on all sources of noise generation. The ambient noise levels should conform to the standards prescribed under EPA Rules, 1989 viz, 75 dB(A) (day time) and 70 dB(A) (night time).	Noise Monitoring has been conducting in and around onshore facility on monthly basis. **Complied.**
vii.	A separate environment management cell equipped with full-fledged laboratory facilities must be set up to carry out the environment monitoring functions.	Separate Environment Management Cell is established with competent technical personnel headed by 1head – HSEQ and reporting to Chief Executive Officer (CEO) of Cairn Oil & Gas directly. **Complied.**
viii.	The project authorities will provide adequate funds both recurring and non-recurring to implement the conditions stipulated by the MOEF as well as the state government along with the implementation schedule for all the conditions stipulated herein. The funds so provided should not be diverted for any other purpose.	The expenditure incurred for O&M of ETP, and Environmental Monitoring for the last 6 years as follows: 2012-13: 1,82,41,911 INR 2013-14: 1,84,13,482 INR 2014-15: 4,93,67,015 INR 2015-16: 1,64,75,766 INR 2016-17: 3,25,28,350 INR 2017-18: 1,34,02,539 INR **Assured to comply.**
ix.	The implementation of the project vis-à-vis environmental action plans will be monitored by Ministry's regional office at Bangalore, State Pollution Control Board and Central Pollution Control board. A six monthly compliance status report should be submitted to the monitoring agencies.	Submitting Half Yearly EC compliance. Submitted Latest on 29.11.2018. **Being Complied.**
x.	The project proponent should inform the public that the project has been accorded environmental clearance by the Ministry and copies of the clearance letter are available with the State Pollution Control Board/Committee and may also be seen at Website of the MOEF at http:/WWW.envfor.nic.in. This should be advertised in at least two local newspapers that are widely circulated in the region of which one shall be in the vernacular language of the locality concerned.	The project authorities informed that the Environmental clearance of the project was advertised in the newspapers. **Complied.**

ENVIRONMENTAL ENGINEER

Appendix-5: Present status of the project in detail

As against eight (08) nos. of Exploratory Drilling wells, seven (07) nos. have been drilled. Details are as below.

Well Name	Easting (m)	Northing (m)	Spud Date
RX-7	636311.50	1826552.50	17-Mar-2002
RX-9	623823.70	1825452.60	20-Jun-2006
RX-10	632111.10	1824289.68	23-Apr-2007
RX-8Z	629477.40	1822578.90	18-Aug-2007
RB-4	627386.10	1821891.93	09-Jan-2008
RX-11	629309.38	1821716.53	13-Nov-2013
RE-6 (RE-North)	623599.53	1818802.07	06-Oct-2014

Compliance Report

Subject: Environmental Clearance for Infill Well Drilling (Development Wells) in Ravva Oil Field (PKGM-1) Block in Kg Offshore Basin, Bay of Bengal, Andhra Pradesh

Reference: J - 11011/207/2004-IA (II) I dated 4th August 2005.

Present Status of the Project:

This EC is for drilling of fifteen (15) nos. of additional infill (development) wells in offshore to sustain the production. All the 15 nos. of in-fill (development) wells as permitted have been drilled in offshore. The details of the same are provided as **Appendix-6**. Out of the fifteen (15) nos. of development wells permitted, currently ten (10) nos. of wells are producing oil and four (04) nos. of wells are functioning as water injectors and one (01) well is shut.

S. No.	Conditions	Compliance Status / Remarks by APPCB
i)	Use of diesel based mud is prohibited. The project authorities should ensure that only water based mud drilling fluid should be used for the proposed off shore drillings. Ministry hereby grants permission for disposal of residual water based drilling fluid and drill cutting after proper washing subject to the following conditions:	Recently no drilling activities were undertaken. The project authorities informed that water based mud was used while drilling the initial sections after which synthetic based mud was used. While preparation of mud it was ensured that its properties meet the MoEF&CC requirements specified under G. S. R. 546 (E) notification. **Assured to comply.**
	The chemical additives used in water based drilling fluid should be biodegradable (mainly organic constituents) and should have toxicity of 96 hr LC50 value >30,000 mg/l as per mysid toxicity or toxicity test conducted on locally available sensitive sea species	No drilling activities carried out at present. The project authorities informed that they regularly analyzed the characteristics of solid waste and discharged after conforming standards/guidelines of MoEF&CC into Sea.
	Thoroughly washed drill cuttings (DC) separated from WBM and unusable portion of WBM having toxicity of 96 hr LC50 >30,000 mg/l shall be discharged off-shore into sea intermittently at an average rate of 50bbl/hr/well from a platform so as to have proper dilution and dispersion without any adverse impact on marine environment.	**Being complied.**
	Drill cuttings of any composition should not be discharged in sensitive areas notified by Ministry of Environment & Forests.	No notified sensitive areas within the PKGM-1 block. **Being complied.**
	Discharge of DC from the installation located within 5 Km away from shore should have no adverse impact on marine eco-system and on the shore. If adverse impact is observed, the company should bring the DC on-shore for disposal in an impervious waste disposal pit.	The project authorities informed that regular monitoring was carried out during the drilling activity and there was no adverse impact. **Being complied.**
	The company should get analysed the drill cuttings generated from each well from any recognized laboratory for its characteristics and results be submitted to MOEF/CPCB/SPCB periodically.	The project informed that during the drilling campaign drill cutting were analyzed by recognized laboratory. **Being complied.**
	M/s ONGC are required to record daily discharge of DC and DF to offshore and also to monitor daily the effluent quality, and submit the compliance report once in every six months to MoEF.	Submitting Half Yearly EC compliance. Submitted Latest on 29.11.2018. **Being Complied.**
	Company should monitor the sea surface water quality in terms of oil content around the well and submit reports to the Ministry on a monthly basis during the period of drilling operations.	At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted 24.04.2018. **Complied.**

S. No.	Conditions	Compliance Status / Remarks by APPCB
	In case DC is associated with high oil content from hydrocarbon bearing formation, then disposal of DC should not have oil content > 10 mg/kg.	The project authorities informed that the drill cuttings are analyzed during the last drilling campaign and oil content was found to be <10mg/kg. **Being complied.**
	The DC wash water should be treated to conform to limits notified under the Environment (Protection) Act, 1986, before disposal into sea. The treated effluent should be monitored regularly.	The project authorities informed that the DC wash water gets collected in the bilge tanks, which are passed through oil water separator before discharge to sea. Drilling is carried out by drilling contractors who own the rigs and OWS is inbuilt in compliance with MARPOL requirements. The OWS is fitted with alarm to ensure that effluent having > 15 ppm oil content is not discharged and informed that they complied during the drilling activity.
	Barite used in preparation of DF shall not contain Hg > 1 mg/kg & Cd > 3 mg/kg.	The project authorities informed that the barite used during drilling fluid preparation does not contain Hg >1mg/kg and Cd >3mg/kg while finalizing the mud programme and informed that they complied during the drilling activity
	Should any, environment friendly technology emerge for substitution of DF and disposal technology, it may be brought to the notice of MoEF and regulatory agencies. If the operator desires to adopt such environment friendly technology prior approval from MoEF shall be taken.	The project authorities informed that till the last drilling campaign conventional drilling technology has been used. **Agreed to comply.**
(ii)	To address the specific operational problems during exploration like stuck pipe, overpressure and hole instability etc. M/S CIL proposes to use Synthetic Base Muds (SBMs). Ministry hereby grants permission for use of the SBMs subject to the following conditions:	The project authorities informed that normally while drilling in the PKGM-1 block biodegradable synthetic based mud of low toxicity was reportedly used. The parameters of the SBM are reportedly in conformity with in the industry specific standard issued by MoEF&CC vide notification G.S.R. 546 (E) and informed that they complied during the drilling activity.
	Well-wise data on quality of SBMs used / wastes including cuttings generated and discharged on a daily basis must be maintained and report submitted to Ministry of Environment & Forests and CPCB.	The project authorities informed that during drilling campaigns data is maintained on quantity of SBM used in each well and informed that they complied during the drilling activity.
	The chemical additives used in the SBMs should have toxicity of 96 hr LC50 value > 30,000 mg/l as per mysid toxicity or toxicity test conducted on locally available sensitive species. The company should ensure that various chemicals used in the proposed SBMs should be bio-degradable in nature.	The project authorities informed that the SBM used in drilling is reportedly biodegradable and less toxic. Bioassay tests conducted for SBM used during the last drilling campaign in 2014 have shown. LC50 values of more than 30,000 mg/l and informed that they complied during the drilling activity.
	Hexavalent chromium compound should not be used in drilling fluid (DF). Alternate chemicals in place of chrome lignosulphonate should be used in the drilling fluids. In case, chrome compound is used the DF/DC should not be disposed offshore. Barite used in the drilling fluid shall not contain Hg > 1 mg/kg and Cd > 3 mg/kg	The project authorities informed that reportedly Hexavalent or any chrome compound is not used in drilling fluid used by Cairn during drilling. The Barite (Barium Sulphate) does not contain Hg > 1mg/l and Cd > 3 mg/kg and informed that they complied during the drilling activity.
	Thoroughly washed drill cuttings separated from SBMs and unusable portion of SBM having toxicity of 96 hr LC50 value >30,000 mg/l shall be discharged offshore into sea intermittently at a rate of 50 bbl/hr/well from a platform so as to have proper dilution and dispersion without any adverse impact on marine environment. SBM should be recycled to the maximum extent.	The project authorities informed that during drilling campaigns the drill cuttings are reportedly separated from drilling mud mechanically by using shale shakers and centrifuges and then discharge to sea intermittently and informed that they complied during the drilling activity.

(iii)	The company should monitor the petroleum hydrocarbons and heavy metals concentration in the marine fish species regularly and submit report to the Ministry.	At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted 24.04.2018. **Complied.**
(iv)	Treated waste water (produced water or formation water or sanitary sewage) should comply with the marine disposal standards (for oil & gas at <40 mg/l) notified under the Environment (Protection) Act, 1986.	The project authorities informed that, reportedly, formation water is not generated during drilling of wells. Wastewater from rig & equipment wash during drilling are routed to bilge and treated at onboard rig oil water separator. **Complied.**
(v)	Requisite infrastructure facilities should be provided near the offshore installations so that booms and skimmers/chemical dispersants could be deployed immediately in case of oil leakage from the installations. Efforts should be made to curtail the oil slick between 500 meters of the installation and accordingly, action plan and facilities to check the oil slick beyond 500 meters should be provided.	Provided with the following: 2000 M Boom Reel, Power packs, 2 Skimmers, Oil Spill Dispersant and others as per Oil Spill Contingency plan for offshore operations of Ravva field, East Coast of India. **Complied.**
(vi)	Approval from DG Shipping under the Merchant Shipping Act prior to commencement of the drilling operations should be obtained. At least 30 days prior to the commencement of drilling, the exact location should be intimated to the Director General of Shipping and the company should abide by any direction he may issue regarding ensuring the safety of navigation in the area.	The project authorities have been obtaining permission from time to time as per Merchant Shipping Act. At present, the project authorities obtained permission for Mahananda Ship which is valid upto 17.02.2019, vide certificate dated 22.07.2014. **Being complied.**
(vii)	The project proponent should also comply with the environmental protection measures and safeguards recommended in the EIA/ EMP /risk analysis report as well as the recommendations of the public hearing panel.	The project authorities obtained ISO 14001 & OHSAS 18000 standards certificates and carrying mock drills regularly. **Being Complied.**
B	**GENERAL CONDITIONS**	
i	The project authority must strictly adhere to the stipulations made by the Central Government as part of the international conventions and Merchant Shipping Act	The project authorities have been obtaining permission from time to time as per Merchant Shipping Act. At present, the project authorities obtained permission for Mahananda Ship which is valid upto 17.02.2019, vide certificate dated 22.07.2014. **Being Complied.**
ii	No further expansion or modifications in the plant should be carried out without prior approval of the Ministry of Environment and Forests. In case of deviations or alterations in the project proposal from those submitted to this Ministry for clearance, a fresh reference should be made to the Ministry to assess the adequacy of conditions imposed and to add additional environmental protection measures required if any	**Agreed to Comply.**
iii	The project authorities must strictly comply with the rules and regulations under Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 as amended on 3rd October 1994. Prior approvals from Chief Inspectorate of Factories, Chief Controller of Explosives, Fire Safety Inspectorate etc, must be obtained where ever applicable	Total Capacity of 1,70,015 KL approved by Chief Controller of Explosives vide dated 31.05.2018. **Complied.**

iv	The project authorities must comply with the rules and regulations with regard to handling and disposal of hazardous wastes in accordance with the Hazardous Wastes (Management & Handling) Rules, 1989 wherever applicable. Authorization from the State Pollution Control Board must be obtained for collection/treatment/storage/disposal of hazardous wastes.	CFO & HW authorization issued by APPCB is valid upto 31.10.2021. **Complied.**
v	The overall noise levels in and around the rig area should be kept well within the standards (85 dBA) by providing noise control measures including acoustic hoods, silencers, enclosures etc on all sources of noise generation. The ambient noise levels should conform to the standards prescribed under EPA Rules, 1989 viz, 75 dBA (day time) and 70 dBA (night time).	Noise Monitoring has been conducting in and around onshore facility on monthly basis. **Complied.**
vi	A separate environment management cell equipped with full fledged laboratory facilities must be set up to carry out the environmental management and monitoring functions.	Separate Environment Management Cell is established with competent technical personnel headed by Head – HSEQ and reporting to Chief Executive Officer (CEO) of Cairn Oil & Gas directly. **Complied.**
vii	The project authorities will provide adequate funds both recurring and non recurring to implement the conditions stipulated by the MOEF as well as the state government along with the implementation schedule for all the conditions stipulated herein. The funds so provided should not be diverted for any other purpose.	The expenditure incurred for O&M of ETP, and Environmental Monitoring for the last 6 years as follows: 2012-13: 1,82,41,911 INR 2013-14: 1,84,13,482 INR 2014-15: 4,93,67,015 INR 2015-16: 1,64,75,766 INR 2016-17: 3,25,28,350 INR 2017-18: 1,34,02,539 INR **Assured to comply.**
viii	The implementation of the project vis-à-vis environmental action plans will be monitored by Ministry's regional office at Bangalore, State Pollution Control Board/ Central Pollution Control board. A six monthly compliance status report should be submitted to the monitoring agencies.	Submitting Half Yearly EC compliance. Submitted Latest on 29.11.2018. **Being Complied.**
ix	The project proponent should inform the public that the project has been accorded environmental clearance by the Ministry and copies of the clearance letter are available with the State Pollution Control Board/Committee and may also be seen at Website of the MOEF at http:/WWW.envfor.nic.in. This should be advertised within seven days from the date of issue of the clearance letter at least in two local newspapers that are widely circulated in the region of which one shall be in the vernacular language of the locality concerned and a copy of the same should be forwarded to the Regional office.	The project authorities informed that the Environmental clearance of the project was advertised in the newspapers. **Complied.**
4	The Ministry or any competent authority may stipulate any further condition(s) on receiving reports from the project authorities. The above conditions will be monitored by the Regional Office of the Ministry located at Bangalore.	**Agreed to comply.**
5	The Ministry may revoke or suspend the clearance if implementation of any of the above conditions is not satisfactory.	**Agreed to comply.**
6	Any other conditions or alteration in the above conditions will have to be implemented by the project authorities in a time bound manner.	**Agreed to comply.**
7	The above conditions will be enforced, inter-alia under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, the Hazardous Waste (Management & Handling) Rules, 2003 and the Public Liability Insurance Act, 1991 along with their amendments and rules.	PLI is valid upto 30.09.2019. **Agreed to comply.**

ENVIRONMENTAL ENGINEER

Appendix-6: Present status of the project in detail

As against 15 Nos. of permitted in-fill wells (Development Wells), 15 nos. have been drilled till date as detailed below.

Platform	Well Name	Easting (m)	Northing (m)	Spud Date
RD	RD-8	621339.19	1815826.95	6/10/2006
	RD-7	621340.94	1815825.46	23/4/2011
	RD-11	621340.48	1815829.37	26/2/2011
	RD-9	621337.45	1815828.44	11/2/2011
	RD-10	621338.91	1815830.74	21/2/2011
RC	RC- 7	620800.84	1813374.23	17/7/2011
	RC- 6	620802.74	1813372.74	3/8/2911
	RC-5	620797.57	1813368.93	18/1/2007
	RC-9	620798.96	1813375.67	19/04/2014
	RC-10	620801.10	1813376.52	09/07/2014
RB	RB-3	627386.94	1821897.81	20/6/2007
RE	RE-4	623603.50	1818797.80	25/3/2007
	RE-5	623605.11	1818800.89	12/08/2014
RF	RF- 7	625663.55	1820447.93	23/4/2011
	RF-6	625654.69	1820446.12	27/5/2007

Compliance Report

Subject: Exploratory drilling in onshore area of PKGM-1 Block located in Chirrayanam village, Uppulaguptam Mandal in East Godavari District

Reference: 10-28/2004-IA-III dated 31st March, 2006.

Present Status of the Project: As against two (02) nos. of permitted exploratory wells, one (01) exploratory well (RX-9) was drilled during July – August, 2006 in Chirrayanam village (Latitude: 16° 30' 27.7" N & Longitude: 82° 09' 36.8" E)

S. No.	Condition	Compliance Status / Remarks by APPCB
i.	It should be ensure that the drilling site will be constructed in such a manner to avoid the any offsite emergencies such as fires and explosions. Though, the drilling pad would occupy and area of approximately 5000 m² (70 m x 70 m), an area of about 2.2 ha (150 m x 150 m) should be made available at each drill site. The rest of the area should serve as buffer zone and should be used for housing containers, drilling pipes, material storages, workshops, etc.	Earmarked 9Acres of land each drill site and provided platform. As against two (02) nos. of permitted exploratory wells, one (01) exploratory well (RX-9) was drilled during July – August, 2006 in Chirrayanam village and proposed 2nd Well drilling activity from March 2019, for which the industry applied for CFE and CFO of the Board. **Assured to comply.**
ii.	Since "blow out" can cause destruction of drilling rig, precautions should be taken to prevent blowouts. All measures indicated in the risk assessment should be implemented.	As against two (02) nos. of permitted exploratory wells, one (01) exploratory well (RX-9) was drilled during July – August, 2006 in Chirrayanam village and proposed 2nd Well drilling activity from March 2019, for which the industry applied for CFE and CFO of the Board. **Assured to comply.**
iii.	Drilling bore wells in the intertidal/ transaction zone for augmenting water supply to the work is not permissible. Proponent should make alternate arrangements.	As against two (02) nos. of permitted exploratory wells, one (01) exploratory well (RX-9) was drilled during July – August, 2006 in Chirrayanam village and proposed 2nd Well drilling activity from March 2019, for which the industry applied for CFE and CFO of the Board. **Assured to comply.**
iv.	Hydro carbon releases should be prevented.	As against two (02) nos. of permitted exploratory wells, one (01) exploratory well (RX-9) was drilled during July – August, 2006 in Chirrayanam village and proposed 2nd Well drilling activity from March 2019, for which the industry applied for CFE and CFO of the Board. **Assured to comply.**
v.	No flare pit to flare hydrocarbon should be located within 500 m from the habitations.	The drill sites are located more than 500mtrs. from the habitation. **Complied.**
vi.	No activity should be carried in mangrove and fish breeding mudflat.	No mangrove and fish breeding mudflat existing at the proposed drill sites. **Complied.**
vii	The discharge of drilling slurries, wastewaters should not be allowed to enter coastal water.	**Agreed to Comply while undertaking the activity.**
viii.	Approval from DG Shipping under the Merchant Shipping Act prior to commencement of the drilling operations should be obtained.	**Not applicable,** as the proposed drilling is onshore activity.
ix.	Use of diesel base mud is prohibited. Only water based drilling fluids / mud should be used for the drilling operation. As reflected in the EMP the drilling fluid should be recycled to a maximum extent. There should be no discharge of drilling fluid/ mud/ cuttings into sea. The unusable drilling fluid and entire drill cuttings should be disposed off onshore in a well designed pit lined with impervious liner. The disposal pit should be provided with leakage collection system. Design details of the waste disposal pit, capping of disposal pit should be approved by the Andhra Pradesh Pollution Control Board. The waste pit after it	Agreed to Comply while undertaking the activity.

S. No.	Condition	Compliance Status / Remarks by APPCB
	is filled up should be covered with impervious liner over which, a thick layer of native soil with slope should be provided.	
x.	The chemical additives used for preparation of drilling fluid (DF) should have low toxicity i.e., 96hr LC50> 30,000 mg/l as per mysid toxicity test conducted on locally available sensitive sea species. The chemicals used (mainly organic constituent) should be bio-degradable.	Agreed to Comply while undertaking the activity.
xi.	Barite used in preparation of DF should not contain Hg > 1mg/kg and Cd>3mg/kg.	Agreed to Comply while undertaking the activity.
xii.	Drilling waste water including drill cutting wash water should be collected in the disposed pit, evaporated and treated and should comply with notified standards for on-shore disposal. The company should get analyzed the drill cuttings generated from each well from any recognized laboratory for its characteristics and results should be submitted to Ministry of Environment & Forests/ CPCB/ Andhra Pradesh Pollution Control Board periodically.	Agreed to Comply while undertaking the activity.
xiii.	The used oil generated from drill site should be collected and sold to registered recyclers having environmentally sound management facility.	Agreed to Comply while undertaking the activity.
xiv.	In case the commercial viability of the project is established, the company will prepare a detailed plan for development of oil and gas fields and obtain fresh clearance from the Ministry.	Agreed to Comply while undertaking the activity.
xv.	Adequate infrastructure facilities should be provided near the offshore installations so that booms, skimmers, chemical dispersants could be deployed immediately in case of oil leakage from the installation. Appropriate Oil Spill Management Plan should be drawn and efforts should be made to curtail the oil slick within 500 meters of the installation and accordingly, action plan and facilities to check the oil slick beyond 500 meters should be provided.	Oil Spill Contingency Plan has already been prepared and submitted to Indian Coast Guard services, Kakinada on 04.10.2016. **Being complied.**
xvi.	No drilling well should be located in mangrove area.	**Complied.**
xvii.	It shall be ensured that during movement of man and material no destruction of mangroves is carried out.	**Complied.**
xviii.	No groundwater from the Coastal Regulation Zone area should be tapped for the project.	Agreed to Comply while undertaking the activity.
xix.	The solid waste generated during the drilling process and from the equipment should be disposed of safely in consultation with Andhra Pradesh State Pollution Control Board.	Agreed to Comply while undertaking the activity.
xx.	The solid waste generated from the drill cutting, solar evaporated drilling mud sediments should be disposed off in the TSDF facility approved by the Andhra Pradesh Board.	Agreed to Comply while undertaking the activity.
xxi.	No camp sites for labours should be set up in Coastal Regulation Zone area. The toilets to be constructed in Coastal Regulation Zone area should have septic tank and soak pit.	Agreed to Comply while undertaking the activity.
xxii.	The wastewater generated from the project shall be treated and disposed of as per the norms laid down by Andhra Pradesh State Pollution Control Board.	Agreed to Comply while undertaking the activity.
xxiii.	Oil blow out preventing device to be provided against the hazard of oil blow out.	Agreed to Comply while undertaking the activity.
xxiv.	Hydrocarbon leak due to loss of containment to be checked and prevented.	Agreed to Comply while undertaking the activity.
xxv.	The project proposed shall also comply with the environmental protection measures and safeguards recommended in the EIA/EMP/DMP report.	Agreed to Comply while undertaking the activity.
B	**GENRAL CONDITIONS:**	
i.	The Project authority must strictly adhere to the stipulations made by the Central Government as part of any International Convention (s) or Merchant Shipping Act.	Agreed to Comply while undertaking the activity.

S. No.	Condition	Compliance Status / Remarks by APPCB
ii.	The project authorities must strictly adhere to the stipulations made by the Andhra Pradesh State Pollution Control Board and the State Government.	Agreed to Comply while undertaking the activity.
iii.	No further expansion or modifications in the plant should be carried out without prior approval of the Ministry of Environment & Forests. In case of deviations or alterations in the project proposal from those submitted to this Ministry for clearance, a fresh reference should be made to the Ministry to assess the adequacy of conditions imposed and to add additional environmental protection measures required, if any.	Agreed to Comply.
iv.	The project must strictly adhere to the regulations made by MARPOL convention 1973/1978 for setting limits, for discharges from offshore oil/gas exploration and production activities.	**Not applicable,** as the proposed drilling is onshore activity.
v.	The project authorities must strictly comply with the rules and regulations under: - Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 as amended on 3rd October 1994. Prior approvals from Chief Inspectorate of Factories, Chief Controller of Explosives, Fire Safety Inspectorate etc. must be obtained wherever applicable.	Agreed to Comply while undertaking the activity.
vi.	The project authorities must strictly comply with the rules and regulations with regard to handling and disposal of hazardous waste (Management & Handling) Rules, 1989/2003 Wherever applicable. Authorization from the State Pollution Control Board must be obtained for collections/treatment/storage/disposal of hazardous wastes.	Agreed to Comply while undertaking the activity.
vii.	The overall noise level in and around the rig area should be kept well within the standards (85 dBA) by providing noise control measures including acoustic hoods, silencers, enclosures etc. On all sources of noise generation. The ambient noise levels should conform to all the standards prescribed under EPA RULES, 1989 viz. 75 dBA (day time) and 70 dBA (night time).	Agreed to Comply while undertaking the activity.
viii.	A separate environmental management cell equipped with full fledged laboratory facilities must be set up to carry out the environmental management and monitoring functions.	Complied.
ix.	The project authorities will provide adequate funds both recurring and non-recurring to implement the conditions stipulated by the Ministry of Environment & Forests as well as the State Government along with the implementation schedule for all the conditions stipulated herein. The funds so provided should not be diverted for other purpose.	The expenditure incurred for O&M of ETP, and Environmental Monitoring for the last 6 years as follows: 2012-13: 1,82,41,911 INR 2013-14: 1,84,13,482 INR 2014-15: 4,93,67,015 INR 2015-16: 1,64,75,766 INR 2016-17: 3,25,28,350 INR 2017-18: 1,34,02,539 INR **Assured to comply.**
x.	The implementation of the project vis-à-vis environmental action plans will be monitored by Ministry's Regional Office at Bhopal/State Pollution Control Board / Central Pollution Control Board. A six monthly compliance status report should be submitted to the monitoring agencies.	Submitting Half Yearly EC compliance. Submitted Latest on 29.11.2018. **Being Complied.**
xi.	The Project Proponent should inform the public that the project has been accorded environmental clearance by the Ministry and copies of the clearance letter are available with the State Pollution Control Board/ Committee and may also be seen at Website of the Ministry and Forests. This should be advertised within seven days from the date of issue of the clearance letter in at least two local newspapers that we are widely circulated in the region of which one shall be in the vernacular language of the locality concerned.	**Complied.**

S. No.	Condition	Compliance Status / Remarks by APPCB
xii.	The Ministry may revoke or suspend the clearance, if implementation of any of the above conditions is not satisfactory.	**Agreed to comply.**
xiii.	The Ministry reserves the right to stipulated additional conditions if found necessary. The company will implement these conditions in a time bound manner.	**Agreed to comply.**

ENVIRONMENTAL ENGINEER

Compliance Report

Subject: Oil and Gas Development in existing Ravva Off-shore Field, PKGM-1 Block, located off Surasniyanam (S.Yanam) in the Bay of Bengal, East Godhavari District, Andhra Pradesh by M/s. Cairn India Limited – Environmental Clearance reg.

Reference: J-11011/81/2013-IA II (I) dated 23rd February, 2015.

Present Status of the Project: No activities under the scope of this EC were undertaken till date in the block.

S. No.	Conditions	Compliance / Remarks by APPCB
	Specific Conditions	
i.	All the specific conditions and general conditions specified in the environmental clearance letter accorded vide Ministry's letter nos. J-11011/6/1991-IA dated 19th December, 1990 and J-11011/6/91-IA dated 19th December, 1991, J-11011/50/2001-IA dated 17th September, 2001 and J-11011/207/2004-IA II (I) dated 4th August, 2005 shall be implemented.	Compliance status of all the specific conditions is submitted as enclosure for each ECs issued
ii.	Only high efficiency DG set with adequate stack height and modern emission control equipment and low sulphur clean diesel shall be used. Acoustic enclosure shall be provided to the DG sets to mitigate the noise pollution.	At present the industry has one number of DG set capacity 1010 KVA (equivalent to 800 kW) and provided acoustic enclosures for control of noise pollution and provided stack of adequate height (10 m).
iii.	CRZ clearance shall be obtained.	Complied. CRZ Clearance has been granted by MoEF&CC, vide Letter No. 11-20/2015-IA.II dated May 25, 2017.
iv.	Gas produced during testing shall be flared with appropriate flaring booms.	Agreed to comply by the proponent during their testing activity
v.	The flare system shall be designed as per good oil field practices and Oil Industry Safety Directorate (OISD) guidelines. The stack height shall be provided as per the regulatory requirements and emissions from stacks will meet the MOEF/CPCB guidelines.	Agreed to comply by the proponent during their activity
vi.	Total water requirement shall not exceed 85m^3/day (45m^3/day fresh water + 40m^3/day seawater) and prior permission shall be obtained from the Competent Authority for the drawl of water. Only water based mud system shall be used.	Agreed to comply by the proponent during their activity
vii.	Water based drilling mud shall be discharged to the sea after proper dilution as per E(P) Rules vide G.S.R 546(E) dated 30th August, 2005.	Agreed to comply by the proponent during their activity
viii.	The Company shall ensure that there shall be no impact on flora fauna due to drilling of wells in the offshore sea. The company shall undertake conservation measures to protect the marine animals/biota in the region. The company shall monitor the petroleum hydrocarbons and heavy metals concentration in the marine fish species regularly and submit report to the Ministry.	Agreed to comply by the proponent during their activity
ix.	Treated wastewater (produced water or formation water) shall comply with the marine disposal standards notified under the Environment (Protection) Act, 1986. Sewage treatment on board of the rig as per MARPOL regulation. Residual chlorine shall not exceed 1 mg/l before disposal. Standards for injection produced water into confined hydrocarbon reservoir structure at more than 1000 m with oil in water content of less than 10 ppm shall be complied.	Agreed to comply by the proponent during their activity
x.	The drill cutting (DC) wash water shall be treated to conform to limits notified under the Environment (Protection) Act, 1986, before disposal into sea. The treated effluent shall be monitored regularly.	Agreed to comply by the proponent during their activity
xi.	All the guidelines shall be followed for the disposal of solid waste, drill cutting and drilling fluids for onshore and offshore drilling operation notified vide GSR 546 (E) dated 30th August, 2005. Different types of wastes shall be kept segregated.	Agreed to comply by the proponent during their activity

S. No.	Conditions	Compliance / Remarks by APPCB
xii.	High efficiency equipment shall be used to separate solids, hydrocarbons and water such as shale shakers with improved capacity to filter smaller solids, low shear pumps for use in produced water shall be employed.	Agreed to comply by the proponent during their activity
xiii.	Good book keeping practices shall be put in place to manage wastes such as waste tracking program i.e. identify where and when the waste generated, the type of waste and its volume, the disposal method and its location, and the personnel responsible for the waste management.	Agreed to comply by the proponent during their activity
xiv.	A waste minimization plan shall be developed and followed through proper inventory management following best practices in drilling operations, good housekeeping practices and optimized equipment maintenance schedules.	Agreed to comply by the proponent during their activity
xv.	Only essential rig personnel shall be on board the rig. Emergency Response Plan and health, safety and environment (HSE) system shall be installed. Geo- hazard and geotechnical studies shall be carried out to ensure safe drilling operations.	Agreed to comply by the proponent during their activity
xvi.	All the hazardous waste generated at the rig/offshore facility shall be properly treated, transported to on shore and disposed of in accordance with the Hazardous Waste (Management, Handling and Transboundary Movement) Rules 2008. No waste oil shall be disposed off into sea. Waste/used oil shall be brought on-shore and sold to MOEF/CPCB authorized recyclers/re-processors only.	Agreed to comply by the proponent during their activity
xvii.	Requisite infrastructure facilities shall be provided near the offshore installations so that booms and skimmers/ chemical dispersants could be deployed immediately in case of oil leakage from the installations. Efforts shall be made to curtail the oil slick within 500 meters of the installation and accordingly, action plan and facilities to check the oil slick within 500 meters shall be provided.	Oil Spill Contingency Plan has already been prepared and submitted to Indian Coast Guard services, Kakinada on 04.10.2016
xviii	Approval from DG Shipping under the Merchant Shipping Act prior to commencement of the drilling operations shall be obtained. At least 30 days prior to the commencement of drilling, the exact location shall be intimated to the Director General of Shipping and the Company shall abide by any direction he may issue regarding ensuring the safety of navigation in the area.	Agreed to comply by the proponent during their activity
xix.	The International 'Good Practices' adopted by the Petroleum Industry viz International norms to safeguard the coastal and marine biodiversity shall be implemented by the company.	Agreed to comply by the proponent during their activity
xx.	The Company shall take necessary measures to reduce noise levels such as proper casing at the drill site and meet DG set norms notified by the MOEF. Height of all the stacks/vents shall be provided as per the CPCB guidelines.	Agreed to comply by the proponent during their activity
xxi.	The design, material of construction, assembly, inspection, testing and safety aspects of operation and maintenance of pipeline and transporting the natural gas/oil shall be governed by ASME/ANSI B 31.8/B31.4 and OISD standard 141.	Agreed to comply by the proponent during their activity
xxii.	The project proponent shall also comply with the environmental protection measures and safeguards recommended in the EIA /EMP/RA/NIO report.	Agreed to comply by the proponent during their activity
xxxiii.	Full drawings and details of Blow Out Preventor to encounter well kick due to high formation pressure, if encountered, shall be submitted to the Ministry's Regional Office within 3 months of the issue of environment clearance.	Agreed to comply by the proponent during their activity
xxiv.	On completion of activities, the well shall be either plugged and suspended (if the well evaluation indicates commercial quantities of hydrocarbon) or killed and permanently abandoned with mechanical plugs and well cap. If well is suspended, it shall be filled with a brine solution containing small quantities of inhibitors to protect the well. The position at the end of the activities shall be communicated in detail to the Ministry indicating the steps taken i.e. whether all the wells are plugged or abandoned and necessary precautions taken.	Agreed to comply by the proponent after completion of their activity

xxv.	A brief report on environmental status & safety related information generated and measures taken as well as frequency of such reporting to the higher Authority shall be submitted to this Ministry and its respective Regional Office at Bangalore.	Submitting Half Yearly EC compliance. Submitted Latest on 29.11.2018.
xxvi.	Petroleum and Natural Gas (Safety in Offshore Operations) Rules 2008 of OISD shall be strictly adhered to.	Agreed to comply by the proponent during their activity
xxvii.	Recommendations mentioned in the Risk Assessment & Consequence Analysis and Disaster Management Plan shall be followed.	Agreed to comply by the proponent during their activity
xxviii.	Adequate funds both recurring and non-recurring shall be earmarked to implement the conditions stipulated by the Ministry of Environment and Forests as well as the State Government along with the implementation schedule for all the conditions stipulated herein. The funds so provided shall not be diverted for any other purposes.	Agreed to comply by the proponent during their activity
xxix.	Petroleum and Natural Gas (safety in Offshore Operations) Rules 2008 of OISD shall be strictly adhered to.	Agreed to comply by the proponent during their activity
xxx.	All commitment made during public hearing /public consultation should be satisfactorily complied. As being done in existing facility, tripartite implementation program between the PP, District administration and Local Panchyat should be accomplished and adequate fund to fulfill public grievance should be kept in the budgetary provision of the company.	Agreed to comply during the implementation of the project.
xxxi.	Concrete plan of action for Enterprise Social Responsibility consisting 5 % of project cost shall be prepared in consultation with the District Authority and the local people and a mechanism for it monitoring should be worked out. Action plan shall be submitted to MoEF's RO Office for monitoring.	Agreed to comply during the implementation of the project.
xxxii.	On completion of drilling, the company has to plug the drilled wells safely and obtain certificate from environment safety angle from the concerned authority.	Agreed to comply by the proponent after completion of their activity
	General Conditions	
i.	The project authorities must strictly adhere to the stipulations made by the Andhra Pradesh Pollution Control Board (APPCB), State Government and any other statutory authority.	Agreed to comply before implementation of the project. Proponent has yet to obtain permission from the APPCB (CFE & CFO)
ii.	No further expansion or modifications in the plant shall be carried out without prior approval of the Ministry of Environment and Forests. In case of deviations or alterations in the project proposal from those submitted to this Ministry for clearance, a fresh reference shall be made to the Ministry to assess the adequacy of conditions imposed and to add additional environmental protection measures required, if any.	Agreed to comply by the proponent during their activity
iii.	The National Ambient Air Quality Emission Standards issued by the Ministry vide G.S.R.No. 826(E) dated 16th November, 2009 shall be followed.	The existing industry has installed one CAAQM station and which is yet to be connected to PCB server.
iv.	The locations of ambient air quality monitoring stations shall be decided in consultation with the State Pollution Control Board (SPCB) and it shall be ensured that at least one stations is installed in the upwind and downwind direction as well as where maximum ground level concentrations are anticipated.	Installed the CAAQM station towards Eastern direction i.e., towards nearby village S. Yanam, which located about 1 KM.
v.	The overall noise levels in and around the plant area shall be kept well within the standards by providing noise control measures including acoustic hoods, silencers, enclosures etc. on all sources of noise generation. The ambient noise levels shall conform to the standards prescribed under Environment (Protection) Act, 1986 Rules, 1989 viz. 75 dBA (day time) and 70 dBA (night time).	At present the industry has one number of DG set capacity 1010 KVA (equivalent to 800 kW) and provided acoustic enclosures for control of noise pollution and provided stack of adequate height (10 m).
vi.	The Company shall harvest rainwater from the roof tops of the buildings and storm water drains to recharge the ground water and use the same water for the process activities of the project to conserve fresh water.	Provided RWH in the premises at Onshore Terminal

vii.	Training shall be imparted to all employees on safety and health aspects of chemicals handling. Pre-employment and routine periodical medical examinations for all employees shall be undertaken on regular basis. Training to all employees on handling of chemicals shall be imparted.	Complied.
viii.	The company shall also comply with all the environmental protection measures and safeguards proposed in the documents submitted to the Ministry. All the recommendations made in the EIA/EMP in respect of environmental management, risk mitigation measures and public hearing relating to the project shall be implemented.	Agreed to comply by the proponent during their activity
ix.	The company shall undertake all relevant measures for improving the socio-economic conditions of the surrounding area. CSR activities shall be undertaken by involving local villages and administration.	Complying. At present the facility has been allocating about INR 6 crores under CSR for developmental activities involving local villagers and District Administration.
x.	The company shall undertake eco-developmental measures including community welfare measures in the project area for the overall improvement of the environment.	Agreed to comply by the proponent during their activity
xi.	A separate Environmental Management Cell equipped with full-fledged laboratory facilities shall be set up to carry out the Environmental Management and Monitoring functions.	Complied.
xii.	The company shall earmark sufficient funds towards capital cost and recurring cost per annum to implement the conditions stipulated by the Ministry of Environment and Forests as well as the State Government along with the implementation schedule for all the conditions stipulated herein. The funds so earmarked for environment management /pollution control measures shall not be diverted for any other purpose.	Agreed to comply by the proponent during their activity
xiii.	A copy of the clearance letter shall be sent by the project proponent to concerned Panchayat, Zila Parisad/Municipal Corporation, Urban local Body and the local NGO, if any, from whom suggestions/ representations, if any, were received while processing the proposal.	Complied.
xiv.	The project proponent shall also submit six monthly reports on the status of compliance of the stipulated Environmental Clearance conditions including results of monitored data (both in hard copies as well as by e-mail) to the respective Regional Office of MoEF, the respective Zonal Office of CPCB and APPCB. A copy of Environmental Clearance and six monthly compliance status report shall be posted on the website of the company.	Submitting Half Yearly EC compliance. Submitted Latest on 29.11.2018.
xv.	The environmental statement for each financial year ending 31st March in Form-V as is mandated shall be submitted to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be put on the website of the company along with the status of compliance of environmental clearance conditions and shall also be sent to the respective Regional Offices of MoEF by e-mail.	Submitted Latest on 05.09.2018.
xvi.	The project proponent shall inform the public that the project has been accorded environmental clearance by the Ministry and copies of the clearance letter are available with the SPCB/Committee and may also be seen at Website of the Ministry at www.moef.nic.in. This shall be advertised within seven days from the date of issue of the clearance letter, at least in two local newspapers that are widely circulated in the region of which one shall be in the vernacular language of the locality concerned and a copy of the same shall be forwarded to the concerned Regional Office of the Ministry.	Complied.
xvii.	The project authorities shall inform the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities and the date of start of the project.	Agreed to comply by the proponent during their activity

ENVIRONMENTAL ENGINEER

Compliance Report

Subject: CRZ Clearance for Expansion of Oil & Gas Development facilities in existing Ravva Off-shore Field, PKGM-1 Block, off Surasniyanam in Bay of Bengal, East Godhavari District, Andhra Pradesh

Reference:F. No. 11-20/2015-IA.III dated 25th May, 2017.

Present Status of the Project: No activities under the scope of this CRZ Clearance were undertaken till date in the block.

#.	Conditions	Compliance / Remarks by APPCB
	A. Specific Conditions	
i.	All the terms and conditions stipulated by the APCZMA in their letterNo.4751/ENV/CZMA/2014dated06.08.2014,shallbestrictl ycomplied with and the status of implementation shall be submitted to all concerned agencies including regional office of the Ministry of Environment, Forest and Climate Change.	Agreed to Comply. The facility has been submitting compliance Half yearly. Submitted latest on 29.11.2018
ii.	The project/ activity shall be carried out strictly be in accordance with the provisions of CRZ Notification, 2011, and shall endeavour to render the coastal ecology of the area including flora and fauna to its original state after completion of the project.	The Project Proponent Agreed to comply while undertaking the activity.
iii.	The project proponent shall ensure that no piling work is undertaken during migratory season of turtles; Project proponent shall develop Sea Turtle Conservation Plan and implementation strategy with special focus on Sacramento Island in consultation with Wildlife Institute of India and Andhra Pradesh Forest Department.	The Project Proponent Agreed to comply while undertaking the activity.
iv.	The project proponent shall ensure compliance to the National Oil Spill Disaster Contingency Plan (NOSDCP) and fulfill the responsibilities as vested therein. A local plan based on NOSDCP shall be prepared by the proponent to mitigate and manage the risk of oil spillage.	Oil Spill Contingency Plan has already been prepared and submitted to Indian Coast Guard services, Kakinada on 04.10.2016
v.	The project proponent shall deposit 2% of the cost of the project (proportional to construction of platform and cost of oil and gas producing wells found after exploratory work) for conservation of coastal and marine biodiversity in the states of Andhra Pradesh. Government of Andhra Pradesh shall establish an independent Marine and Coastal Biodiversity Foundation where this 2% contribution is to be deposited as a corpus fund and its interest shall be used to undertake activities specific to marine and coastal biodiversity conservation. Guidelines to establishment of the Marine and Coastal Biodiversity Foundation can be followed based on the guidelines of Mangrove Foundation of Maharashtra. The project proponent shall follow up with the State Government in this regard and ensure that the Foundation is established during the development of the project itself.	The Project Proponent Agreed to comply while undertaking the activity.
vi.	There shall be no disposal of solid or liquid wastes on the coastal area. Solid waste management shall be as per Solid Wastes Management Rules, 2016. A team comprising of members of the EAC and others with expertise in the subject may visit the project site periodically during the construction phase to supervise and suggest additional measures if desired.	The Project Proponent Agreed to comply while undertaking the activity.
vii.	The project proponent shall ensure that monitoring of hydrocarbons & temperature is regularly carried out through an independent institute like IIT, Chennai, Andhra University or other accredited institutes in addition to in-house monitoring. The monitoring reports shall be submitted to the concerned department in the State Government and the regional office of the Ministry.	Complied. At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted on 24.04.2018.
viii.	The project proponent shall ensure that marker buoy and light indicators are established close to the route of the pipeline to avoid damage to the fishing nets (if any) and shall ensure that round the clock surveillance around the RC Platform is carried out to avoid any damage to the local fishing vessels.	The Project Proponent Agreed to comply while undertaking the activity.

ix.	The project proponent shall undertake post-project monitoring of estuarine and coastal waters at regular intervals and follow internationally acceptable protocols while dealing with marine biological aspects. The monitoring reports shall be submitted to the concerned department in the State Government and the regional office of the Ministry.	The Project Proponent Agreed to comply while undertaking the activity.
x.	The guidelines issued by the CPCB for extraction of oil and gas shall be strictly followed. The drill cuttings and drilling fluids for offshore installations should confine to the guidelines issued by CPCB/ APPCB.	The Project Proponent Agreed to comply while undertaking the activity.
B	**General Conditions**	
i.	Adequate provision for infrastructure facilities including water supply, fuel and sanitation must be ensured for construction workers during the construction phase of the project to avoid any damage to the environment.	The Project Proponent Agreed to comply while undertaking the activity.
ii.	Full support shall be extended by the project proponent to the officers of this Ministry/ Regional Office of the Ministry, during inspection of the project for monitoring purposes by furnishing full details and action plan including action taken reports in respect of mitigation measures and other environmental protection activities.	The Project Proponent Agreed to comply while undertaking the activity.
iii.	A six-monthly monitoring report shall need to be submitted by the project proponents to the Regional Office of this Ministry regarding the implementation of the stipulated conditions.	Submitting Half Yearly EC compliance. Submitted Latest on 29.11.2018.
iv.	The Ministry of Environment, Forest & Climate Change or any other competent authority may stipulate any additional conditions or modify the existing ones, if necessary in the interest of environment and the same shall be complied with.	The Project Proponent Agreed to comply while undertaking the activity.
v.	The Ministry reserves the right to revoke this clearance if any of the conditions stipulated are not complied with to the satisfaction of the Ministry.	The Project Proponent Agreed to comply while undertaking the activity.
vi.	In the event of a change in project profile or change in the implementation agency, a fresh reference shall be made to the Ministry.	The Project Proponent Agreed to comply while undertaking the activity.
vii.	The project proponents shall inform the Regional Office of the Ministry, the date of financial closure and final approval of the project by the concerned authorities and the date of start of land development work.	The Project Proponent Agreed to comply while undertaking the activity.
viii.	A copy of the CRZ Clearance letter shall also be displayed on the website of the concerned State Pollution Control Board. The Clearance letter shall also be displayed at the Regional Office, District Industries Centre and Collector's Office/ Tehsildar's Office for 30 days.	Complied.
5.	The above stipulations would be enforced among others under the provisions of Water (Prevention and Control of Pollution) Act 1974, the Air (Prevention and Control of Pollution) Act 1981, the Environment (Protection) Act, 1986, the Public Liability (Insurance) Act, 1991 and EIA Notification 1994, including the amendments and rules made thereafter.	The Project Proponent Agreed to comply while undertaking the activity.
6.	All other statutory clearances such as the approvals for storage of diesel from Chief Controller of Explosives, Fire Department, Civil Aviation Department, and clearances under the Forest Conservation Act, 1980 and Wildlife (Protection) Act, 1972 etc. shall be obtained, as applicable by project proponents from the respective competent authorities.	The Project Proponent Agreed to comply while undertaking the activity.
7.	The project proponent shall advertise in at least two local Newspapers widely circulated in the region, one of which shall be in the vernacular language informing that the project has been accorded CRZ Clearance and copies of clearance letters are available with the State Pollution Control Board and may also be seen on the website of the Ministry of Environment, Forest & Climate Change at The advertisement should be made within Seven days from the date of receipt of the Clearance letter and a copy of the same should be forwarded to the Regional office of this Ministry at Chennai.	Complied. A public notice has been published in the following newspapers: Eenadu (Telugu), East Godavari Dist. Edition– dtd. 02-06-2017. The Hindu (English), East Godavari Dist. Edition–dtd. 02-06-2017.
8.	This Clearance is subject to final order of the Hon'ble Supreme Court of India in the matter of Goa Foundation Vs. Union of India in Writ Petition (Civil) No.460 of 2004, as may be applicable to this project.	The Project Proponent Agreed to comply while undertaking the activity.

9.	Any appeal against this clearance shall be with the National Green Tribunal, if preferred, within a period of 30 days as prescribed under Section 16 of the National Green Tribunal Act, 2010.	The Project Proponent Agreed to comply while undertaking the activity.
10.	Status of compliance to the various stipulated environmental conditions and environmental safeguards will be uploaded by the project proponent on its website.	Being Complied.
11.	A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, ZillaParishad/ Municipal Corporation, Urban Local Body and the Local NGO, if any, from whom suggestions/representations, if any, were received while processing the proposal. The clearance letter shall also be put on the website of the company by the proponent.	The Project Proponent Agreed to comply while undertaking the activity.
12.	The proponent shall upload the status of compliance of the stipulated EC conditions, including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of the Ministry, the respective Zonal Office of CPCB and the SPCB.	The Project Proponent Agreed to comply while undertaking the activity.
13.	The project proponent shall also submit six monthly reports on the status of compliance of the stipulated EC conditions including results of monitored data (both in hard copies as well as by e-mail) to the respective Regional Office of MoEF&CC, the respective Zonal Office of CPCB and the SPCB.	Being Complied.
14.	The environmental statement for each financial year ending 31st March in Form-V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be put on the website of the company along with the status of compliance of EC conditions and shall also be sent to the respective Regional Offices of the Ministry by e-mail.	Submitting regularly.

ENVIRONMENTAL ENGINEER

Appendix-9:

Compliance to the NOC (No Objection Certificate) issued by APCZMA (Reference LetterNo.4751/ENV/CZMA/2014dated06.08.2014)

#.	Conditions	Compliance / Remarks by APPCB
1.	The proposed installation shall conform to the norms prescribed in the CRZ Notification, 2011 issued by the Ministry of Environment and Forests, Government of India S. 0. No. 19(E), dated 06-01-2011.	Agreed to comply.
2.	Regular monitoring of treated waste water discharged into the sea shall be taken up to study the impact on marine organism.	The Project Proponent Agreed to comply while undertaking the activity.
3.	The monitoring of hydrocarbons & temperature shall be entrusted to an independent agency like Andhra University and other accredited institutions in addition to in-house monitoring.	Complied. At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted 24.04.2018.
4.	Marker buoy and light indicators shall be established close to the route of the pipeline to avoid damage to the fishing nets. Round the clock surveillance around the RC Platform shall be maintained to avoid any damage to the local fishing vessels.	The Project Proponent Agreed to comply while undertaking the activity.
5.	The industry shall undertake large-scale afforestation measures in surrounding areas and available waste lands along the coast which is devoid of tree growth particularly near Surasainayanam Village and areas in the vicinity, where the denudation has been rather intensive.	The Project Proponent Agreed to comply while undertaking the activity.
6.	The industry shall supplement the activities of the Forest and Wildlife Department in conservation of Coringa Wetland Eco-system including mangroves.	The Project Proponent Agreed to comply while undertaking the activity.
7.	The nearby coastal waters are known to support rich and diverse biotic communities, where some of the best fishing grounds of the east coast exist. The industry shall undertake post-project monitoring of estuarine and coastal waters and the industry is advised to follow internationally acceptable protocols while dealing with marine biological aspects.	The Project Proponent Agreed to comply while undertaking the activity.
8.	The industry shall follow international codes and standards for laying the submarine pipelines.	The Project Proponent Agreed to comply while undertaking the activity.
9.	Adequate safety measures shall be incorporated to avoid any possible accidents due to structural failures and to prevent blow outs of Natural Gas / Hydrocarbons.	The Project Proponent Agreed to comply while undertaking the activity.
10.	There shall not be any obstruction to fishing activity beyond 500m exclusive drilling zone.	The Project Proponent Agreed to comply while undertaking the activity.
11.	Bio-assay analysis shall be conducted periodically to establish the toxicity levels. Fish tissue analysis of local fish species shall be conducted to evaluate the bio-accumulation of hydrocarbons and heavy metals.	Complied. At present the Facility has been monitoring through the Marine Biological Laboratory, Andhra university, Visakhapatnam and last report submitted 24.04.2p1-4018.
12.	The guidelines issued by the CPCB for extraction of oil and gas shall be followed. The drill cuttings and drilling fluids for offshore installations should confine to the guidelines issued by CPCB/ APPCB.	The Project Proponent Agreed to comply while undertaking the activity.
13.	Solid waste generated during drilling operations shall be in accordance with the guidelines stipulated under Environment (Protection) Third Amendment Rules, 2005 notified vide Notification No. GSR 546(E), dated 30-08-2005.	The Project Proponent Agreed to comply while undertaking the activity.
14.	Effluent generated from the drilling operations shall be disposed after treatment and preferably re-used subject to its suitability.	The Project Proponent Agreed to comply while undertaking the activity.
15.	The conditions stipulated in Petroleum and Natural Gas (Safety in Offshore operations) Rules, 2008 shall be followed scrupulously.	Being Complied.

ENVIRONMENTAL ENGINEER

Annex 12

Report against Compliance to the Conditions stated in the Consent for Operation (CFO) and the Hazardous Waste (HW) Authorisation Order submitted to APPCB on 25 Jan. 2018

RV/18/IM/APPCB/13

25th January 2018

To,
The Environmental Engineer,
Andhra Pradesh Pollution Control Board,
Regional Office,
2-532, Shanti nagar,
Ramanayyapet, Kakinada

Sub: Compliance Report to Consent & Authorization Order

Ref: Consent Order No. APPCB/VSY/RJY/546/CFO/HO/2016 valid up to 31.10.2021 and Amendment Consent Order No. APPCB/VSY/RJY/546/CFO/HO/2017-233

Sir,

Please find attached condition wise compliance report of conditions stipulated in Schedule B & C of above mentioned Consent & Authorization Order for your information and records.

Thanking you,

Regards

Muthukumarasamy D

Installation Manager
Ravva Operations
Vedanta Limited, Cairn Oil & Gas

Copy to: The Senior Environmental Engineer, APPCB, Hyderabad

Encl.: as above

CFO compliance status – six monthly submission for July 2017 to December 2017

No	Conditions stipulated in Consent & Authorization Order	Compliance Status
1	**All other conditions mentioned in schedule A,B&C of the combined CFO &HWA order issued by the board vide order APPCB/VSP/RJY/546/CFO/HO/2016 dated 22.07.2016 will remain the same**	**For information**
2	**The industry shall comply with the standards issued by MoEF &CC/CPCB from time to time**	**Noted for compliance**
3	**The facility shall submit the compliance report to all the stipulated conditions for consent for operation for every six months in January and July of every year.**	**Noted for compliance**
4	**The facility shall ensure the dedicated fund is allotted towards environment relief fund(ERF) in the public liability insurance policy and submit a copy of the policy at the regional office, Kakinada every year.**	**Complied.**
	Schedule - A	
1	Any up-set condition in any industrial plant / activity of the industry, which result in, increased effluent / emission discharge and/ or violation of standards stipulated in this order shall be informed to this Board, under intimation to the Collector and District Magistrate and take immediate action to bring down the discharge / emission below the limits.	Noted for compliance
2	The industry should carryout analysis of waste water discharges or emissions through chimneys for the parameters mentioned in this order on quarterly basis and submit to the Board.	Complied.
3	All the rules & regulations notified by Ministry of Law and Justice, Government of India regarding Public Liability insurance Act, 1991. Should be followed as applicable.	Complied
4	The industry should put up two sign boards (6x ft. each) at publicly visible places at the main gate indicating the products, effluent discharge standards, air emission standards, hazardous waste quantities and validity of CFO and exhibit the CFO order at a prominent place in the factory premises.	Complied
5	Not withstanding anything contained in this consent order, the Board hereby reserves the right and powers to review / revoke any and/or all the conditions imposed herein above and to make such variations as deemed fit	Noted for information

<table>
<tr><td></td><td>for the purpose of the Acts by the Board.</td><td></td></tr>
<tr><td>6</td><td>The industry shall file the water cess returns in Form-I as required under section (5) of Water (Prevention and Control of Pollution) Cess Act, 1977 on or before the 5th of every calendar month, showing the quantity of water consumed in the previous month along with water meter readings. The industry shall remit water cess as per the assessment orders as and when issued by Board.</td><td>Complied</td></tr>
<tr><td>7</td><td>The applicant shall submit Environment statement in Form V before 30th September every year as per Rule No.14 0f E P Rules, 1996 & amendments thereof</td><td>Complied</td></tr>
<tr><td>8</td><td>The applicant should make applications through Online for renewal of Consent (under Water and Air Acts) and Authorization under HWM Rules at least 120 days before the date of expiry of this order, along with prescribed fee under Water and Air Acts and detailed compliance of CFO conditions for obtaining Consent & HW Authorization of the Board. The industry should immediately submit the revised application for consent to this Board in the event of any change in the raw material used, processes employed, quantity of trade effluents & quantity of emissions. Any change in the management shall be informed to the Board' The person authorized should not let out the premises / lend/ sell /transfer their industrial premises without obtaining prior permission of the State pollution Control Board.</td><td>Noted for compliance</td></tr>
<tr><td>9</td><td>Any person aggrieved by an order made by the State Board under Section 25, Section 25, Section 27 of Water Act., 1974 or Section 21 of Air Act, 1981 may within thirty days from the date on which the order is communicated to him, prefer an appeal as per Andhra Pradesh Water Rules, 1976 and Air Rules 1982, to Appellate authority constituted under Section 28 of the Water(Prevention and Control of Pollution) Act, 1974 and Section 31 of the Air(Prevention and Control of pollution) Act, 1991.</td><td>For information</td></tr>
<tr><td colspan="3">Schedule - B</td></tr>
<tr><td>1</td><td>The effluent discharged shall not contain constituents in excess of the tolerance limits mentioned below
<table>
<tr><th>Parameter No</th><th>limiting Standards</th></tr>
<tr><td>pH</td><td>5.50 -9.00</td></tr>
<tr><td>Oil and Grease</td><td>10 mg/l</td></tr>
<tr><td>Suspended Solids</td><td>100 mg/l</td></tr>
<tr><td>BOD 27oCfor 3 days</td><td>30 mg/l</td></tr>
</table></td><td>All parameters within prescribed limits. Monthly environmental monitoring reports submitted to APPCB.</td></tr>
</table>

	Chromium as Cr: 0.10 mg/l Copper as Cu: 0.05 mg/l Cyanide as CN: 0.005 mg/l Fluoride as F: 1.50 mg/l Leas as Pb: 0.05 mg/l Mercury as Hg: 0.01 mg/l Nickel Ni: 0.10 mg/l Zinc as Zn: 0.10g / l	
2	The source of water is borewel /irrigation canal.The following is the permitted water consumption. Purpose: Quantity KLD Industrial Cooling , boiler feed: 70 Domestic purposes: 140 Total: 210 Separate meters with necessary pipe-line shall be maintained for assessing the quantity of water used for each of the purposes mentioned above for cess assessment purpose	Separate water meters is being maintained for all specified streams
	Air pollution	
1	The emissions shall not contain constituents in excess of the prescribed limits mentioned below: Chimney No: 1 | Parameter: Particulater matter | Emission Standards: 115 mg/Nm3	All parameters within prescribed limits. Monthly environmental monitoring reports submitted to APPCB .
2	The industry shall comply with ambient air quality standards of PM10 (Particulate Matter size less than 10pm) - 100 µg/ m3; PM2.5 (Particulate Matter size less than 2.5 pm) - 60 µg/ m3 ; SO2 - 80 µg/ m3; NOx - 80 µg/ m3, outside the factory premises at the periphery of the industry. Standards for other parameters as mentioned in the National Ambient Air Quality Standards CPCB Notification No. B-29016/l 20/90/PCI-1, dated 18.11.2009. Noise Levels; Day time (5 AM to 10 PM) - 75 dB (A) Night time (10 PM to 6 AM)- 70 dB (A)	All parameters within prescribed limits. Monthly environmental monitoring reports submitted to APPCB
8	The industry shall comply with emission limits for DG sets of capacity up to 800 KW as per the Notification G.S.R.520 (E), dated 01.07.2003 and G.S.R.448(E), dated L2.07.2004 under the Environment (Protection) Act	All parameters within prescribed limits. Monthly environmental monitoring reports submitted to APPCB

	Rules. In case of DG sets of capacity more than 800 KW shall comply with emission limits as per the Notification G.S.R.489 (E), dated 09.07.2002 at serial no.96, under the Environment (Protection) Act, 1986.	
	General	
1	The industry shall handover the original Consent order No. APPCB/VSP/RJY/546/CFO/HO12015-1180, dated 21.01.2015, having validity up to 28.02.2017 to the RO, Kakinada after receipt of this order and the same stands cancelled from the date of receipt of this order.	Complied.
2	The industry shall operate ETP and STP and maintain records.	Complied
3	The industry shall maintain separate digital water flow meters with totalisers for the following: i. Produced water generation from hydrocarbon production operations. ii. Saline water drains from deep ground reservoir. iii. Produced water re-injected through PWRI system. iv. Treated waste water inlet to ETP and at outlet. v. Marine discharge before outfall.	Separate digital water flow meters with totalisers is being maintained for all water streams.
4	The industry shall ensure no burning of effluents in the pits shall not be carried out at any stage.	Complied.
5	The industry shall ensure that the gas does not contain sulphides / sulphur compounds.	Complied.
6	The power mains, switches shall be such that the power to the facility be shut without affecting power for emergency utilities, control room, sprinkler systems, ROVs, emergency material transfer pumps, telephones, etc.	Complied
7	The Disaster Management Plan (DMP) shall be updated every year taking into account changes in the installation, other in the proximity facilities which may materially affect the installation.	ERP(Emergency response plan) is being updated annually
8	Proof of having insured the facility under the Public Liability Insurance Act shall be submitted to the Board annually.	Complied. The copy of the PLI has been submitted to the Board. PLI copy is being submitted annually.
9	The industry shall comply with the guidelines for disposal of Solid Waste, Drill Cutting and Drilling Fluids for Onshore Drilling operations as stipulated in the in the MoEF Notification	Noted for compliance. Complied to the board directions

	G.S.R.545 (E), dated 30.08.2005 and other Notifications, Rules made under EP Act.	
10	Existing Greenbelt shall not be disturbed in the proposed activity. Greenbelt of adequate width and density shall be developed along the boundary of the industry with minimum area of 33% of total area 90.25 Ha.	Complied.
	Schedule – C **[See rule 6(2)]**	
1	All the rules and regulations notified by Ministry of Environment and Forests, Government of India under the E P Act, 1986 in respect of management, handling, transportation and storage of the Hazardous wastes should be followed.	Complied
2	The industry shall not store hazardous waste for more than 90 days as per the Hazardous & Other Wastes (Management and Transboundary Movement) Rules, 2016 and amendments thereof.	Hazardous wastes stored and disposed as per HWM rules.
3	The industry shall store Used / Waste Oil and Used Lead Acid Batteries in a secured way in their premises till its disposal to the manufacturers dealers on buyback basis.	Used/waste oil and used lead acid batteries stored at a dedicated hazardous waste storage yard till disposed.
4	The industry shall maintain 6 copy manifest system for transportation of waste generated, and a copy shall be submitted to concerned Regional Office of APPCB. The driver who transports Hazardous Waste should be well acquainted about the procedure to be followed in case of an emergency during transit. The transporter should carry a Transport Emergency (TREM)Card.	6 copy manifest system followed. Copy is being submitted to the APPCB regional office, Kakinada. All other procedures is being followed and complied.
5	The industry shall maintain proper records for Hazardous & other wastes stated in Authorisation in FORM-3 i.e., quantity of Incinerable waste, land disposal waste, recyclable waste etc., and file annual returns in Form-4 as per Rule 6 (5) of the Hazardous & Other Wastes (Management & Transboundary Movement) Rules, 2016 and amendments thereof.	Hazardous waste record maintained in Form-3. Annual returns in Form- 4 are being submitted annually. Complied.
6	The industry shall submit the condition wise compliance report of the conditions stipulated in Schedule A, B & C of this Order on half yearly basis to Board Office, Hyderabad and concerned Regional Office.	Six monthly condition wise compliance report is being submitted to board office, Hyderabad and regional office, Kakinada . Complied

Annex 13

Membership Certificate of Vedanta Ltd (Cairn Oil & Gas) with Coastal Waste Management Project (TSDF), Vishakhapatnam

COASTAL WASTE MANAGEMENT PROJECT

(A Division Of RAMKY ENVIRO ENGINEERS LTD)

Treatment Storage and Disposal Facility (TSDF)
JN Pharmacity, E. Bonangi, Parawada Mandal
Visakhapatnam, A.P., India. E-mail : cwmp@ramky.com
Tel : 08924-236014, Fax : 08924-236013

Membership Certificate For Managing Hazardous Wastes

This is certify that M/s. VEDANTA LIMITED

RAVVA ONSHORE TERMINAL,UPPALAGUPTAM (M),KAKINADA,EAST GODAVARI(D)-532213

is a member of Coastal Waste Management Project With Membership No. CWMP/EGD/CEL/079

From 01-04-2020 & Valid Up to 31-03-2021

for Project Head

Annex 14

NOC from APWALTA for Ground Water Extraction

GOVERNMENT OF ANDHRA PRADESH
COMMISSIONER, RURAL DEVELOPMENT & ADMINSTRATOR, APWALTA
D.No.29-6-6/1, Ward No.24, Charitasri Hospitals Building, Nakkala Road, Suryarao Pet, A.P., Vijayawada - 520 002.
Phone: 0866- 2432096, E-mail: scrdap@gmail.com

From:
Sri B.Ramanjaneyulu, I.A.S.,
Commissioner, PR & RD,
& Administrator, APWALTA,
A.P., Hyderabad.

To,
M/s Cairn Oil & Gas, Vedanta Limited,
Surasaniyannam Village,
Uppalaguptam Mandal,
East Godavari District,
Andhra Pradesh – 533 213.

Lr.No.19/RD/SLNA/STE/APWALTA-NOC/2016 Dated: 03.01.2018.

Sir,

Sub:- AP – RD – APWALTA – Grant of Permission (NOC) to extract 10.413 cum/day of Saline ground water only from the existing six (6) bore wells, by M/s Cairn Oil & Gas, Vedanta Limited, for their Ravva On-shore Terminal located at 1 km from shore line in Surasaniyannam Village, Uppalaguptam Mandal, East Godavari District – Orders issued - Reg.

Ref:-
1. G.O.Ms no.339/PR&RD (RD.IV) dated 06.11.2004 of AP water, land and trees (APWALTA) rules, 2004.
2. Application of M/s Cairn Oil & Gas, Vedanta Limited dated 13.07.2017
3. Report of CSIR-NGRI, Hyderabad submitted by M/s Cairn Oil & Gas, Vedanta Limited vide lr.no. GW-GGN-RV/01 dated 18.08.2017.
4. Note orders dated 01.01.2018

***

Adverting to the subject references cited and based on the study report and recommendations given by the CSIR-NGRI, Hyderabad, the Grant of Permission (NOC) is hereby accorded to extract 10.413 cum/day of Saline ground water only, from the existing six (6) bore wells, by M/s Cairn Oil & Gas, Vedanta Limited, for their Ravva On-shore Terminal located at 1 km from shore line in Surasaniyannam Village, Uppalaguptam Mandal, East Godavari District, Andhra Pradesh.

The Grant of Permission (NOC) is issued subject to the implementation of the following conditions:

- The dewatered quantum of water is to be put to gainful use. This may include water supply and provide to water supply agencies, agriculture and dust

suppression by the industry, utilization by the mining industry, utilization for artificial recharge to groundwater etc.

- Piezometers/piezometric wells for monitoring the groundwater levels are to be mandatorily installed within the premises and in peripheral areas. The record of water level data and quality be maintained and to be provided periodically or whenever demanded by the regulatory agency.
- Rainwater harvesting shall be undertaken to recharge groundwater source with suitable artificial recharge structures in buffer zone wherever groundwater utilization is more. Every year status of implementation of recharge activities report shall be submitted to the agencies concerned (CGWA, CGWB and SCWD).
- Roof Top Rain Water harvesting shall be done in colony and plant area and also maintain water butts.
- Storm runoff must also be harvested through suitable artificial recharge structures in buffer zone villages like check dams, percolation tanks, farm ponds, gabion structures etc. Where groundwater utilization is more in buffer zone villages.
- Developing green belt in large scale in and around the lease area and colony area by adopting the phyto remediation method to prevent the contamination of any in the long run.
- Don't let out the stagnated water of mine into streams / streamlets before ensure the quality.
- Officers of the Ground Water Department must be allowed to inspect the plant area, recharge structures, groundwater abstraction structures, Piezometers and data whenever found necessary.
- It is mandatory to implement the germane guidelines of the Central Ground Water Authority constituted under sub-section (3) of Environment (Protection) Act, 1986.

- The permission accorded to the M/s Cairn Oil & Gas, Vedanta Limited, is liable to be cancelled in case of non-compliance of any of the conditions as mentioned above.
- This NOC is subject to prevailing Central / State Government rules / laws or Court orders related to Dewater from mines / Construction of recharge or conservation or conservation structures / discharge of effluents or any such matter as applicable.
- This NOC does not absolve the applicant / proponent of his obligation / requirement to obtain other statutory and administrative clearances from other statutory and administrative authorities.
- The NOC does not imply that other statutory / administrative clearances shall be granted to the project by the concerned authorities. Such authorities would consider the project on merits and be taking decisions independently of the NOC.
- This NOC is valid for two years from the date of issue of this letter.

Yours faithfully,

2.1.18

For Commissioner, PR & RD &
Administrator, APWALTA.

3/1/18

Copy to:

1. The Director, Ministry of Environment and Forests (I. A. Division), Paryavaran Bhawan, CGO Complex, Lodhi Road, New Delhi – 110 003.
2. The Regional Director, Central Ground Water Board, Southern Region, Hyderabad.
3. The Member Secretary, Central Ground Water Board, Bhujal Bhawan, Faridabad.
4. The Director, Ground Water Department, AP, Vijayawada.
5. The District Collector, East Godavari District, Andhra Pradesh.
6. The Project Director, DWMA, East Godavari District.
7. The peshi/Commissioner, RD.

Annex 15

Results of Micro-Meteorological Monitoring, Conducted by Vimta Labs during Jan–Mar, 2018

Average Micrometeorology observed during January to March 2018 at Ravva Terminal

Time, Hours	Average Temperature degree C	Average Relative Humidity %	Average Wind Speed, m/s	Average Wind Direction, degrees	Average Cloud Cover, Octas	Average Rainfall, mm
06 to 31 Jan 2018						
00:00:00	20.6	72.3	1.9	140	2.1	0.0
01:00:00	20.3	73.9	2.1	170	1.7	0.0
02:00:00	20.6	76.3	1.4	180	2.0	0.0
03:00:00	21.2	77.4	1.3	215	1.8	0.0
04:00:00	22.0	77.7	1.7	220	2.2	0.0
05:00:00	22.7	78.0	1.2	200	2.2	0.0
06:00:00	23.2	77.6	1.2	220	1.8	0.0
07:00:00	23.7	77.3	1.3	230	2.2	0.0
08:00:00	24.4	77.4	0.8	290	2.1	0.0
09:00:00	25.0	75.4	1.4	210	2.3	0.0
10:00:00	25.7	75.2	2.3	150	2.2	0.0
11:00:00	26.4	75.2	3.2	150	2.3	0.0
12:00:00	27.2	76.7	3.9	150	2.2	0.0
13:00:00	28.0	78.0	4.1	155	2.4	0.0
14:00:00	28.3	79.0	4.4	150	2.1	0.0
15:00:00	27.9	79.9	4.4	155	2.4	0.0
16:00:00	27.0	77.4	4.1	140	2.0	0.0
17:00:00	26.1	72.9	3.7	140	2.0	0.0
18:00:00	25.0	68.8	3.0	150	2.0	0.0
19:00:00	23.8	67.3	2.3	150	2.3	0.0
20:00:00	23.0	67.2	2.6	150	2.2	0.0
21:00:00	22.2	67.8	2.3	160	1.9	0.0
22:00:00	21.7	68.8	2.1	180	2.2	0.0
23:00:00	21.2	70.5	1.7	170	1.9	0.0
01 to 28 February 2018						
00:00:00	28.6	65.7	2.4	160	1.5	0.0
01:00:00	28.4	67.1	2.1	160	1.8	0.0
02:00:00	27.9	70.9	2.1	170	1.7	0.0
03:00:00	27.4	73.6	1.5	180	1.3	0.0
04:00:00	26.9	75.0	1.3	180	1.6	0.0
05:00:00	26.8	75.0	1.3	180	1.8	0.0
06:00:00	26.5	74.5	1.2	215	2.2	0.0
07:00:00	26.7	74.2	1.2	230	1.7	0.0
08:00:00	27.6	73.6	1.4	210	1.9	0.0
09:00:00	29.9	73.2	1.4	180	1.6	0.0
10:00:00	31.1	72.9	1.9	180	1.9	0.0
11:00:00	31.3	73.9	1.9	180	1.6	0.0
12:00:00	31.5	74.9	2.1	190	2.0	0.0
13:00:00	31.7	76.1	2.1	160	1.6	0.0
14:00:00	31.7	77.5	2.2	180	1.8	0.0
15:00:00	31.7	74.2	2.3	200	1.4	0.0
16:00:00	31.6	70.1	2.5	170	1.8	0.0

Time, Hours	Average Temperature degree C	Average Relative Humidity %	Average Wind Speed, m/s	Average Wind Direction, degrees	Average Cloud Cover, Octas	Average Rainfall, mm
17:00:00	31.4	65.4	2.6	190	1.8	0.0
18:00:00	31.0	62.2	2.3	190	2.0	0.0
19:00:00	30.6	60.9	2.3	170	2.4	0.0
20:00:00	30.3	61.9	2.5	180	2.0	0.0
21:00:00	30.0	61.8	2.9	160	2.5	0.0
22:00:00	29.5	62.3	2.4	160	1.8	0.0
23:00:00	29.1	63.5	3.3	150	1.8	0.0
01 to 31 March 2018						
00:00:00	29.1	78.6	2.3	180	1.7	0.0
01:00:00	28.7	78.5	2.1	165	1.4	0.1
02:00:00	28.3	79.4	2.3	165	2.0	0.0
03:00:00	27.9	80.6	2.2	160	1.5	0.0
04:00:00	27.6	81.4	2.4	170	1.6	0.0
05:00:00	27.3	81.8	3.3	150	1.5	0.0
06:00:00	27.2	82.7	3.6	140	1.9	0.0
07:00:00	27.4	82.6	4.1	150	2.2	0.0
08:00:00	28.8	76.5	4.6	150	1.5	0.0
09:00:00	31.1	67.0	4.9	160	1.6	0.0
10:00:00	31.8	64.4	4.6	170	1.4	0.0
11:00:00	32.1	64.0	4.5	150	1.9	0.0
12:00:00	32.3	63.8	4.3	141	1.8	0.0
13:00:00	32.6	62.8	3.8	150	1.7	0.0
14:00:00	32.6	63.4	3.5	140	1.6	0.0
15:00:00	32.5	63.7	2.4	170	2.0	0.0
16:00:00	32.3	64.8	2.4	160	1.4	0.0
17:00:00	31.8	65.9	2.6	185.8174	1.8	0.0
18:00:00	31.3	68.3	2.0	150	1.7	0.0
19:00:00	30.8	70.9	1.9	150	1.6	0.0
20:00:00	30.5	72.5	2.5	170	2.0	0.0
21:00:00	30.0	74.3	2.4	160	1.7	0.0
22:00:00	29.6	76.4	2.3	150	2.0	0.0
23:00:00	29.3	78.2	2.5	170	2.0	0.0

Note: The above monthly averages for 24 hours worked out from hourly monitored data

Annex 16

Results of Ambient Air Quality Monitoring, Conducted by Vimta Labs during Jan–Mar, 2018

AMBIENT AIR QUALITY																
AAQ1 - S.Yanam Village																
Sampling Date	**PM_{10} µg/m³**	**$PM_{2.5}$ µg/m³**	**SO_2 µg/m³**	**NO_2 µg/m³**	**H_2S µg/m³**	**Total VOC's ppm**	**NH_3 µg/m³**	**Pb µg/m³**	**As µg/m³**	**Ni µg/m³**	**Benzene µg/m³**	**BaP ng/m³**	**HC (CH_4) ppm**	**NMHC ppm**	**CO µg/m³**	**O_3 µg/m³**
06/01/2018	49.9	22.1	13.2	15.1	1.5	0.13	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	233	9.1
09/01/2018	50.1	21.9	14.6	16.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	255	9.4
10/01/2018	51.0	20.8	12.4	14.1	1.6	0.18	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	245	10.3
18/01/2018	49.5	21.1	13.3	15.0	1.4	0.12	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	230	9.3
19/01/2018	50.3	23.1	14.1	16.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	250	8.8
22/01/2018	49.5	22.6	13.6	15.5	1.3	0.15	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	242	10.1
23/01/2018	50.2	23.4	12.2	13.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	233	9.5
31/01/2018	49.3	22.7	12.7	14.4	1.5	0.14	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	223	10.4
01/02/2018	51.6	20.9	13.5	15.2	1.2	0.11	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	231	9.8
05/02/2018	49.2	21.9	12.1	13.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	215	11.6
06/02/2018	52.5	22.4	13.4	15.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	205	11.2
14/02/2018	50.1	23.5	12.8	14.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	198	10.3
15/02/2018	49.2	21.6	12.5	14.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	215	11.8
19/02/2018	51.6	23.9	13.3	15.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	212	10.7
21/02/2018	52.0	24.3	12.4	14.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	193	12.3
28/02/2018	50.3	23.6	13.2	14.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	203	11.5
01/03/2018	52.1	24.1	11.7	13.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	189	12.1
05/03/2018	54.1	23.8	12.5	14.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	200	13.2
06/03/2018	53.3	24.4	11.8	13.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	191	12.6
14/03/2018	51.2	23.2	12.0	13.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	181	12.7
15/03/2018	55.1	21.9	11.5	13.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	175	13.5
19/03/2018	54.6	22.4	12.3	14.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	180	13.3
20/03/2018	53.4	24.2	11.6	13.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	173	12.9
29/03/2018	55.4	22.3	12.2	13.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	184	13.2
30/03/2018	53.2	24.5	11.9	13.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	171	12.8
Maximum	**55.4**	**24.5**	**14.6**	**16.5**	**1.6**	**0.18**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.1**	**<0.1**	**255**	**13.5**
Minimum	**49.2**	**20.8**	**11.5**	**13.2**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.1**	**<0.1**	**171**	**8.8**
Average	**51.5**	**22.8**	**12.7**	**14.4**	**1.4**	**0.14**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.1**	**<0.1**	**209**	**11.3**
98 Percentile	**55.3**	**24.5**	**14.4**	**16.4**	**1.6**	**0.18**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.1**	**<0.1**	**253**	**13.4**

AMBIENT AIR QUALITY																
AAQ2 - Gopavaram Village																
Sampling Date	**PM_{10} µg/m³**	**$PM_{2.5}$ µg/m³**	**SO_2 µg/m³**	**NO_2 µg/m³**	**H_2S µg/m³**	**Total VOC's ppm**	**NH_3 µg/m³**	**Pb µg/m³**	**As µg/m³**	**Ni µg/m³**	**Benzene µg/m³**	**BaP ng/m³**	**HC (CH_4) ppm**	**NMHC ppm**	**CO µg/m³**	**O_3 µg/m³**
10/01/2018	49.3	20.5	13.2	13.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	228	8.9
11/01/2018	51.6	20.3	12.8	15.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	220	9.2
19/01/2018	50.2	21.2	12.7	13.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	232	7.5
20/01/2018	49.5	20.9	13.0	14.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	227	10.1
22/01/2018	48.8	21.5	12.8	14.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	230	9.6
23/01/2018	50.1	22.1	13.0	15.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	226	8.9
31/01/2018	51.2	21.8	11.5	13.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	213	10.6
01/02/2018	50.4	20.7	12.0	14.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	220	9.2
05/02/2018	52.7	22.0	12.8	15.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	211	11.1
06/02/2018	49.8	20.3	11.4	13.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	198	10.6
14/02/2018	50.3	20.8	12.7	14.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	201	9.8
15/02/2018	51.9	21.9	12.1	14.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	195	11.2
19/02/2018	49.2	20.7	11.8	13.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	203	10.2
20/02/2018	52.2	22.3	12.6	14.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	209	11.7
28/02/2018	50.0	21.9	11.7	13.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	189	12.2
01/03/2018	53.0	22.0	12.5	14.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	200	11.5
05/03/2018	52.3	23.1	11.0	12.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	185	10.8
06/03/2018	51.2	22.2	11.8	13.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	182	11.6
14/03/2018	54.2	23.5	12.0	14.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	187	12.2
15/03/2018	52.8	21.6	10.8	12.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	178	13.1
19/03/2018	53.7	22.7	11.2	12.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	171	11.8
20/03/2018	51.6	23.8	12.1	13.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	185	12.3
29/03/2018	54.7	22.6	10.9	12.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	169	13.2
30/03/2018	52.6	23.9	11.5	13.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	175	12.2
Maximum	**54.7**	**23.9**	**13.2**	**15.3**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**232**	**13.2**
Minimum	**48.8**	**20.3**	**10.8**	**12.4**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**169**	**7.5**
Average	**51.4**	**21.8**	**12.1**	**13.8**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**201**	**10.8**
98 Percentile	**54.5**	**23.9**	**13.1**	**15.2**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**231**	**13.2**

AMBIENT AIR QUALITY																
AAQ3 – Samanthakuru Village																
Sampling Date	**PM_{10} µg/m³**	**$PM_{2.5}$ µg/m³**	**SO_2 µg/m³**	**NO_2 µg/m³**	**H_2S µg/m³**	**Total VOC's ppm**	**NH_3 µg/m³**	**Pb µg/m³**	**As µg/m³**	**Ni µg/m³**	**Benzene µg/m³**	**BaP ng/m³**	**HC (CH_4) ppm**	**NMHC ppm**	**CO µg/m³**	**O_3 µg/m³**
12/01/2018	48.2	19.8	11.3	13.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	221	8.0
13/01/2018	47.4	21.6	12.5	14.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	211	7.5
17/01/2018	48.2	20.5	12.4	14.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	223	9.5
18/01/2018	46.8	18.4	12.5	13.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	220	7.2
24/01/2018	47.3	20.8	11.6	13.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	222	8.7
25/01/2018	49.2	20.3	12.2	14.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	217	7.9
29/01/2018	48.4	21.1	11.2	13.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	209	10.1
30/01/2018	50.1	20.4	10.8	13.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	211	8.7
07/02/2018	47.0	21.3	12.5	14.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	203	9.9
08/02/2018	49.1	22.0	10.7	12.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	192	10.1
12/02/2018	50.4	20.1	12.0	13.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	196	9.2
13/02/2018	48.3	21.2	11.4	13.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	189	10.7
21/02/2018	47.7	20.0	10.8	12.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	198	9.6
22/02/2018	49.8	21.6	11.9	13.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	203	11.2
26/02/2018	51.6	22.0	11.0	12.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	184	10.4
27/02/2018	48.5	21.3	11.8	13.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	194	11.0
07/03/2018	50.6	23.0	10.3	12.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	182	12.4
08/03/2018	48.8	21.5	10.7	12.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	205	11.7
12/03/2018	51.6	23.2	10.2	13.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	184	11.9
13/03/2018	49.4	20.9	9.8	11.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	174	12.7
21/03/2018	52.3	22.0	10.3	12.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	196	12.0
22/03/2018	50.9	23.5	10.5	12.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	179	11.8
26/03/2018	52.4	22.7	9.7	11.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	166	11.4
27/03/2018	50.7	23.1	10.4	12.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	172	12.5
Maximum	**52.4**	**23.5**	**12.5**	**14.5**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**223**	**12.7**
Minimum	**46.8**	**18.4**	**9.7**	**11.3**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**166**	**7.2**
Average	**49.4**	**21.3**	**11.2**	**13.0**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**198**	**10.3**
98 Percentile	**52.4**	**23.4**	**12.5**	**14.4**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**223**	**12.6**

AMBIENT AIR QUALITY																
AAQ4 – Uppalaguptham Village																
Sampling Date	**PM_{10} µg/m³**	**$PM_{2.5}$ µg/m³**	**SO_2 µg/m³**	**NO_2 µg/m³**	**H_2S µg/m³**	**Total VOC's ppm**	**NH_3 µg/m³**	**Pb µg/m³**	**As µg/m³**	**Ni µg/m³**	**Benzene µg/m³**	**BaP ng/m³**	**HC (CH_4) ppm**	**NMHC ppm**	**CO µg/m³**	**O_3 µg/m³**
12/01/2018	51.6	21.7	11.8	13.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	225	9.4
13/01/2018	49.2	22.8	13.1	15.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	243	8.9
16/01/2018	50.4	20.9	11.9	13.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	221	9.5
17/01/2018	49.7	22.1	12.8	15.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	230	8.2
24/01/2018	51.4	21.7	12.0	14.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	240	10.3
25/01/2018	50.3	20.7	13.1	15.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	226	9.6
29/01/2018	51.0	23.0	11.7	13.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	211	8.6
30/01/2018	52.3	21.8	12.2	14.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	219	9.9
07/02/2018	49.6	23.2	13.0	15.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	214	11.8
08/02/2018	51.6	21.5	11.2	13.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	223	9.2
12/02/2018	50.5	22.0	12.5	15.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	204	10.5
13/02/2018	49.2	23.1	10.8	13.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	198	11.9
21/02/2018	51.2	21.9	11.6	14.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	206	10.9
22/02/2018	52.4	23.5	12.4	14.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	212	12.4
26/02/2018	50.2	21.6	11.5	13.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	218	11.7
27/02/2018	53.3	23.2	12.3	14.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	211	12.2
07/03/2018	52.5	23.7	10.8	13.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	204	10.4
08/03/2018	51.4	21.5	11.1	13.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	190	12.6
12/03/2018	54.0	24.0	10.4	12.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	208	11.6
13/03/2018	52.0	22.8	11.4	13.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	186	13.2
21/03/2018	54.1	23.9	10.5	12.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	201	12.6
22/03/2018	52.7	24.2	12.6	14.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	198	13.7
26/03/2018	54.4	22.6	10.3	12.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	172	11.9
27/03/2018	53.3	24.8	11.2	13.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	188	12.9
Maximum	**54.4**	**24.8**	**13.1**	**15.3**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**243**	**13.7**
Minimum	**49.2**	**20.7**	**10.3**	**12.8**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**172**	**8.2**
Average	**51.6**	**22.6**	**11.8**	**14.0**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**210**	**11.0**
98 Percentile	**54.3**	**24.5**	**13.1**	**15.3**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**242**	**13.5**

AMBIENT AIR QUALITY																
AAQ5 – Kothapalli Village																
Sampling Date	**PM_{10} µg/m³**	**$PM_{2.5}$ µg/m³**	**SO_2 µg/m³**	**NO_2 µg/m³**	**H_2S µg/m³**	**Total VOC's ppm**	**NH_3 µg/m³**	**Pb µg/m³**	**As µg/m³**	**Ni µg/m³**	**Benzene µg/m³**	**BaP ng/m³**	**HC (CH_4) ppm**	**NMHC ppm**	**CO µg/m³**	**O_3 µg/m³**
12/01/2018	47.5	20.1	11.7	13.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	224	7.3
13/01/2018	49.6	19.8	12.8	14.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	220	6.8
16/01/2018	50.5	20.7	12.1	13.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	218	9.1
17/01/2018	48.2	20.1	11.8	13.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	226	7.0
24/01/2018	47.9	19.6	12.6	14.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	213	8.6
25/01/2018	49.8	21.6	12.3	14.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	220	7.4
29/01/2018	50.6	20.6	10.6	12.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	224	9.9
30/01/2018	48.6	21.5	11.8	13.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	214	8.2
09/02/2018	51.8	19.8	12.6	14.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	206	10.0
10/02/2018	48.0	21.0	11.9	13.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	194	9.6
12/02/2018	51.1	20.3	10.4	12.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	202	8.7
13/02/2018	49.6	21.4	12.3	14.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	191	10.2
23/02/2018	52.0	20.2	11.0	13.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	200	9.1
24/02/2018	50.4	21.8	11.8	13.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	205	10.7
26/02/2018	49.5	22.2	10.9	12.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	211	9.9
27/02/2018	51.6	21.5	11.7	13.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	196	10.5
09/03/2018	50.5	22.9	10.2	12.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	184	12.2
10/03/2018	52.6	20.6	10.6	12.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	191	11.5
12/03/2018	51.8	23.4	9.6	11.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	186	10.6
13/03/2018	50.0	21.1	11.1	13.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	176	12.1
23/03/2018	53.0	20.9	9.9	11.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	182	11.8
24/03/2018	51.5	23.5	10.4	12.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	160	11.2
26/03/2018	53.1	22.9	9.8	11.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	177	12.5
27/03/2018	52.8	21.8	10.3	12.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	171	11.8
Maximum	**53.1**	**23.5**	**12.8**	**14.7**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**226**	**12.5**
Minimum	**47.5**	**19.6**	**9.6**	**11.3**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**160**	**6.8**
Average	**50.5**	**21.2**	**11.3**	**13.1**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**200**	**9.9**
98 Percentile	**53.1**	**23.5**	**12.7**	**14.6**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**225**	**12.4**

AMBIENT AIR QUALITY																
AAQ6 – Chalapalli Village																
Sampling Date	**PM_{10} µg/m³**	**$PM_{2.5}$ µg/m³**	**SO_2 µg/m³**	**NO_2 µg/m³**	**H_2S µg/m³**	**Total VOC's ppm**	**NH_3 µg/m³**	**Pb µg/m³**	**As µg/m³**	**Ni µg/m³**	**Benzene µg/m³**	**BaP ng/m³**	**HC (CH_4) ppm**	**NMHC ppm**	**CO µg/m³**	**O_3 µg/m³**
06/01/2018	51.2	23.7	12.3	15.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	235	10.2
08/01/2018	49.5	22.8	14.8	16.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	251	9.4
09/01/2018	50.7	23.1	12.1	14.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	230	9.8
19/01/2018	52.1	23.4	13.6	15.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	268	10.6
20/01/2018	49.8	22.5	14.2	16.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	238	9.5
22/01/2018	51.7	23.6	11.9	14.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	254	11.2
24/01/2018	50.9	24.3	13.7	15.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	240	9.9
31/01/2018	52.6	23.6	12.5	14.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	227	10.2
01/02/2018	50.7	22.4	13.3	15.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	231	11.4
05/02/2018	53.1	22.8	12.2	14.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	210	12.1
06/02/2018	50.4	23.3	13.2	16.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	224	11.4
16/02/2018	52.4	24.4	12.6	14.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	216	10.6
17/02/2018	53.6	23.2	12.3	15.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	215	9.8
19/02/2018	52.3	24.8	13.1	16.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	202	11.0
20/02/2018	50.8	25.2	12.2	15.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	198	12.5
28/02/2018	51.0	24.5	13.0	16.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	209	11.8
01/03/2018	55.2	25.6	11.5	13.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	211	12.3
05/03/2018	51.3	24.7	12.3	14.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	206	13.7
06/03/2018	54.7	25.3	11.6	13.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	223	14.0
16/03/2018	53.1	24.1	12.0	14.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	201	13.2
17/03/2018	56.0	23.8	11.7	13.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	215	13.5
19/03/2018	54.1	25.7	12.1	15.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	191	14.0
20/03/2018	52.6	25.6	11.4	13.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	208	13.6
29/03/2018	56.3	24.7	12.0	14.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	199	14.2
30/03/2018	54.8	25.4	11.7	14.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	202	13.9
Maximum	**56.3**	**25.7**	**14.8**	**16.7**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**268**	**14.2**
Minimum	**49.5**	**22.4**	**11.4**	**13.7**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**191**	**9.4**
Average	**52.4**	**24.1**	**12.5**	**14.9**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**220**	**11.8**
98 Percentile	**56.2**	**25.7**	**14.5**	**16.5**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**261**	**14.1**

AMBIENT AIR QUALITY																
AAQ7 – Rameswaram Village																
Sampling Date	**PM_{10} µg/m³**	**$PM_{2.5}$ µg/m³**	**SO_2 µg/m³**	**NO_2 µg/m³**	**H_2S µg/m³**	**Total VOC's ppm**	**NH_3 µg/m³**	**Pb µg/m³**	**As µg/m³**	**Ni µg/m³**	**Benzene µg/m³**	**BaP ng/m³**	**HC (CH_4) ppm**	**NMHC ppm**	**CO µg/m³**	**O_3 µg/m³**
10/01/2018	46.3	19.2	10.6	12.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	222.0	6.9
11/01/2018	45.6	18.4	12.2	14.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	238.0	8.1
18/01/2018	46.7	19.0	11.7	13.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	221.0	6.8
19/01/2018	47.0	18.8	12.0	13.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	231.0	7.4
22/01/2018	45.9	19.4	11.8	13.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	227.0	8.0
23/01/2018	47.2	18.9	11.5	14.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	219.0	7.1
31/01/2018	46.8	20.3	10.5	12.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	232.0	9.6
01/02/2018	46.3	19.6	11.0	13.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	206.0	7.8
05/02/2018	45.9	20.5	10.7	12.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	210.0	9.6
06/02/2018	47.9	18.8	9.3	11.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	215.0	10.1
16/02/2018	46.8	19.3	10.6	12.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	202.0	8.3
17/02/2018	47.2	20.4	11.1	13.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	188.0	9.8
19/02/2018	45.6	19.2	9.7	11.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	197.0	8.8
20/02/2018	48.7	20.8	10.5	12.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	202.0	10.3
28/02/2018	46.5	21.2	9.6	11.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	183.0	9.5
01/03/2018	47.4	20.5	10.4	12.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	205.0	10.1
05/03/2018	48.8	22.0	8.9	10.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	166.0	12.1
06/03/2018	47.7	19.8	9.7	11.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	184.0	11.3
16/03/2018	49.1	22.3	10.1	12.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	179.0	10.8
17/03/2018	48.3	21.1	8.7	10.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	192.0	11.9
19/03/2018	49.4	22.2	9.1	12.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	163.0	12.1
20/03/2018	49.0	20.7	9.5	11.4	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	153.0	11.7
29/03/2018	48.7	22.6	8.8	10.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	161.0	12.3
30/03/2018	49.2	21.8	9.4	12.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	156.0	11.6
Maximum	**49.4**	**22.6**	**12.2**	**14.5**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**238**	**12.3**
Minimum	**45.6**	**18.4**	**8.7**	**10.5**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**153**	**6.8**
Average	**47.4**	**20.3**	**10.3**	**12.4**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**198**	**9.7**
98 Percentile	**49.3**	**22.5**	**12.1**	**14.3**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**235**	**12.2**

AMBIENT AIR QUALITY																
AAQ8 – Cherriyanam Village																
Sampling Date	**PM_{10} µg/m³**	**$PM_{2.5}$ µg/m³**	**SO_2 µg/m³**	**NO_2 µg/m³**	**H_2S µg/m³**	**Total VOC's ppm**	**NH_3 µg/m³**	**Pb µg/m³**	**As µg/m³**	**Ni µg/m³**	**Benzene µg/m³**	**BaP ng/m³**	**HC (CH_4) ppm**	**NMHC ppm**	**CO µg/m³**	**O_3 µg/m³**
12/01/2018	44.6	19.6	10.3	13.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	219	8.8
13/01/2018	43.6	18.6	11.6	14.0	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	212	8.5
17/01/2018	45.1	19.2	10.4	12.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	221	9.6
18/01/2018	44.1	19.2	11.3	13.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	224	8.2
25/01/2018	43.9	18.5	10.5	12.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	221	10.5
27/01/2018	44.7	19.3	11.6	14.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	215	9.0
29/01/2018	45.8	20.1	9.9	11.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	208	10.0
30/01/2018	44.2	19.4	10.7	13.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	210	9.3
09/02/2018	43.8	20.3	11.3	14.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	202	10.8
10/02/2018	44.4	18.6	10.3	12.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	188	10.3
12/02/2018	45.8	19.1	11.6	14.2	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	192	9.5
13/02/2018	45.3	20.2	9.7	12.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	185	10.9
23/02/2018	46.9	19.0	10.7	13.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	194	9.9
24/02/2018	46.8	19.8	11.5	14.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	202	11.4
26/02/2018	43.9	20.2	10.6	12.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	180	10.7
27/02/2018	45.5	19.7	11.4	13.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	190	11.2
09/03/2018	44.1	21.1	9.9	12.5	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	178	12.3
10/03/2018	45.2	19.9	10.7	13.3	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	168	11.5
12/03/2018	46.6	21.2	9.8	11.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	177	10.8
13/03/2018	45.9	19.3	10.2	12.8	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	167	12.1
23/03/2018	47.0	20.4	9.7	11.9	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	180	12.6
24/03/2018	45.6	21.5	10.5	12.6	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	151	11.7
26/03/2018	47.1	20.3	9.4	11.7	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	166	12.3
27/03/2018	45.7	21.6	10.4	12.1	<1.0	<0.1	<20	<0.001	<0.001	<0.001	<0.01	<0.01	<0.1	<0.1	154	11.3
Maximum	**47.1**	**21.6**	**11.6**	**14.2**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**224**	**12.6**
Minimum	**43.6**	**18.5**	**9.4**	**11.7**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**151**	**8.2**
Average	**45.2**	**19.8**	**10.6**	**13.0**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**192**	**10.6**
98 Percentile	**47.1**	**21.6**	**11.6**	**14.2**	**<1.0**	**<0.1**	**<20**	**<0.001**	**<0.001**	**<0.001**	**<0.01**	**<0.01**	**<0.1**	**<0.1**	**223**	**12.5**

Annex 17

Hourly Equivalent Noise Levels, Based on Ambient Noise Monitoring Conducted by Vimta Labs during March, 2018

AMBIENT NOISE																								
Code	**Noise Monitoring Location**	**Hourly Equivalent Noise Levels (Leq Hourly)**																						
		7:00 hrs.	**8:00 hrs.**	**9:00 hrs.**	**10:00 hrs.**	**11:00 hrs.**	**12:00 hrs.**	**13:00 hrs.**	**14:00 hrs.**	**15:00 hrs.**	**16:00 hrs.**	**17:00 hrs.**	**18:00 hrs.**	**19:00 hrs.**	**20:00 hrs.**	**21:00 hrs.**	**22:00 Hrs.**	**23:00 Hrs.**	**24:00 Hrs.**	**1:00 Hrs.**	**2:00 Hrs.**	**3:00 Hrs.**	**4:00 Hrs.**	**5:00 Hrs.**	**6:00 Hrs.**
N1	Outside Ravva Terminal - Near Temple	55.8	60.1	61.9	62.6	57.8	53.8	53.3	53.2	56.5	54.6	55.6	64.2	64.7	52.7	50.4	52.0	45.6	45.6	44.9	45.0	45.2	43.8	55.3	55.7
N2	Living Quarter (LQ)	48.6	52.9	54.8	55.4	50.7	46.7	46.1	46.0	49.3	47.4	48.4	57.0	57.5	45.5	43.2	44.8	38.4	38.4	37.7	37.9	38.1	36.7	48.1	48.6
N3	Surasaniyanam Village	46.9	51.2	54.0	53.6	51.9	51.9	44.4	44.3	48.8	49.6	51.5	54.6	55.9	50.8	41.5	44.1	37.2	38.0	36.0	36.1	36.4	35.0	42.7	43.1
N4	S.Yanam Beach – Cyclone Shelter	47.5	51.5	54.5	54.5	50.8	45.5	44.5	44.6	48.1	46.3	47.4	55.9	56.4	44.2	43.0	43.6	37.2	36.8	36.5	37.0	36.7	35.8	47.0	46.6
N5	Challapalli Village	54.6	54.5	55.5	53.2	51.2	50.6	45.5	44.5	52.5	52.7	57.7	57.7	51.3	46.7	52.1	43.0	45.9	46.6	43.9	44.0	37.0	36.7	35.8	47.0
N6	Gopavaram Village	49.3	53.6	55.5	55.6	51.9	49.1	47.5	46.7	50.0	52.3	52.6	57.7	58.2	46.2	43.9	44.2	39.1	39.1	38.4	38.6	38.8	37.4	48.8	47.4
N7	Gachakayala Pora Village	46.7	50.7	53.4	52.9	51.7	44.5	42.9	43.9	47.3	44.9	46.2	55.4	54.9	43.1	41.0	42.6	36.3	36.6	35.1	35.6	35.6	34.5	45.9	46.3
N8	Cherriyanam Village	45.8	50.1	52.0	52.5	50.9	44.8	44.8	43.2	46.6	48.4	51.7	53.5	54.8	42.8	40.4	42.0	35.6	35.7	34.9	35.1	35.3	33.9	45.3	45.8

Annex 18

Results of Traffic Survey, Conducted by Vimta Labs during March, 2018

TRAFFIC SURVEY DATA SHEET						
Monitoring Location : Challapalli village				**GPS Reading : N16⁰29.851', E 082⁰03.338'**		
Monitoring Direction : Amalapuram To S.Yanam				**Monitoring Date: 26 / 03 / 2018**		
SN.	**Monitoring Time**	**Two and 3 Wheeler Auto Rickshaw**	**Four Wheelers Car/Jeep**	**Light Commercial Vehicles Tractors / Mini Truck**	**Buses and Trucks / Tankers**	**Heavy Vehicles / Truck (Bi-Axle and Multi axle)**
1	06 to 07	19	3	3	3	8
2	07 to 08	22	2	5	4	8
3	08 to 09	33	3	4	3	7
4	09 to 10	24	6	2	7	4
5	10 to 11	21	4	4	4	3
6	11 to 12	16	6	3	4	4
7	12 to 13	12	4	4	4	3
8	13 to 14	22	3	6	4	4
9	14 to 15	12	2	3	3	4
10	15 to 16	15	4	4	4	3
11	16 to 17	18	6	4	3	6
12	17 to 18	19	3	3	3	3
13	18 to 19	17	4	3	3	4
14	19 to 20	22	3	2	4	3
15	20 to 21	17	3	4	3	3
16	21 to 22	18	4	2	2	4
17	22 to 23	26	7	3	3	6
18	23 to 24	10	3	0	0	2
19	24 to 01	3	0	1	0	1
20	01 to 02	3	0	0	1	2
21	02 to 03	0	0	0	0	1
22	03 to 04	1	1	0	1	0
23	04 to 05	9	0	1	1	2
24	05 to 06	19	2	0	2	2
Total		**378**	**73**	**61**	**66**	**87**

TRAFFIC SURVEY DATA SHEET						
Monitoring Location : Challapalli village				**GPS Reading : N16^{0}29.851' , E 082^{0}03.338'**		
Monitoring Direction: S.Yanam To Amalapuram				**Monitoring Date : 26 / 03 / 2018**		
SN.	**Monitoring Time**	**Two and 3 Wheeler Auto Rickshaw**	**Four Wheelers Car/Jeep**	**Light Commercial Vehicles Tractors / Mini Truck**	**Buses and Trucks / Tankers**	**Heavy Vehicles / Truck (Bi-Axle and Multi axle)**
1	06 to 07	24	4	3	3	8
2	07 to 08	20	3	2	2	4
3	08 to 09	29	6	4	4	3
4	09 to 10	39	7	4	5	7
5	10 to 11	28	8	2	3	8
6	11 to 12	20	3	6	1	10
7	12 to 13	28	6	5	8	12
8	13 to 14	30	7	6	3	4
9	14 to 15	24	4	3	2	6
10	15 to 16	20	4	4	3	4
11	16 to 17	26	4	2	3	2
12	17 to 18	36	6	4	4	3
13	18 to 19	17	6	6	4	4
14	19 to 20	9	3	4	3	6
15	20 to 21	9	4	3	3	7
16	21 to 22	9	2	4	1	4
17	22 to 23	3	1	2	3	3
18	23 to 24	5	0	3	2	6
19	24 to 01	1	0	1	0	7
20	01 to 02	3	0	0	0	3
21	02 to 03	0	2	0	3	4
22	03 to 04	3	3	0	2	4
23	04 to 05	8	2	2	3	6
24	05 to 06	17	3	3	3	5
	Total	**408**	**88**	**73**	**68**	**130**

TRAFFIC SURVEY DATA SHEET						
Monitoring Location : Kunavaram Bus Stop				**GPS Reading : N16^{0}31.843' , E 082^{0}03.210'**		
Monitoring Direction : Amalapuram To Chalapalli				**Monitoring Date : 22 / 03 / 2018**		
SN	**Monitoring Time**	**Two and 3 Wheeler Auto Rickshaw**	**Four Wheelers Car / Jeep**	**Light Commercial Vehicles Tractors / Mini Truck**	**Buses and Trucks / Tankers**	**Heavy Vehicles / Truck (Bi-Axle and Multi axle)**
1	06 to 07	20	3	11	4	8
2	07 to 08	20	4	8	8	7
3	08 to 09	44	4	6	4	8
4	09 to 10	50	3	4	3	4
5	10 to 11	50	8	6	4	3
6	11 to 12	52	9	4	6	4
7	12 to 13	47	4	3	4	3
8	13 to 14	21	3	3	6	4
9	14 to 15	22	4	2	4	6
10	15 to 16	65	8	3	8	8
11	16 to 17	55	22	4	3	4
12	17 to 18	45	17	4	4	2
13	18 to 19	40	6	4	3	7
14	19 to 20	37	4	4	8	8
15	20 to 21	47	4	3	2	2
16	21 to 22	19	3	4	2	3
17	22 to 23	14	3	4	2	0
18	23 to 24	8	4	3	0	0
19	24 to 01	3	0	0	0	4
20	01 to 02	9	0	0	3	0
21	02 to 03	5	1	0	0	4
22	03 to 04	5	2	3	2	6
23	04 to 05	21	3	7	3	7
24	05 to 06	17	4	4	2	11
	Total	**716**	**123**	**94**	**85**	**113**

TRAFFIC SURVEY DATA SHEET						
Monitoring Location : Kunavaram Bus stop				**GPS Reading : N16^{0}31.843' , E 082^{0}03.210'**		
Monitoring Direction : Chalapalli To Amalapuram				**Monitoring Date : 22 / 03 / 2018**		
SN.	**Monitoring Time**	**Two and 3 Wheeler Auto Rickshaw**	**Four Wheelers Car / Jeep**	**Light Commercial Vehicles Tractors / Mini Truck**	**Buses and Trucks / Tankers**	**Heavy Vehicles / Truck (Bi-Axle and Multi axle)**
1	06 to 07	38	11	7	2	3
2	07 to 08	43	4	7	3	3
3	08 to 09	37	3	3	2	2
4	09 to 10	45	4	4	3	3
5	10 to 11	39	2	3	4	4
6	11 to 12	28	4	2	4	6
7	12 to 13	27	4	4	1	3
8	13 to 14	27	4	3	2	2
9	14 to 15	30	3	2	1	2
10	15 to 16	29	4	2	3	3
11	16 to 17	30	2	1	2	3
12	17 to 18	32	3	3	3	4
13	18 to 19	27	7	3	4	7
14	19 to 20	36	4	6	3	3
15	20 to 21	29	7	4	3	7
16	21 to 22	21	4	3	3	4
17	22 to 23	20	3	4	2	0
18	23 to 24	16	0	4	0	0
19	24 to 01	8	1	0	0	4
20	01 to 02	6	0	0	2	5
21	02 to 03	4	2	0	0	0
22	03 to 04	4	0	1	0	4
23	04 to 05	10	3	2	2	3
24	05 to 06	22	2	4	4	0
	Total	**608**	**81**	**72**	**53**	**75**

TRAFFIC SURVEY DATA SHEET						
Monitoring Location : Challapalli Village				**GPS Reading : N16^{0}29.851', E 082^{0}03.338'**		
Monitoring Direction : Amalapuram To S.Yanam				**Monitoring Date : 31 / 03 / 2018**		
SN.	**Monitoring Time**	**Two and 3 Wheeler Auto Rickshaw**	**Four wheelers Car / Jeep**	**Light Commercial Vehicles Tractors / Mini Truck**	**Buses and Trucks / Tankers**	**Heavy Vehicles / Truck (Bi-Axle and Multi axle)**
1	06 to 07	15	3	3	2	4
2	07 to 08	16	2	2	2	3
3	08 to 09	26	3	4	3	4
4	09 to 10	19	3	2	2	2
5	10 to 11	16	4	2	4	3
6	11 to 12	12	4	3	2	3
7	12 to 13	11	3	2	4	3
8	13 to 14	16	3	3	2	2
9	14 to 15	10	2	3	3	4
10	15 to 16	10	4	2	4	3
11	16 to 17	14	3	3	2	3
12	17 to 18	13	3	1	3	3
13	18 to 19	15	2	3	2	2
14	19 to 20	18	3	2	2	3
15	20 to 21	15	3	2	2	3
16	21 to 22	14	4	1	2	4
17	22 to 23	20	4	3	3	3
18	23 to 24	8	3	0	0	2
19	24 to 01	3	0	1	0	1
20	01 to 02	2	0	0	1	2
21	02 to 03	0	0	0	0	1
22	03 to 04	1	1	0	1	0
23	04 to 05	6	0	1	1	2
24	05 to 06	15	2	0	2	2
	Total	295	59	43	49	62

TRAFFIC SURVEY DATA SHEET						
Monitoring Location : Challapalli village				**GPS Reading : N16⁰29.851' , E 082⁰03.338'**		
Monitoring Direction : S.Yanam To Amalapuram				**Monitoring Date : 31 / 03 / 2018**		
SN.	**Monitoring Time**	**Two and 3 Wheeler Auto Rickshaw**	**Four Wheelers Car / Jeep**	**Light Commercial Vehicles Tractors / Mini Truck**	**Buses and Trucks / Tankers**	**Heavy Vehicles / Truck(Bi-Axle and Multi axle)**
1	06 to 07	19	3	2	2	5
2	07 to 08	18	2	2	2	4
3	08 to 09	24	4	3	3	3
4	09 to 10	30	5	3	3	4
5	10 to 11	24	4	2	3	6
6	11 to 12	18	2	3	1	7
7	12 to 13	22	3	5	4	8
8	13 to 14	23	5	4	3	4
9	14 to 15	20	3	3	2	3
10	15 to 16	17	4	2	2	4
11	16 to 17	21	3	2	3	2
12	17 to 18	30	4	3	2	3
13	18 to 19	14	3	4	4	4
14	19 to 20	8	2	3	2	5
15	20 to 21	6	3	3	3	3
16	21 to 22	6	2	4	1	4
17	22 to 23	2	1	2	2	3
18	23 to 24	4	0	3	2	2
19	24 to 01	1	0	1	0	4
20	01 to 02	3	0	0	0	3
21	02 to 03	0	1	0	2	4
22	03 to 04	3	2	0	2	2
23	04 to 05	5	2	2	2	5
24	05 to 06	11	2	3	3	5
	Total	329	60	59	53	97

TRAFFIC SURVEY DATA SHEET						
Monitoring Location : Kunavaram Bus Stop				**GPS Reading : N16^{0}31.843' , E 082^{0}03.210'**		
Monitoring Direction : Amalapuram To Chalapalli				**Monitoring Date : 24 / 03 / 2018**		
SN.	**Monitoring Time**	**Two and 3 Wheeler Auto Rickshaw**	**Four Wheelers Car / Jeep**	**Light Commercial Vehicles Tractors / Mini Truck**	**Buses and Trucks / Tankers**	**Heavy Vehicles / Truck (Bi-Axle and Multi Axle)**
1	06 to 07	16	2	8	2	5
2	07 to 08	16	2	7	5	6
3	08 to 09	37	4	5	4	5
4	09 to 10	42	2	4	3	4
5	10 to 11	43	5	5	4	3
6	11 to 12	46	7	4	2	2
7	12 to 13	41	3	3	4	3
8	13 to 14	15	3	3	5	4
9	14 to 15	18	4	2	4	5
10	15 to 16	47	6	3	3	4
11	16 to 17	50	19	3	3	2
12	17 to 18	41	14	2	4	2
13	18 to 19	33	5	4	3	4
14	19 to 20	35	3	2	6	6
15	20 to 21	42	4	3	2	2
16	21 to 22	12	3	3	2	3
17	22 to 23	11	3	4	2	0
18	23 to 24	7	3	3	0	0
19	24 to 01	3	0	0	0	4
20	01 to 02	8	0	0	3	0
21	02 to 03	5	1	0	0	3
22	03 to 04	5	2	3	2	4
23	04 to 05	18	2	4	3	5
24	05 to 06	15	4	2	2	8
	Total	606	101	77	68	84

TRAFFIC SURVEY DATA SHEET						
Monitoring Location : Kunavaram Bus Stop				**GPS Reading : N16^{0}31.843' , E 082^{0}03.210'**		
Monitoring Direction : Chalapalli To Amalapuram				**Monitoring Date : 24/03/2018**		
SN.	**Monitoring Time**	**Two and 3 Wheeler Auto Rickshaw**	**Four Wheelers Car / Jeep**	**Light Commercial Vehicles Tractors / Mini Truck**	**Buses and Trucks / Tankers**	**Heavy Vehicles / Truck (Bi-Axle and Multi axle)**
1	06 to 07	31	8	6	2	2
2	07 to 08	39	3	5	2	3
3	08 to 09	33	3	3	2	2
4	09 to 10	40	4	4	3	3
5	10 to 11	37	2	3	2	2
6	11 to 12	27	3	2	1	3
7	12 to 13	25	4	4	1	3
8	13 to 14	25	3	3	2	2
9	14 to 15	26	3	2	1	2
10	15 to 16	27	3	2	3	2
11	16 to 17	27	2	1	2	3
12	17 to 18	27	3	3	3	3
13	18 to 19	25	5	3	2	5
14	19 to 20	32	4	3	3	3
15	20 to 21	21	5	2	2	4
16	21 to 22	17	2	3	2	4
17	22 to 23	13	2	2	2	0
18	23 to 24	14	0	3	0	0
19	24 to 01	7	1	0	0	4
20	01 to 02	4	0	0	2	3
21	02 to 03	4	2	0	0	0
22	03 to 04	4	0	1	0	2
23	04 to 05	6	2	2	2	3
24	05 to 06	13	2	3	3	0
	Total	524	66	60	42	58

Annex 19

Phytosociology of Different Vegetation Types

Phytosociology of Beach Habitats in the Study Area

SN.	Species	Habitat	Frequency	Relative Frequency	Density	Relative Density	Abundance	Relative Abundance
1	*Thespesia populneoides*	Shrub	100.00	1.11	4.71	2.57	4.71	0.10
2	*Clerodendrum inerme*	Shrub	100.00	1.11	4.43	2.41	4.43	0.10
3	*Caesalpinia bonduc*	Climber	57.14	0.64	4.29	2.34	4.29	0.09
4	*Derris trifoliata*	Climber	71.43	0.80	3.86	2.10	3.86	0.08
5	*Cassytha filiformis*	Climber	57.14	0.64	3.43	1.87	3.43	0.07
6	*Ipomoea biloba*	Climber	100.00	0.84	5.14	2.36	5.14	0.09
7	*Spinifex littoreus*	Climber	100.00	0.84	3.57	1.64	3.57	0.07
8	*Crotalaria striata*	Herb	85.71	0.95	5.43	0.12	5.43	0.12
9	*Tephrosia purpurea*	Herb	85.71	0.95	15.29	0.33	15.29	0.33

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Phytosociology of Shelter Belt Habitats in the Study Area

SN.	Species	Habitat	Frequency	Relative Frequency	Density	Relative Density	Abundance	Relative Abundance
1	*Casurina equistifolia*	Tree	100.00	1.25	53.20	72.28	53.20	0.72
2	*Borassus flabellifer*	Tree	40.00	0.50	1.60	2.17	1.60	0.02
3	*Cocos nucifera*	Tree	100.00	1.25	11.40	15.49	11.40	0.15
4	*Calatropis procera*	Tree	100.00	1.25	4.00	5.43	4.00	0.05
9	*Pandanus tectorius*	Tree	60.00	0.75	3.40	4.62	3.40	0.05

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Phytosociology of Mangrove Habitats in the Study Area

SN.	Species	Habitat	Frequency	Relative Frequency	Density	Relative Density	Abundance	Relative Abundance	IVI
1	*Avicennia officinalis*	Tree	100	0.58	10.4	11.08	10.4	0.11	11.77
2	*Avicennia marina*	Tree	75	0.44	2.0	2.14	2.0	0.02	2.59
3	*Rhizophora apiculata*	Tree	50	0.29	2.4	2.54	2.4	0.03	2.85
4	*Rhizophora mucronata*	Tree	62.5	0.36	3.0	3.20	3.0	0.03	3.60
5	*Bruguiera gymnorrhiza*	Tree	62.5	0.36	2.4	2.54	2.4	0.03	2.93
6	*Xylocarpus moluccensis*	Tree	50	0.29	1.6	1.74	1.6	0.02	2.04
7	*Ceriops decandra*	Tree	62.5	0.36	2.8	2.94	2.8	0.03	3.33
8	*Excoecaria agallocha*	Tree	100	0.58	5.3	5.61	5.3	0.06	6.25
9	*Lumnitzera racemosa*	Tree	75	0.44	3.8	4.01	3.8	0.04	4.48
10	*Scyphiphora hydrophyllacea*	Tree	25	0.15	1.4	1.47	1.4	0.01	1.63
11	*Sarcolobus carinatus*	Tree	25	0.15	0.6	0.67	0.6	0.01	0.82
12	*Dalbergia spinosa*	Tree	50	0.29	1.4	1.47	1.4	0.01	1.77
13	*Avicennia alba*	Tree	75	0.44	4.4	4.67	4.4	0.05	5.16
14	*Xylocarpus granatum*	Tree	75	0.44	5.3	5.61	5.3	0.06	6.10
15	*Bruguiera cylindrica*	Tree	62.5	0.36	4.1	4.41	4.1	0.04	4.81
16	*Sonneratia caseolaris*	Tree	62.5	0.36	3.4	3.60	3.4	0.04	4.00
1	*Derris trifohata*	Climber	50	0.29	2.9	3.07	2.9	0.03	
2	*Clerodendrum inerme*	Shrub	50	0.29	2.1	2.27	2.1	0.02	
3	*Sesuvium portulacastrum*	Herb	62.5	0.36	8.9	0.09	8.9	0.09	
4	*Sueda meritima*	Herb	62.5	0.36	9.1	0.10	9.1	0.10	
5	*Sueda portulacastrum*	Herb	75	0.44	9.3	0.10	9.3	0.10	
6	*Salicornia brachiata*	Herb	62.5	0.36	7.4	0.08	7.4	0.08	

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Phytosociology of Aquaculture Ponds Habitats in the Study Area

SN.	Species	Habit	Frequency	Relative Frequency	Density	Relative Density	Abundance	Relative Abundance	IVI
1	*Albizia saman*	Tree	66.67	1.04	1.67	9.52	1.67	0.10	10.66
2	*Cocos nucifera*	Tree	100.00	1.57	12.83	73.33	12.83	0.73	75.63
3	*Azadirachta indica*	Tree	66.67	1.04	1.00	5.71	1.00	0.06	6.81
4	*Mangifera indica*	Tree	50.00	0.78	0.67	3.81	0.67	0.04	4.63
5	*Millettia pinnata*	Tree	50.00	0.78	0.67	3.81	0.67	0.04	4.63
6	*Prosopis juliflora*	Tree	50.00	0.78	0.67	3.81	0.67	0.04	4.63

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Phytosociology of Agricultural land in the Study Area

SN.	Species	Habitat	Frequency	Relative Frequency	Density	Relative Density	Abundance	Relative Abundance	IVI
1	*Trewia nudiflora*	Tree	60.00	0.14	0.60	0.64	0.60	0.01	0.78
2	*Ficus benghalensis*	Tree	40.00	0.09	0.40	0.42	0.40	0.00	0.52
3	*Annona squamosa*	Tree	40.00	0.09	0.40	0.42	0.40	0.00	0.52
4	*Peltophorum inerme*	Tree	60.00	0.14	0.60	0.64	0.60	0.01	0.78
5	*Leucaena latisiliqua*	Tree	60.00	0.14	1.00	1.06	1.00	0.01	1.21
6	*Samanea saman*	Tree	60.00	0.14	1.60	1.70	1.60	0.02	1.85
7	*Carica Papaya*	Tree	80.00	0.18	0.80	0.85	0.80	0.01	1.04
8	*Phoenix sylvestris*	Tree	60.00	0.14	1.20	1.27	1.20	0.01	1.42
9	*Ficus racemosa*	Tree	40.00	0.09	0.40	0.42	0.40	0.00	0.52
10	*Pithecelobium dulce*	Tree	40.00	0.09	0.60	0.64	0.60	0.01	0.73
11	*Sapindus laurifolius*	Tree	20.00	0.05	0.20	0.21	0.20	0.00	0.26
12	*Ficus hispida*	Tree	40.00	0.09	0.60	0.64	0.60	0.01	0.73
13	*Psidium guajava*	Tree	40.00	0.09	0.40	0.42	0.40	0.00	0.52
14	*Azadirachta indica*	Tree	20.00	0.05	0.20	0.21	0.20	0.00	0.26
15	*Artocarpus integrifolia*	Tree	20.00	0.05	0.20	0.21	0.20	0.00	0.26
16	*Cocos nucifera*	Tree	100.00	0.23	7.00	7.43	7.00	0.07	7.73
17	*Tecoma stans*	Tree	20.00	0.05	0.20	0.21	0.20	0.00	0.26
18	*Tamarindus indica*	Tree	20.00	0.05	0.20	0.21	0.20	0.00	0.26
19	*Asparagus racemosa*	Climber	40.00	0.09	1.00	0.27	1.00	0.01	
20	*Kirganelia reticulata*	Shrub	60.00	0.14	2.00	0.53	2.00	0.02	
21	*Jatropha gossypifolia*	Shrub	40.00	0.09	0.40	0.11	0.40	0.00	
22	*Acanthus ilicifloius*	Shrub	20.00	0.05	0.20	0.05	0.20	0.00	
23	*Calotropis procera*	Shrub	100.00	0.23	1.60	0.42	1.60	0.02	
24	*Lantana camara*	Shrub	80.00	0.18	2.00	0.53	2.00	0.02	
25	*Paspalidium geminatum*	Herb	80.00	0.18	5.80	0.06	5.80	0.06	
26	*Eragrostis japonica*	Herb	60.00	0.14	5.00	0.05	5.00	0.05	
27	*Crotolaria retusa*	Herb	80.00	0.18	2.00	0.02	2.00	0.02	
28	*Porterecia coarctata*	Herb	60.00	0.14	4.60	0.05	4.60	0.05	
29	*Gomphrena celosioides*	Herb	60.00	0.14	4.00	0.04	4.00	0.04	
30	*Cassia occidentalis*	Herb	60.00	0.14	5.60	0.06	5.60	0.06	
31	*Croton bonplandianus*	Herb	60.00	0.14	5.60	0.06	5.60	0.06	
32	*Typha angustata*	Herb	20.00	0.05	2.60	0.03	2.60	0.03	
33	*Achyranthes aspera*	Herb	60.00	0.14	3.60	0.04	3.60	0.04	
34	*Alternanthera sessilis*	Herb	60.00	0.14	4.80	0.05	4.80	0.05	
35	*Alternanthera pungens*	Herb	40.00	0.09	6.40	0.07	6.40	0.07	
36	*Dactyloctenium aegypticum*	Herb	60.00	0.14	3.60	0.04	3.60	0.04	
37	*Solanum xanthocarpum*	Herb	80.00	0.18	3.80	0.04	3.80	0.04	
38	*Parthenium hysterophorus*	Herb	40.00	0.09	3.20	0.03	3.20	0.03	
39	*Cassia alata*	Herb	80.00	0.18	5.80	0.06	5.80	0.06	
40	*Oldenlandia herbacea*	Herb	60.00	0.14	2.00	0.02	2.00	0.02	
41	*Sporobolus diander*	Herb	40.00	0.09	0.80	0.01	0.80	0.01	
42	*Portulaca oleracea*	Herb	40.00	0.09	1.20	0.01	1.20	0.01	

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Annex 20

Faunal Species Observed / Reported from the Study Area

Butterflies Recorded from the Study Area

SN	Common Name	Scientific name	Family	IUCN/ WPA	Remarks
1	Plum Judy	*Abisara echerius*	Lycaenidae	Not assessed	Common
2	Painted Lady	*Vanessa cardui*	Nymphalidae	Not assessed	Common
3	Yellow Pansey	*Junonia hierta*	Nymphalidae	Not assessed	Common
4	Peacock Pansey	*Junonia almana*	Nymphalidae	Not assessed	Common
5	Lemon Pansey	*Junonia lemnonias*	Nymphalidae	Not assessed	Common
6	Grey Pansey	*Junonia atlites*	Nymphalidae	Not assessed	Common
7	Common Leopard	*Phalanta phalantha*	Nymphalidae	Not assessed	Common
8	Common Baron	*Euthalia aconthea*	Nymphalidae	Not assessed	Common
9	Chocolate Pansey	*Junonia iphita*	Nymphalidae	Not assessed	Common
10	Blue Pansey	*Junonia orithiya*	Nymphalidae	Not assessed	Common
11	Striped Tiger	*Danaus genutia*	Nymphalidae	Not assessed	Common
12	Plain Tiger	*Danaus chrysippus*	Nymphalidae	Not assessed	Common
13	Glassy Tiger	*Parantica aglea*	Nymphalidae	Not assessed	Common
14	Common Fevering	*Ypthima baldus*	Nymphalidae	Not assessed	Common
15	Common Evening Brown	*Melanitis leda*	Nymphalidae	Not assessed	Common
16	Common Crow	*Euploea core*	Nymphalidae	Not assessed	Common
17	Blue Tiger	*Tirumala limniace*	Nymphalidae	Not assessed	Common
18	Red Helen	*Papilio helenus*	Papilionidae	Not assessed	Common
19	Tailed Jay	*Graphium agamemnon*	Papilionidae	Not assessed	Common
20	Lime Butterfly	*Papilio demoleus*	Papilionidae	Not assessed	Common
21	Common Rose	*Atrophaneura aristolochiae*	Papilionidae	Not assessed	Common
22	Common Jay	*Graphium doson*	Papilionidae	Not assessed	Common
23	Spotless Grass Yellow	*Eurema laeta*	Pieridae	Not assessed	Common
24	Small Grass Yellow	*Eurema brigitta*	Pieridae	Not assessed	Common
25	Common Jezebel	*Delias eucharis*	Pieridae	Not assessed	Common
26	Common Grass Yellow	*Eurema hecabe*	Pieridae	Not assessed	Common

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Fishes Reported from the Study Area

SN.	Family	Scientific Name	Habitat		
			Fresh Water	Brackish Water	Marine Water
1.	Aplocheilidae	*Aplocheilus panchax*	✓	✓	
2.	Carcharhinidae	*Scoliodon laticaudus*		✓	✓
3.	Dasyatidae	*Himantura uarnak*		✓	✓
4.	Myliobatidae	*Aetobatus narinari*		✓	✓
5.	Notopteridae	*Notopterus notopterus*	✓		
6.	Elopidae	*Elops machnata*		✓	✓
7.	Megalopidae	*Megalops cyprinoides*	✓	✓	
8.	Moringuidae	*Moringua raitaborua*		✓	
9.		*Lycodontis punctatus*		✓	
10.		*Lycodontis sathete*		✓	
11.		*Thyrsoidea macrura*		✓	
12.	Ophichthidae	*Bascanichthys deraniyagalai*	✓	✓	
13.		*Cirrhimuraena playfairii*		✓	✓
14.		*Muraenichthys gymnopterus*		✓	✓
15.		*Muraenichthys macropterus*		✓	✓
16.		*Pisodonophis boro*	✓	✓	
17.	Congridae	*Ariosoma anago*		✓	
18.		*Uroconger lepturus*			✓

SN.	Family	Scientific Name	Habitat		
			Fresh Water	Brackish Water	Marine Water
19.	Muraenesocidae	*Congresox talabon*		✓	✓
20.		*Muraellesox bagio*		✓	✓
21.	Clupeidae	*Anodontosoma chacunda*	✓	✓	✓
22.		*Dayella malabarica*		✓	✓
23.		*Dussulnieria acuta*		✓	✓
24.		*Dussumieria elopsoides*			✓
25.		*Escualosa thoracata*		✓	✓
26.		*Hilsa kelee*		✓	✓
27.		*Nematalosa nasus*		✓	✓
28.		*Sardinella fimbriata*		✓	✓
29.		*Tenualosa ilisha*		✓	✓
30.		*Tenualosa toil*		✓	✓
31.	Pristigasteridae	*Ilisha elongate*		✓	✓
32.		*Ilisha filigera*		✓	✓
33.		*Ilisha kampeni*		✓	✓
34.		*Opisthopterus tardoore*		✓	✓
35.		*Raconda russeliana*		✓	✓
36.	Engraulididae	*Coilia dussumieri*	✓	✓	✓
37.		*Coilia neglecta*		✓	✓
38.		*Coilia ramcarati*		✓	✓
39.		*Coilia reynaldi*		✓	✓
40.		*Encrasicholina heteroloba*			✓
41.		*Setipinna taty*		✓	✓
42.		*Setipinna tenuifilis*		✓	✓
43.		*Stolephorus andhraensis*			✓
44.		*Stolephorus baganensis*		✓	✓
45.		*Stolephorus commersonii*		✓	✓
46.		*Stolephorus dubiosus*	✓	✓	
47.		*Stolephorus indicus*		✓	✓
48.		*Stolephorus insularis*		✓	✓
49.		*Stolephorus waitei*	✓	✓	✓
50.		*Thryssa dussumieri*		✓	✓
51.		*Thryssa gautamiensis*		✓	✓
52.		*Thryssa hamiltonii*		✓	✓
53.		*Thryssa kammalensoides*		✓	
54.		*Thryssa mystax*		✓	✓
55.		*Thryssa purava*		✓	✓
56.		*Thryssa setirostris*		✓	✓
57.		*Thryssa stenosoma*		✓	
58.	Chanidae	*Chanos chanos*	✓	✓	✓
59.	Cyprinidae	*Catla catla*	✓		
60.		*Cirrhinus cirrhosis*	✓	✓	
61.		*Cirrhinus mrigala*	✓		
62.		*Cirrhinus reba*	✓		
63.		*Danio devario*	✓	✓	
64.		*Esomus danricus*	✓		
65.		*Labeo boga*	✓	✓	
66.		*Labeo boggut*	✓	✓	
67.		*Labeo calbasu*	✓	✓	
68.		*Labeo fimbriatus*	✓		
69.		*Labeo rohita*	✓		
70.		*Osteobrama cotio peninsularis*	✓		✓
71.		*Puntius conchonius*	✓	✓	
72.		*Puntius sophore*	✓	✓	
73.		*Puntius ticto*	✓	✓	
74.		*Puntius vittatus*	✓	✓	

SN.	Family	Scientific Name	Habitat		
			Fresh Water	Brackish Water	Marine Water
75.		*Salmostoma bacaila*	✓	✓	
76.	Cobitidae	*Lepidocephalus guntea*	✓	✓	
77.	Siluriformes	*Aorichthys seenghala*	✓	✓	
78.		*Mystus gulio*	✓	✓	
79.		*Mystus vittatus*	✓	✓	
80.		*Rita pavimentatus*	✓	✓	
81.	Siluridae	*Wallago attu*	✓	✓	
82.	Schilbeidae	*Pseudeutropius atherinoides*	✓	✓	
83.		*Silonia childreni*	✓	✓	
84.	Pangasiidae	*Pangasius pangasius*	✓	✓	
85.	Sisoridae	*Bagarius bagarius*	✓	✓	
86.	Clariidae	*Clarias batrachus*	✓	✓	
87.	Heteropneustidae	*Heteropneustes fossilis*	✓	✓	
88.	Ariidae	*Ariodes dussumieri*		✓	✓
89.		*Arius arius*		✓	✓
90.		*Arius jella*		✓	✓
91.	Plotosidae	*Plotosus canius*	✓	✓	✓
92.	Synodontidae	*Saurida micropectoralis*		✓	✓
93.		*Saurida tumbil*			✓
94.		*Synodus indicus*			✓
95.		*Trachinocephalus myops*			✓
96.	Harpadontidae	*Harpadon nehereus*		✓	✓
97.	Bregmacerotidae	*Bregmaceros macclellandii*		✓	✓
98.	Ophidiidae	*Brotula multibarbata*			✓
99.	Batrachoididae	*Batrichthys grunniens*	✓	✓	
100.	Hemiramphidae	*Hyporhamphus limbatus*		✓	✓
101.		*Hyporhamphus xanthopterus*	✓	✓	
102.		*Euleptorhamphus viridis*		✓	✓
103.	Belonidae	*Strongylura leiura*		✓	✓
104.		*Strongylura strongylura*		✓	✓
105.		*Xenentodon cancila*		✓	✓
106.	Oryziidae	*Oryzias melastigma*	✓	✓	
107.	Aplocheilidae	*Aplocheilus blocki*	✓	✓	
108.	Atherinidae	*Atherinomorus duodecimalis*		✓	✓
109.	Syngnathidae	*Halicampus koilomatodon*		✓	✓
110.		*Hippichthys cyanospilos*			✓
111.		*Hippichthys spicifer*			✓
112.		*Microphis brachyurus*			✓
113.	Synbranchidae	*Ophisternon bengalense*	✓		✓
114.	Scorpaenidae	*Minous monodactylus*			✓
115.		*Trachicephalus uranoscopus*		✓	✓
116.	Platycephalidae	*Grammoplites scaber*			✓
117.		*Platycephalus indicus*			✓
118.	Centropomidae	*Lates calcarifer*			✓
119.	Ambassidae	*Ambassis commersoni*			✓
120.		*Ambassis gymnocephalus*			✓
121.		*Ambassis kopsii*		✓	✓
122.		*Ambassis miops*		✓	✓
123.		*Pseudambassis ranga*		✓	✓
124.	Serranidae	*Epinephelus coioides*		✓	✓
125.		*Epinephelus malabaricus*		✓	✓
126.		*Promicrops lanceolatus*			✓
127.	Teraponidae	*Terapon jarbua*			✓
128.		*Terapon theraps*			✓
129.	Apogonidae	*Archamia lineolata*			✓
130.		*Sillaginopsis panijus*		✓	✓

SN.	Family	Scientific Name	Habitat		
			Fresh Water	Brackish Water	Marine Water
131.	Sillaginidae	*Sillago sihama*		✓	✓
132.		*Sillago vincenti*		✓	✓
133.	Lactariidae	*Lactarius lactarius*			✓
134.	Rachycentridae	*Rachycentron canadus*			✓
135.	Carangidae	*Alectis indicus*			✓
136.		*Atropus atropos*			✓
137.		*Carangoides oblongus*			✓
138.		*Caranx carangus*			✓
139.		*Caranx ignobilis*			✓
140.		*Caranx para*			✓
141.		*Caranx sexfasciatus*			✓
142.		*Megalaspis cordyla*			✓
143.		*Parastromateus niger*			✓
144.		*Scomberoides lysan*			✓
145.		*Scomberoides tala*			✓
146.		*Scomberoides tol*			✓
147.		*Trachinotus blochii*			✓
148.		*Trachinotus mookalee*			✓
149.	Leiognathidae	*Leiognathus blochii*		✓	✓
150.		*Leiognathus brevirostris*		✓	✓
151.		*Leiognathus dussumieri*		✓	✓
152.		*Leiognathus equulus*	✓	✓	✓
153.		*Leiognathus fasciatus*		✓	✓
154.		*Leiognathus splendens*		✓	✓
155.		*Secutor insidiator*		✓	✓
156.		*Secutor ruconius*		✓	✓
157.	Lutjanidae	*Lutjanus argentimaculatus*			✓
158.		*Lutjanus fulviflammus*		✓	
159.		*Lutjanus johni*			✓
160.		*Lutjanus kasnzira*			✓
161.		*Lutjanus russelli*			✓
162.	Lobotidae	*Lobotes surinamensis*			
163.	Gerreidae	*Gerres acinaces*			✓
164.		*Gerres filamentosus*			✓
165.		*Gerres lncidus*		✓	
166.		*Gerres macracanthus*		✓	
167.		*Gerres oyena*			
168.	Haemulidae	*Pomadasys argyreus*			✓
169.		*Pomadasys kaakan*			✓
170.		*Pomadasys maculatum*			✓
171.		*Pomadasys olivaceum*			✓
172.	Sparidae	*Acanthopagrus berda*		✓	✓
173.		*Acanthopagrus latus*		✓	✓
174.	Sciaenidae	*Chrysochir aureus*		✓	✓
175.		*Daysciaena albida*		✓	✓
176.		*Dendrophysa russelli*			✓
177.		*Johnieops aneus*			✓
178.		*Johnieops dussumieri*			✓
179.		*Johnieops sina*			✓
180.		*Johnius belangeri*		✓	✓
181.		*Johnius coitor*			✓
182.		*Johnius dussumieri*			✓
183.		*Nibea maculata*			✓
184.		*Nibea soldado*			✓
185.		*Otolithes ruber*		✓	✓
186.		*Panna microdon*			✓

SN.	Family	Scientific Name	Habitat		
			Fresh Water	Brackish Water	Marine Water
187.		*Protonibea diacanthus*			✓
188.	Mullidae	*Upeneus sulphureus*			✓
189.	Drepanidae	*Drepane longimanus*		✓	✓
190.		*Drepane punctatus*			✓
191.	Platacidae	*Platax orbicularis*			✓
192.		*Platax teira*			✓
193.	Scatophagidae	*Scatophagus argus*		✓	
194.	Nandidae	*Nandus nandus*			
195.	Cichlidae	*Etroplus maculatus*		✓	
196.	Mugilidae	*Liza macrolepis*			✓
197.		*Liza melinoptera*			✓
198.		*Liza parsia*		✓	
199.		*Liza subviridis*		✓	✓
200.		*Liza tade*			✓
201.		*Mugil cephalus*	✓	✓	✓
202.		*Rihnomugil corsula*	✓	✓	
203.		*Valamugil cunnesius*			✓
204.		*Valamugil seheli*			✓
205.	Sphyraenidae	*Sphyraena jello*			✓
206.		*Sphyraena obtusata*		✓	✓
207.	Polynemidae	*Eleutheronema tetradactylum*			✓
208.		*Polydactylus sexfilis*			✓
209.		*Polydactylus sextarius*			✓
210.	Uranoscopidae	*Uranoscopus cognatus*			✓
211.	Blennidae	*Omobranchus ferox*		✓	✓
212.		*Omobranchus punctatus*			✓
213.		*Omobranchus zebra*		✓	✓
214.	Callionymidae	*Callionymus filamentosus*		✓	✓
215.		*Callionymus fluviatilis*			✓
216.		*Callionymus sagitta*			✓
217.	Gobiidae	*Acentrogobius caninus*			✓
218.		*Acentrogobius cyanomos*			✓
219.		*Acentrogobius madraspatensis*		✓	
220.		*Acentrogobius masoni*		✓	
221.		*Acentrogobius viridipunctatus*			✓
222.		*Apocryptes bato*		✓	
223.		*Apocryptodon madurensis*		✓	
224.		*Bathygobius fuscus*			✓
225.		*Bathygobius ostreicola*			✓
226.		*Boleophthalmus boddarti*		✓	
227.		*Boleophthalmus dussumieri*		✓	✓
228.		*Callogobius meillnoptera*		✓	
229.		*Chiramenu fluviatilis*		✓	
230.		*Favonigobius reichei*		✓	✓
231.		*Glossogobius biocellatus*			✓
232.		*Glossogobius giuris*		✓	✓
233.		*Gobiopsis macrostoma*			
234.		*Mahidolia mystacina*		✓	✓
235.		*Oligolepis acutipennis*			✓
236.		*Oxyuricthys formosanus*		✓	
237.		*Oxyuricthys microlepis*			✓
238.		*Oxyuricthys tentacularis*			✓
239.		*Parachaeturichthys polynema*			✓
240.		*Paragobiopsis orbicularis*		✓	
241.		*Parapocryptes macrolepis*		✓	
242.		*Parapocryptes rictuosus*			✓

SN.	Family	Scientific Name	Habitat		
			Fresh Water	Brackish Water	Marine Water
243.		*Parapocryptes serperaster*		✓	✓
244.		*Periophthalmus koelreuteri*			✓
245.		*Pseudapocryptes lanceolatus*		✓	
246.		*Scartelaos histophorus*		✓	✓
247.		*Silhouttea indicus*		✓	
248.		*Stigmatogobius.javanicus*		✓	
249.		*Stigmatogobius micrognathus*		✓	
250.		*Stigmatogobius minima*		✓	✓
251.		*Stigmatogobius sadanundio*			
252.		*Stigmatogobius Yanamensis*		✓	
253.		*Yongeichthys criniger*			✓
254.	Gobioididae	*Odontanablyopus rubicundus*		✓	
255.		*Pseudotrypauchen multiradiatus*		✓	✓
256.		*Taenioides anguillaris*		✓	
257.		*Taenioides buchanani*		✓	✓
258.		*Taenioides cirratus*		✓	✓
259.	Trypauchenidae	*Amblyotrypauchen arctocephalus*			✓
260.		*Ctenotrypauchen microcephalus*			✓
261.		*Trypauchen vagina*			✓
262.	Eleotrididae	*Bunaka gyrinoides*		✓	
263.		*Butis butis*		✓	✓
264.		*Butis melanostigma*		✓	✓
265.		*Eleotris fusca*		✓	✓
266.		*Eleotris melanosoma*		✓	✓
267.		*Incara multisquamatus*		✓	
268.		*Odonteleotris canina*			
269.		*Ophieleotris aporos*		✓	✓
270.		*Prionobutis koilomatodon*		✓	✓
271.	Kurtidae	*Kurtus indicus*		✓	✓
272.	Acanthuridae	*Acanthurus bleekeri*			✓
273.		*Acanthurus xanthopterus*			✓
274.	Siganidae	*Siganus canaliculatus*		✓	✓
275.	Trichiuridae	*Eupleurogranlmus muticus*		✓	✓
276.		*Lepturacanthus savala*		✓	✓
277.		*Trichiurus lepturus*		✓	✓
278.	Scombridae	*Rastrelliger kanagurta*			✓
279.		*Scomberomorus commerson*			✓
280.		*Scomberomorus guttatus*		✓	✓
281.	Stromateidae	*Pampus argenteus*		✓	✓
282.		*Pampus chinensis*		✓	✓
283.	Anabantidae	*Anabas cobojius*		✓	
284.	Belontidae	*Colisa fasciatus*		✓	
285.	Channidae	*Channa punctatus*	✓	✓	
286.	Mastacembelidae	*Macrognathus aral*	✓	✓	
287.		*Macrognflthus pancalus*		✓	
288.	Bothidae	*Pseudorhombus arsius*		✓	✓
289.		*Pseudorhombus elevatus*		✓	✓
290.		*Pseudorhombus triocellatus*		✓	✓
291.	Soleidae	*Euryglossa orientalis*			✓
292.		*Euryglossa pan*		✓	✓
293.		*Solea ovata*		✓	
294.		*Synaptura albomaculata*		✓	✓
295.	Cynoglossidae	*Cynoglossus arel*		✓	✓
296.		*Cynoglossus bilineatus*		✓	✓
297.		*Cynoglossus cynoglossus*		✓	✓
298.		*Cynoglossus lida*		✓	✓

SN.	Family	Scientific Name	Habitat		
			Fresh Water	Brackish Water	Marine Water
299.		*Cynoglossus lingua*		✓	✓
300.		*Cynoglossus macrostomus*		✓	✓
301.		*Cynoglossus punticeps*		✓	✓
302.		*Cynoglossus semifasciatus*		✓	✓
303.		*Paraplagusia bilineata*		✓	✓
304.		*Paraplagusia blochii*		✓	✓
305.	Triacanthidae	*Triacanthus brevirostris*			✓
306.	Ostraciidae	*Ostracion tuberculatus*			✓
307.	Tetraodontidae	*Arothron reticularis*			✓
308.		*Arothron stellatus*			✓
309.		*Chelonodon fluviatilis*		✓	✓
310.		*Chelonodon patoca*		✓	✓
311.		*Lagocephalus lunaris*			✓
312.		*Lagocephalus spadiceus*		✓	✓

Source: Editor-Director, 2001. Fauna of Godavari Estuary, Estuarine Ecosystem Series 4:i-iv, 1-166 (ZSI, Calcutta)

Amphibians Reported from the Study Area

SN.	Family	Scientific Name	Common English Name	IUCN Status/WPA	Remarks	Observation
1.	Bufonidae	*Duttaphrynus melanostictus*	Common Asian Toad	LC / Not Listed	Frequent	Seen
2.	Dicroglossidae	*Euphlyctis cyanophlyctis*	Indian Skipper Frog	LC / Not Listed	Frequent	Seen
3.	Dicroglossidae	*Hoplobatrachus tigerinus*	Indian Bull Frog	LC / Not Listed	Frequent	Seen

Note: LC-Least Concern
Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Reptiles Observed / Reported from the Study Area

SN.	Family	Species	Common Name	Threat as per IUCN / WPA	Remark	Observation
A.	**Order : Testudines (Turtles)**					
1	Cheloniidae	*Lepidochelys olivacea*	Olive ridley turtle	Vulnerable/ Schedule 1	Frequent	Carcasses seen
2	Trionychidae	*Lissemys punctata*	Indian flapshell turtle	LC/I	Common	Seen
B.	**Order: Sauria (Lizards, Skinks, Geckos)**					
2	Agamidae	*Calotes versicolor*	Common calotes	LC	Common	Seen
3	Agamidae	*Sitana ponticeriana*	Fan-throated Lizard	LC	Common	Seen
4	Agamidae	*Psammophilous blanfordianus*	Rock Agama	LC	Frequent	Seen
5	Gekkonidae	*Hemidactylus brookii*	Brook's gecko	LC	Common	Seen
6	Gekkonidae	*Hemidactylus flavivirides*	House gecko	LC	Common	Seen
7	Scincidae	*Eutropis carinata*	Common skink	LC	Common	Seen

SN.	Family	Species	Common Name	Threat as per IUCN / WPA	Remark	Observation
A.	**Order : Testudines (Turtles)**					
8	Varanidae	*Varanus bengalensis*	Monitor lizard	LC/ Schedule 1 Pt II	Common	Reported in working plan
C.	**Order: Squamata (Squamata)**					
9	Colubridae	*Amphiesma stolatum*	Striped keelback	Not Listed	Common	Reported in working plan
10	Colubridae	*Ptyas mucosus*	Rat snake	Not Listed/ Schedule 2	Common	Reported in working plan
11	Colubridae	*Xenochrophis piscator*	Checkered keelback	Not Listed/ Schedule 2	Common	Seen
12	Elapidae	*Naja naja*	Spectacled cobra	Not listed/ Schedule 2	Common	Report

Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Avifaunal Species Observed/Reported from the Study Area

SN.	Scientific Name	Common Name	Family	IUCN Status	WPA Status	Migratory Status	Habitat
1	*Merops philippinus*	Blue tailed bee-eater	Meropidae	LC	IV	R	Open scrub, farmlands
2	*Merops orientalis*	Small green bee-eater	Meropidae	LC	IV	R	Open scrub, farmlands
3	*Cypsiurus balasiensis*	Asian Palm swift	Apodidae	LC	IV	R	Open scrub, farmlands, palm groves
4	*Dicaeum agile*	Thick-billed flowerpecker	Dicaeidae	LC	IV	R	Farmland, dense vegetation
5	*Anas poecilorhyncha*	Spotbilled duck	Anatidae	LC	IV	R	Wetland
6	*Terpsiphone paradisi*	Asian Paradise flycatcher	Monarchinae	LC	IV	R	Dense vegetation
7	*Ceryle rudis*	Lesser pied kingfisher	Alcedinidae	LC	IV	R	Wetland
8	*Calidris canutus*	Red Knot	Scolopacidae	LC	IV	WV	Wetland
9	*Streptopelia senegalensis*	Laughing Dove	Columbidae	LC	IV	R	Open scrub, farmlands
10	*Streptopelia chinensis*	Spottted dove	Columbidae	LC	IV	R	Open scrub, farmlands
11	*Pycnonotus cafer*	Red-vented bulbul	Pycnonotidae	LC	IV	R	All habitats
12	*Streptopelia decaocto*	Eurasian collared dove	Columbidae	LC	IV	R	Open areas, semi-arid
13	*Athene brama*	Spotted owlet	Strigidae	LC	IV	R	Vegetated areas
14	*Himantopus himantopus*	Black winged stilt	Dromadidae	LC	IV	R	Wetland
15	*Acridotheres tristis*	Common mynah	Sturnidae	LC	IV	R	All habitats
16	*Sterna caspia*	Caspian tern	Sturnidae	LC	IV	WV	Wetland, coastal areas, creeks
17	*Sturnus contra*	Pied myna	Sternidae	LC	IV	R	All habitats
18	*Acridotheres fuscus*	Jungle mynah	Sternidae	LC	IV	R	All habitats
19	*Nycticorax nycticorax*	Night heron	Ardeidae	LC	IV	R	Wetland
20	*Anthus rufulus*	Paddyfield pippit	Motacillidae	LC	IV	R	Open scrub
21	*Coracias benghalensis*	Indian roller	Coraciidae	LC	IV	R	Dry scrub
22	*Upupa epops*	Common hoopoe	Upupidae	LC	IV	R	Open scrub
23	*Prinia inornata*	Plain prinia	Sylviinae	LC	IV	R	Vegetated areas
24	*Prinia hodgsonii*	Grey breasted prinia	Sylviinae	LC	IV	R	Vegetated areas
25	*Mirafra cantillans*	Singing bush lark	Alaudidae	LC	IV	R	Semi-arid open fields, beach
26	*Tringa ochropus*	Green sandpiper	Scolopacidae	LC	IV	WV	wetland
27	*Ardea purpurea*	Purple heron	Ardeidae	LC	IV	WV	Wetland
28	*Dendrocygna javanica*	Lesser whistling duck	Anatidae	LC	IV	R	Wetland
29	*Ixobrychus cinnamomeus*	Chestnut bittern	Ardeidae	LC	IV	R	Wetland, paddy fields
30	*Ixobrychus flavicollis*	Black bittern	Ardeidae	LC	IV	R	Wetland
31	*Ixobrychus sinensis*	Yellow bittern	Ardeidae	LC	IV	R	Wetland
32	*Phalacrocorax niger*	Little cormorant	Phalacrocoracidae	LC	IV	R	Wetland

SN.	Scientific Name	Common Name	Family	IUCN Status	WPA Status	Migratory Status	Habitat
33	*Phalacrocorax fuscicollis*	Indian shag	Phalacrocoracidae	LC	IV	R	Wetland
34	*Amaurornis phoenicurus*	White breasted waterhen	Rallidae	LC	IV	R	Wetland
35	*Haliastur indus*	Brahminy kite	Accipitridae	LC	IV	R	All habitats
36	*Centropus sinensis*	Southrn Coucal	Cuculidae	LC	IV	R	Farms and dense vegetation
37	*Dicrurus macrocercus*	Black drongo	Dicruridae	LC	IV	R	Open scrub
38	*Bubulcus coromandus*	Eastern Cattle egret	Ardeidae	LC	IV	R	Wetland
39	*Limosa lapponica*	Bar-tailed Godwit	Scolopacidae	LC	IV	WV	Wetland
40	*Limosa limosa*	Western black tailed godwit	Scolopacidae	NT	IV	WV	Wetland
41	*Calidris minuta*	Little stint	Scolopacidae	LC	IV	WV	Wetland
42	*Chroicocephalus ridibundus*	Great back-headed gull	Laridae	LC	IV	WV	Sea coast
43	*Tringa totanus*	Common Redshank	Scolopacidae	LC	IV	WV	Wetland
44	*Anthus richardi*	Richard's pippit	Motacillidae	LC	IV	WV	Wetland
45	*Alauda gulgula*	Oriental skylark	Alaudidae	LC	IV	R	Semi-arid, open land, beach
46	*Tachybaptus ruficollis*	Little Grebe (Dabchick)	Gaviidae	LC	IV	R	Wetland
47	*Accipiter badius dussumieri*	Shikra	Accipitridae	LC	IV	R	All habitats
48	*Nettapus coromandelianus*	Cotton teal	Anatidae	LC	IV	WV	Wetland
49	*Perdicula asiatica*	Jungle bush quail	Phasianidae	LC	IV	R	Forest, grassland
50	*Ardeola grayii*	Indian pond heron	Ardeidae	LC	IV	R	Wetland
51	*Francolinus pondicerianus*	Grey francolin	Phasianidae	LC	IV	R	Open grasslands
52	*Corvus splendens*	House crow	Corvidae	LC	IV	R	Human habitats
53	*Artamus fuscus*	Ashy woodswallow	Artamidae	LC	IV	R	Dense palm groves
54	*Egretta garzetta*	Little egret	Ardeidae	LC	IV	R	Wetland
55	*Threskiornis melanocephalus*	Black headed ibis	Threskiornithidae	NT	IV	R	Wetland
56	*Pseudibis papillosa*	Black Ibis	Threskiornithidae	LC	IV	R	Wetland
57	*Egretta gularis*	Western reef heron	Ardeidae	LC	IV	R	Wetland, mangrove
58	*Charadrius leschenaultii*	Greater sand plover	Charadriidae	LC	IV	V	Wetland, mangrove
59	*Charadrius mongolus*	Lesser sand plover	Charadriidae	LC	IV	WV	Wetland, mangrove
60	*Tringa stagnatilis*	Marsh sandpiper	Scolopacidae	LC	IV	WV	Wetland, mangrove
61	*Pluvialis fulva*	Pacific golden plover	Charadriidae	LC	IV	WV	Wetland, mangrove
62	*Calidris alpina*	Dunlin	Scolopacidae	LC	IV	WV	Wetland, mangrove
63	*Calidris temminckii*	Teminick's stint	Scolopacidae	LC	IV	WV	Wetland, mangrove
64	*Charadrius alexandrinus*	Kentish plover	Charadriidae	LC	IV	WV	Wetland, mangrove
65	*Dendrocitta vagabunda*	Rufous tree pie	Corvidae	LC	IV	R	Dense vegetation
66	*Halcyon smyrnensis*	White breasted kingfisher	Alcedinidae	LC	IV	R	Wetland
67	*Milvus migrans*	Pariah kite	Accipitridae	LC	IV	R	All habitats

SN.	Scientific Name	Common Name	Family	IUCN Status	WPA Status	Migratory Status	Habitat
68	*Vanellus indicus*	Red wattled lapwing	Charadriidae	LC	IV	R	Wetland, open scrub
69	*Corvus macrorhynchos*	Jungle crow	Corvidae	LC	IV	R	All habitats
70	*Eudynamys scolopaceus*	Asian koel	Cuculidae	LC	IV	R	All habitats
71	*Dinopium benghalense*	Black-rumped flameback	Picidae	LC	IV	R	Dense vegetation
72	*Psittacula krameri*	Rose-ringed parakeet	Psittacidae	LC	IV	R	Dense vegetation
73	*Numenius phaeopus*	Whimbrel	Scolopacidae	LC	IV	WV	Wetland
74	*Tringa nebularia*	Green shank	Scolopacidae	LC	IV	WV	Wetland
75	*Mesophoyx intermedia*	intermediate egret	Ardeidae	LC	IV	R	Wetland
76	*Tringa glareola*	Wood sandpiper	Scolopacidae	LC	IV	WV	Wetland
77	*Calidris ferruginea*	Curlew sandpiper	Scolopacidae	LC	IV	WV	Wetland
78	*Tringa erythropus*	Spotted redshank	Scolopacidae	LC	IV	WV	Wetland
79	*Ardea cinerea*	Grey heron	Ardeidae	LC	IV	R	Wetland
80	*Casmerodius albus*	Great egret	Ardeidae	LC	IV	R	Wetland
81	*Vanellus cinereus*	Grey headed lapwing	Charadriidae	LC	IV	WV	Wetland
82	*Anastomus oscitans*	Asian Openbilled Stork	Ciconiidae	LC	IV	R	Wetland
83	*Metopidius indicus*	Bronze winged jacana	Jacanidae	LC	IV	R	Wetland
84	*Lanius cristatus*	Brown Shrike	Laniidae	LC	IV	R	Scrub
85	*Columba livia*	Blue rock pigeon	Columbidae	LC	IV	R	All habitats
86	*Cinnyris asiaticus*	Purple sunbird	Nectariniidae	LC	IV	R	Gardens
87	*Nectarinia zeylonica*	Purple rumped sunbird	Nectariniidae	LC	IV	R	Gardens
88	*Passer domesticus*	House sparrow	Passerinae	LC	IV	R	Human habitation
89	*Oriolus kundoo*	Golden oriole	Oriolidae	LC	IV	R	Habitation
90	*Gallirallus striatus*	Slaty-breasted rail	Rallidae	LC	IV	R	Mangrove wetlands
91	*Zoonavena sylvatica*	Indian white rumped spinetail	Apodidae	LC	IV	R	Coastal
92	*Butorides striata*	Striated Heron (Green heron)	Ardeidae	LC	IV	R	Wetland
93	*Calidris alba*	Sanderling	Scolopacidae	LC	IV	WV	Wetland
94	*Alcedo atthis*	Small blue kingfisher	Alcedinidae	LC	IV	R	Wetland
95	*Pandion haliaetus*	Osprey	Pandionidae	LC	I	WV	Wetland
96	*Larus brunnicephalus*	Brown headed gull	Laridae	LC	IV	WV	Seacoast

Note: LC-Least Concern; NT-Near Threatened, R-Resident, WV-Winter Visitor,Sch. -Schedule; Pt - Part; WPA- Wildlife (Protection) Act, 1972;
Source: Coastal Site and Surrounding Areas Survey by ERM during 12-19 Dec 2017 and 11-17 April 2018

Mammal Species Observed/Reported from the Study Area

SN.	Family	Scientific Name	Common Name	Category as per IUCN / WPA Sch.	Remarks	Observation
1	Cercopithecidae	*Macaca mullatta*	Rhesus Monkey	LC/-	Common	Reported
2	Canidae	*Canis aureus*	Jackal	LC /Sch. II	Common	Observed
3	Canidae	*Vulpes bengalensis*	Indian Fox	LC /Sch. II	Frequent	Reported
4	Felidae	*Felis chaus*	Jungle Cat	LC /Sch. II	Frequent	Reported
5	Felidae	*Prionailurus viverrinus*	Fishing Cat	EN/ Sch. I	Rare	Reported
6	Viverridae	*Viverricula indica*	Small Indian Civet	LC /Sch. II	Frequent	Reported
7	Viverridae	*Paradoxurus hermaphroditus*	Common Palm Civet	LC /Sch. II	Frequent	Reported
8	Herpestidae	*Herpestes edwardsii*	Grey Mongoose	LC /Sch. IV	Common	Observed
9	Mustelidae	*Lutragale perspicillata*	Smooth coated otter	VU/ Sch. II	Occasional	Reported
10	Leporidae	*Lepus nigricollis*	Indian Hare	LC/IV	Common	Reported
11	Soricidae	*Suncus murinus*	House Shrew	LC/-	Common	Reported
12	Sciuridae	*Funambulus palmarum*	Three-striped Palm Squirrel	LC/-	Common	Reported
13	Muridae	*Bandicota bengalensis*	Lesser Bandicoot-rat	LC/Sch.V	Common	Reported
14	Muridae	*Bandicota indica*	Bandicoot rat	LC/Sch.V	Common	Reported
15	Muridae	*Rattus rattus*	House Rat	LC/Sch.V	Common	Reported
16	Muridae	*Mus musculus*	House Mouse	LC/Sch.V	Common	Reported
17	Muridae	*Mus booduga*	Little Indian Field Mouse	LC/Sch.V	Common	Reported
18	Pteropodidae	*Pteropus giganteus*	Indian Flying Fox	LC/Sch.V	Common	Reported
19	Pteropodidae	*Rosettus leschenaultia*	Fulvous fruitbat	LC/Sch.V	Common	Reported
20	Pteropodidae	*Cynopterus sphinx*	Short nosed fruitbat	LC/Sch.V	Occasional	Reported
21	Pteropodidae	*Taphozous melanopogon*	Sheath-tailed bat	LC/-	Occasional	Reported
22	Pteropodidae	*Megaderma lyra*	Indian false vampire bat	LC/-	Occasional	Reported
23	Vespertilionidae	*Pipistrellus coromandra*	Indian Pipistrelle	LC/-	Common	Reported
24	Vespertilionidae	*Pipistrellus pipistrellus*	Common Pipistrelle	LC/-	Common	Reported
25	Manidae	*Manis crassicaudata*	Indian Pangolin	NT/Sch. I Pt I	Rare	Reported

Note: EN-Endangered, VU-Vulnerable, NT-Near Threatened, LC-Least Concern, Sch.-Schedule, IUCN - International Union for Conservation of Nature, WPA-Wildlife Protection Act, 1972
Source: Coastal Site & Surrounding Areas Survey by ERM during 12-19 Dec 2017 & 11-17 April 2018

Marine Fishes within the Kakinada Area

SN.	Family	English Name	Scientific Name	Depth of Occurrence	Peak period of Occurrence
A	**Marine Fish Species without Swim bladder (Cartilaginous Skeleton)**				
1	Carcharhinidae	Milk shark	*Rhizoprionodon acutus*	5 - 50 m	Feb.- May & Oct -Nov.
2		Grey sharpnose shark	*Rhizoprionodon oligolinx*	5 - 50 m	Feb.- May &Oct.- Nov.
3		Blacktip shark	*Carcharhinus limbatus*	5 - 50 m	Feb.- May &Oct. -Nov.
4		Spot-tail shark	*Carcharhinus sorrah*	5 - 50 m	Feb.- May &Oct.- Nov.
5	Rhincodontidae	Whale Shark**	*Rhincodon typus*	20-50 m	November-March,
6	Stromateidae	Brown pomfret	*Parastromateus niger*	5-50 m	Feb.- May,Aug. &Nov.
7		Silver pomfret	*Pampus argenteus*	5 - 50 m	Apr.-Jul. & Dec.
8	Svnodontidae	Greater lizardfish	*Saurida tumbil*	5-70 m	Jan., Jul. & Oct.- Dec.
9		Brushtooth lizardfish	*Saurida undosquamis*	5-70 m	Jan., Jul. & Oct.- Dec.
10	Rhinobatidae	Shovel-nose ray	*Rhinobatos annandalei*	3-80m	Dec. - Mar.
11	Myliobatidae	Common eagle ray	*Myliobatis aquila*	5-50m	Nov. – Apr
B	**Marine Fish Species with Swim bladder (Bony Skeleton)**				
12	Carangidae	Indian Scad	*Decapterus russelli*	10 - 80 m	Jan. - Apr.
13	Chirocentridae	Wolf herring	*Chirocentrus dorab*	3 - 70 m	Jul. - Sep.
14	Clupeidae	Indian Sardine	*Sardinella aurita*	1 - 60 m	Jan. - Nov.
15	Psettodidae	Flat fish	*Psettodes erumei*	5 - 50 m	Dec. - May
16	Dussumieridae	Rainbow sardine	*Dussumieria acuta*	Upto 50 m	Oct. - Dec.
17	Engraulidae	Spotty-face anchovy	*Stolephorus waitei*	Upto 50 m	Jan.-May & Jul. -Sep.
18		Commerson's anchovy	*Stolephorus commersonii*	Upto 50 m	Jan.-May & Jul.-Sep
19		Bagan anchovy	*Stolephorus baganensis*	Upto 50 m	Jan.-May & Jul.-Sep
20		Devis' anchovy	*Encrasicholina devisi*	Upto 50 m	Jan.-May & Jul.-Sep
21	Harpodontidae	Bombay duck	*Harpodon nehereus*	Upto 60 m	May - Oct
22	Lactaridae	White fish	*Lactarius lactarius*	5 - 50 m	Jul. - Sep.
23	Leiognathidae	Orangefin ponyfish	*Leiognathus bindus*	5 - 50 m	Jan-May & Oct. -Dec
24		Shortnose ponyfish	*Leiognathus brevirostris*	5 - 50 m	Feb., Jun., Jul. & Nov
25		Pugnose ponyfish	*Secutor insidiator*	5 - 50 m	Jun. - Sep
26		Toothpony	*Gazza minuta*	5 - 50 m	May, Aug. & Dec
27	Lutjanidae,	Bengal snapper	*Lipocheilus bengalensis*	5 - 50 m	Feb., May & Jul
28	Mullidae	Goat fish	*Upeneus vittatus*	5 - 50 m	Jul.-Sep. & Nov.-Dec.
29	Anguillidae	Indian Shortfin eel	*Anguilla bicolor pacifica*	5 - 50 m	Jul.-Nov.
30	Anguillidae	Mottled eel	*Anguilla nebulosa*	5 - 50 m	Jul.-Nov.
31	Nemipteridae	Mauvelip threadfin bream	*Nemipterus mesoprion*	10-80m	Dec. - Mar.
32		Japanese threadfin bream	*Nemipterus japonicus*	10-80m	Nov. - Mar
33		Delagoa threadfin bream	*Nemipterus bipunctatus*	10-80m	Sep. - Dec
34	Nomeidae	Drift fish	*Psenes indicus*	5-70 m	Oct. - Jan.
35	Polynemidae	Indian Salmon	*Eleutheronema rhadinum*	5-50m	Dec. - Feb
36	Sciaenidae	Longfin kob	*Atrobucca nibe*	5-60 m	Jan. - May
37		Karut croaker	*Johnius carutta*	5-50m	Sep. - Nov.
38		Sharptooth hammer croaker	*Johnius dussumieri*	5-50 m	Apr.-Jul.
39		Sharpnose hammer croaker	*Johnius borneensis*	5 - 50 m	Jan.-Jun.
40		Tiger-toothed croaker	*Otolithes ruber*	5 - 50 m	Apr. - Nov.
41		Blotched croaker	*Nibea maculata.*	5- 50 m	Jul. - Aug.
42		Greyfin croaker	*Pennahia anea*	5-70m	Jan. - Mar. & Dec.
43	Scombridae	Rake gillat mackerel	*Rastrelliger kanagurta*	Upto 80 m	Jan.- Apr. & Aug.-Dec.
44	Sphyraenidae	Sharpfin barracuda	*Sphyraena acutipinnis*	Upto 80 m	Dec.-Jun.
45	Trichiuridae	Largehead hairtail	*Trichiurus lepturus*	5 - 50 m	Oct. - Dec.
46		Gangetic ribbonfish	*Trichiurus gangeticus*	5-50m	Jan. - Dec.
47		Small headed ribbon fish	*Lepturacanthus savala*	5-50m	Jul. - Aug.
48		Small head hairtail	*Eupleurogrammus muticus.*	5-50m	Jul.-Aug.

Source: Marine Fish Calander, Kakinada, 1988 as updated with recent accepted Scientific Names

*** Sathiyaselvam P, Prashanthi P, Kathula T, Ravi Kumar M, Kalghatgi RG, Mishra SBL. Increasing numbers of whale sharks along the Andhra Pradesh coast, India – the conservation nd management initiatives taken by EGREE Foundation. QScience Proceedings (The 4th International Whale Shark Conference) 2016:iwsc4.55 http://dx.doi.org/10.5339/qproc.2016.iwsc4.55*

Annex 21

Site Specific Conservation Plan & Wildlife Management Plan for Schedule I Species

1 SPECIES SPECIFIC CONSERVATION PLAN FOR EXPANSION OF OFFSHORE & ONSHORE OIL & GAS EXPLORATION, DEVELOPMENT & PRODUCTION IN EXISTING RAVVA FIELD, PKGM-1 BLOCK LOCATED NEAR SURASNIYANAM VILLAGE (S.YANAM) IN KRISHNA GODAVARI BASIN, EAST GODAVARI DISTRICT, ANDHRA PRADESH

The annex covers wildlife conservation of Schedule I species observed in onshore and offshore PKGM-1 Block Study area.

1.1 ONSHORE HABITATS

The available onshore habitats within the study area are mangroves, beach habitats, shelterbelt plantation along coastlines, agricultural farms and backwaters. The onshore species of conservational significance are mostly confined to mangrove vegetation, beach habitats, and backwaters. The species identified within the onshore habitats are given in ***Table 1.***

Table 1 Onshore Species of Conservation Priorities in PKGM-1 Block Study Area

SN.	Species	Schedule 1 of the WPA, 1972	IUCN (2018-1) / CITES
1.	Olive Ridley Turtle (*Lepidochelys olivacea)*	Sch. I (Part II)	Vulnerable/ CITES Appendix I
2.	Indian flap shell Turtle (*Lissemys punctata)*	Sch. I (Part II)	Least Concern/ CITES Appendix II
3.	Smooth-coated otter (*Lutrogale perspicillata*)	Sch. II (Part IV)	Vulnerable/ Appendix II
4.	Monitor Lizard (*Varanus bengalensis)*	Sch. I (Part II)	Least Concern/CITES Appendix I
5.	Osprey (*Pandion haliaetus)*	Sch. I (Part III)	Least Concern/CITES Appendix II
6.	Brahminy Kite (*Haliastur indus)*	Sch. I (Part III)	Least Concern/CITES Appendix II
7.	Shikra (*Accipiter badius dussumieri)*	Sch. I (Part III)	Least Concern/ CITES Appendix II
8.	Pariah Kite (*Milvus migrans)*	Sch. I (Part III)	Least Concern/ CITES Appendix II
9.	Fishing Cat (*Prionailurus viverrinus)*	Sch. I (Part I)	Vulnerable/ CITES Appendix II
10.	Indian Pangolin (*Manis crassicaudata)*	Sch. I (Part I)	Endangered/CITES Appendix I

1.2 OFFSHORE HABITATS

The offshore species of conservational significance reported in the offshore habitat within the study area of PKGM-1 Blockfor are given in ***Table 2.***

Table 2 Offshore Species of Conservation Priorities of PKGM-1 Block Study Area

SN	Species	Schedule 1 of the WPA, 1972	IUCN (2018-1) / CITES
1.	Short-beaked Common Dolphin (*Delphinus delphis)*	Sch. I (Part I)	Least Concern/CITES Appendix II
2.	Common Bottlenose Dolphin (*Tursiops truncates)*	Sch. I (Part I)	Least Concern/CITES Appendix II

Note: Mink whale has been reported in Kakinada area much away (~50 km) from PKGM-1 Block.

The conservation plan for the identified the WPA Scheduled I species is given in ***Table 3***

Table 3 Conservation Plan for Species and Habitats of Conservational Priority Species in the Study Area

SN.	Species	Occurrence	Habitats within Study Area	Threats	Broad Conservation Actions	Responsibilities	Actions Required	Cost of Five Years Conservation Plan	
								Capital Cost (INR lakhs)	Recurring Cost (INR lakhs)
	Onshore Habitat				•				
1.	Olive Ridley Turtle (*Lepidochelys olivacea)*	Primary Survey and Secondary Sources	Solitarily nesting of Olive Ridley Turtles were observed during survey along the beach within the study area. EGREE Foundation along with State Forest Department has raised in-situ and ex- situ protection for Olive Ridley nests. The hatching success (1) of 84% has been achieved by State Forest Department. Some of the locations include Sacramento Shoals or Kandikoppamore than 10 km from any of the proposed wells. Gachykola Pora (GK Pora) (within Block Area), Surasariyanam (S Yanam) 440 m /SW of proposed well pad 1. and Vasalathippa 2 km /NW of A point of Block. These nesting sites are maintained by EGREE foundation and State Forest Department. These nests are under protection and two watchers from the local villages have been assigned duties during the nesting season (Novto April) for identification of any freshly laid nest, provide protection/barricading to each nest, note the date and time of laying and put a signage reflecting same. On the onset of hatching date, the hatchlings after emergence are safely transported to the sea. The total number of successful hatchlings are counted and the record is maintained for the entire nesting season. During the entire course of incubation, the watchers protect the nest from natural predators such a feral dogs and jackals in the region. Over the period, nesting protection effort by EGREE and Forest Department has increased the nesting frequency of Olive Ridley Turtles and the area is becoming an important solitary nesting habitat.	Following threats are envisaged to the nesting population within study area • the beach pollution (waste discarded offshore washed away onshore and accumulated in the beach area); • natural predators such as feral dogs and jackals which feed on the active nests and emerging hatchlings; • preying of hatchlings by raptor species; • Incidental capture in fishing nets or collision with trawlers; • natural threats such as beach erosion destroying the nesting habitat; and • Beach side light illumination can also disorient emerging hatchling to more towards shore instead of sea and lead to mortality.	• During nesting season, patrolling and monitoring of nests along the beach need to be strengthened. • Beach cleaning activities to be promoted involving Vedanta Ltd (Cairn Oil & Gas) staff, local communities and NGOs working in the area; • Minimization of existing lighting around beach area and installing the turtle friendly lights (wavelength between 590 nanometer (nm) and 610 nm) for any proposed installation, • Commission research studies involving reputed researchers to understand the breeding and nesting patterns of Olive Ridley Turtles in the Study area. • Assist EGREE and Forest department in sea turtle conservation education and awareness campaign, in the coastal villages and fishermen villages, promote usage of Turtle Excluder Devices in fishing nets.	Primary-Forest and Wildlife Department Secondary – Financial assistance from the company	a) Hiring patrolling boat to forest department for strengthening patrolling at the beach side areas. Capital cost of arranging survey equipment's and recurring cost for hiring of one boat during breeding and nesting season of turtles for patrolling b) Conducting one meeting annually by bringing in turtle expert and capacity building of the forest department staffs. Cost include development of posters, logistics for meeting and remuneration cost and logistics of external expert c) Putting up 10 signboards at access and approach roads Capital cost of erecting each signboard (Rs. 20,000), recurring cost for maintenance and reprinting. d) Awareness campaign to be conducted for conservation of marine turtle and cetacean species with fishermen community. Two meeting to be conducted per year. Cost include development of posters, logistics for meeting.	a) 1.0 b) 2.0 c) 2.0 d) 2.0	a) 15.0 (@ Average INR 3.0 per year) b) 10.0 (@ Average INR 2.0 per year) c) 5.0 (@ Average INR 1.0 per year) d) 10.0 (@ Average INR 2.0 per year)
2.	Indian flapshell Turtle (*Lissemys punctata)*	Primary Survey	Near Vasaltippa lagoon area, along fresh water channel, and backwaters.	Threats within the Study area is identified as hunting, mortality due to fish bycatch and road kills	• Identify basking sites of this species and enhance protection of these sites through village communities. • Awareness campaigns to be carried out among village communities, focusing on local schools for protection of the species • Involve local communities in celebration of wildlife week and create awareness to conserve these species.	Primary-Forest and Wildlife Department Secondary – Financial assistance from Vedanta Ltd (Cairn Oil & Gas)	As included above in serial no. 1 b	As included above in serial no. 1 b	As included above in serial no. 1 b

SN.	Species	Occurrence	Habitats within Study Area	Threats	Broad Conservation Actions	Responsibilities	Actions Required	Cost of Five Years Conservation Plan	
								Capital Cost (INR lakhs)	Recurring Cost (INR lakhs)
3	Monitor lizard (*Varanus bengalensis)*	Primary Survey	Monitor lizards in the study area was predominantly found in agricultural habitats.	Threats is identified as road kills	• While laying approach road, measures will be taken to keep natural drainage unhindered, by construction of culverts, which will provide crossing points for reptiles and minimize risk of road kill. • Awareness campaigns to be carried out among village communities, focusing on local schools.	Primary-Forest and Wildlife Department Secondary – Financial assistance from Vedanta Ltd (Cairn Oil & Gas)	As included above in serial no. 1 b	As included above in serial no. 1 b	As included above in serial no. 1 b
4	Smooth-coated otter (*Lutrogale perspicillata*)	Secondary Sources	Smooth coated Otters have been identified in a previous study [2] at Mangrove plantation area next to Ravva Terminal and close to Lagoon area near Gachykola Pora and Pallem village close to Mangrove vegetation area. The otter population in the study area was not worked out in the said study. The otter population in the nearby protected area Coringa Wildlife Sanctuary is on decline [1] (2002-324 Individuals, 2012-57 individuals).	The threats identified in the study area are 1. Loss of Habitat (Wetlands are being converted into Aquaculture Ponds and agriculture lands); 2. Over exploitation of fish fauna from the area; 3. Pollution of waterways with industrial, agricultural pesticides and municipal waste 4. High level of human disturbance in the mangrove habitat 5. Otters caught in fishing nets and get drowned(Otter Guards not used in fishing nets) and 6. Oil spills, poaching and conflicts with aquaculture and fisheries.	• Identify the habitats within the study area; • Estimate the population trends in the Study Area; • Development of new Mangrove habitats and restoration of degraded mangrove habitats; • Awareness for conservation of species in local population in order to minimize Human-Otter conflicts; • Awareness to local fisherman ti use fishing nets with Otter Guards	Primary-Forest and Wildlife Department Secondary – Financial assistance from Vedanta Ltd (Cairn Oil & Gas)	Funding for the research on the occurrence of Fishing Cat and Smooth Coated Otter in the area using camera traps. The cost included would be a onetime cost to be provided to the forest department for procuring equipment's and recurring cost to hired agency for conducting research	5.0	25.0
5	Fishing Cat (*Prionailurus viverrinus)*	Secondary Sources	Habitats [3] for Fishing Cat are the vast expanse of mangrove vegetation within the study area and shelterbelt plantation areas, aquaculture ponds for fishes. The species is nocturnal, their habitat can be traced with the help of the pug marks or scats as indirect evidences or direct sightings during the night surveys or camera trapping exercise.	There are chances of human-fishing cat conflicts in the study area. The existed human-fishing cat conflicts could be categorized into five different types viz. conflict between fishing cat and fishermen, aqua farmers, villagers, encounters during developmental activities and others like road kills, target killing, etc.,	• Forest department is trying to have a better knowledge about present distribution pattern of the species throughout the region. In this regards, forest department will be assisted by capacity building through funding camera trapping research in the Study area. • Awareness campaign will be carried out about conservation of Fishing Cats in the villages particularly focused on local schools and communities dependent on aquaculture. • Awareness programmes, radio-telemetry studies, responsible gap plantation and habitat restoration were recommended for conservation and management of the fishing cats	Primary-Forest and Wildlife Department Secondary – Financial assistance from Vedanta Ltd (Cairn Oil & Gas)	As included above in serial no. 4	As included above in serial no. 4	As included above in serial no. 4
6.	Indian Pangolin (*Manis crassicaudata)*	Secondary Sources	The species was reported[1] based on community consultation at N. Kothapalli that the species was observed by the locals in agricultural areas.	Threats within the Study area is identified as road kills	• Putting up signage on roads cautioning to go slow and emphasizing the right of way for animals. • Create awareness and sensitize company as well as contactor drivers driving project related vehicles through short orientation programme, to avoid road kill.	Primary-Forest and Wildlife Department Secondary – Financial assistance from Vedanta Ltd (Cairn Oil & Gas)	As included above in serial no. 4	As included above in serial no. 4	As included above in serial no. 4

SN.	Species	Occurrence	Habitats within Study Area	Threats	Broad Conservation Actions	Responsibilities	Actions Required	Cost of Five Years Conservation Plan	
								Capital Cost (INR lakhs)	Recurring Cost (INR lakhs)
7.	Osprey (*Pandion haliaetus)*	Primary Survey	Covering all available habitats, more concentrated near the lagoons, fresh water ponds and creeks	The anthropogenic threats to these species is mortality by electrocution from power transmission lines and entanglement in the protective net/nylon strings covers over the fish culture ponds.	• Birds of prey may sometimes select communication tower or tall manmade structures for nesting. Care should be taken before initiating any maintenance work in such structures to prevent mortality or nest loss. • Awareness campaign will be carried out in local villages, on conservation of birds of prey and their ecosystem services and values.	Primary-Forest and Wildlife Department Secondary – Financial assistance from Vedanta Ltd (Cairn Oil & Gas)	Awareness campaign to be conducted for conservation of identified Schedule I species, their ecosystem and values at two villages (preferable at village schools).	1.0	10.0
8.	Brahminy kite (*Haliastur indus)*	Primary Survey							
9.	Shikra (*Accipiter badius dussumieri)*	Primary Survey							
10.	Pariah kite (*Milvus migrans)*	Primary Survey							
	Offshore Habitat				•				
1.	Short-beaked Common Dolphin (*Delphinus delphis)*	Secondary Sources	Marine mammals such as Short-beaked Common Dolphin (*Delphinus delphis*) Common Bottlenose Dolphin (*Tursiops truncates*) and Mink Whale (*Balaenoptera acutorostrata*) are reported (4) from the offshore areas of the study area.	The main threats across these species is construction related noise and discharge of drilling waste, the Whale species will not be affected as atleast 50 m draft is required to whale species, however some impacts are envisaged to Dolphin species which can swim within 5 m draft. There is also threat of mortality due to fish bycatch of Dolphin species.	• Campaign will be carried out about awareness generation and conservation of these Cetacean species in the coastal villages, schools and particularly in fisherman community's dependent on sea. • Enhance offshore protection of Cetaceans by assisting Forest Department, State maritime fisheries department and Indian Coast Guard.	Primary-Indian Coast Guard Secondary – Forest and Wildlife Department Tertiary - Financial assistance from Vedanta Ltd (Cairn Oil & Gas)	As included above in serial no. 1 b	As included above in serial no. 1 b	As included above in serial no. 1 b
2.	Common Bottlenose Dolphin (*Tursiops truncates)*	Secondary Sources							
							Total	13.0	75.0

Note: 1. Biodiversity Management Plan of Coringa Wildlife Sanctuary 2013-2023 Andhra Pradesh Forest Department

2. Biodiversity Management Plan for Ravva Block, Vedanta Limited (Cairn Oil and Gas) January 2018 prepared by Terracon Ecotech Private Limited, Mumbai
3. Naidu A., Kantimahanti M., Kumar N. P., Thompson K. Sreedhar S.S. and Rao A. 2015. Recent records of fishing cat and its conservation in coastal South India. Cat News 62, 7-9.
4. http://www.marineconnection.org/docs/Indian_Marine_Mammals.pdf

Annex 22

Proceedings of Environmental Public Consultation

ANDHRA PRADESH POLLUTION CONTROL BOARD
REGIONAL OFFICE
Plot No.2,IDA, RAMANAYYAPET,KAKINADA-533005

A.Ramarao Naidu,
Environmental Engineer.

Ph :0884 -2374066
E-mail:rokkd-ee1@appcb.gov.in

Lr.No.14-R/PCB/RO-KKD/2018-1345

Date. 24 -10-2018.

To
Sri Sriharipasad Reddy,
Installation Manager,
M/s.Vedanta Limited (Cairn Oil & Gas),
S.Yanam Village,
Uppalaguptam Mandal,
East Godavari District.

Sir,

Sub: APPCB-RO-KKD- M/s.Vedanta Limited (Cairn Oil & Gas) – Application for "Expansion of Offshore & Onshore Oil & Gas Exploration, Development & Production in existing Ravva (PKGM-1) Offshore Block, of Surasaniyanam in Bay of Bengal, East Godavari District, Andhra Pradesh – Environmental Public Hearing (EPH) conducted on 11.10.2018 at 11:00 AM at Beach Front, Surasani Yanam Beach Road, Near the sites of proposed onshore well pads - 1,2 & 3, Surasani Yanam(V), Uppalaguptam(M), East Godavari District – Proceedings communicated – Regarding.

Ref:
1. EIA Notification, Dt.14.09.06 of MoE&F, Govt., of India.
2. Application of the Industry received on 23.08.2018.
3. MoEF TOR Lr. No. F. No. IA-J-11011/41/2018-IA-II (I), Dt.24.03.2018.
4. Inusty's letter furnished to the Joint Collector towards commitment for implementation of CSR activities on 23.10.2018.

* * * *

With reference to the above, It is to submit that M/s.Vedanta Limited (Cairn Oil & Gas) has proposed Offshore & Onshore Oil & Gas Exploration, Development & Production in 123 wells (83 Exploration wells + 40development wells) in existing Ravva (PKGM-1) Offshore Block, of Surasaniyanam in Bay of Bengal, East Godavari District, Andhra Pradesh, with estimated project cost of about Rs.7,924 Crores. For this project, the Public Hearing was conducted on 11.10.2018 under the Chairmanship of the Joint Collector & Addl. District Magistrate, East Godavari District.

The proceeding copy along with video CD of the hearing is here with submitted for favour of kind information and necessary action.

Yours faithfully,

24/10/18

ENVIRONMENTAL ENGINEER

Proceedings of the Environmental Public Hearing of M/s.Vedanta Limited (Cairn Oil & Gas) for the proposed Offshore & Onshore Oil & Gas Exploration, Development & Production in 123 wells (83 Exploration wells + 40development wells) in existing Ravva (PKGM-1) Offshore Block, of Surasaniyanam in Bay of Bengal, East Godavari District.

In accordance with the Notification No.S.O.1533, Dt.14.09.2006 of Ministry of Environment & Forests, Government of India, New Delhi, the Environmental Engineer, Andhra Pradesh Pollution Control Board, Regional Office, Kakinada published Notification in two leading Telugu & English newspapers for conducting Public Hearing and inviting suggestions, views, comments and objections from the Public on the proposed Offshore & Onshore Oil & Gas Exploration, Development & Production in 123 wells (83 Exploration wells + 40development wells) in existing Ravva (PKGM-1) Offshore Block, off Surasaniyanam in Bay of Bengal, East Godavari District. The Public Hearing was held on 11.10.2018 at 11.00 AM At Beach Front, Surasani Yanam Beach Road, Near the sites of proposed onshore well pads - 1,2 & 3, Surasani Yanam(V), Uppalaguptam(M), East Godavari District. The proceedings of the above Public Hearing are as follows:

The following Panel of Public Hearing was present and recorded the proceedings:

1) Dr. A.Mallikarjuna, IAS	Joint Collector & Addl. District Magistrate, East Godavari District. Chairman of the Panel.
2) Sri A.Ramarao Naidu	Environmental Engineer, APPCB, Regional Office, Kakinada. Member Convener,

The attendance of the Public Hearing is kept as **Annexure 'A'.**

At the outset, the Environmental Engineer, A.P.Pollution Control Board, Regional Office, Kakinada, welcomed the Joint Collector & Addl. District Magistrate, East Godavari District. He also welcomed the public representatives and the general public to the Public Hearing. He informed to the public that M/s.Vedanta Limited(Cairn Oil & Gas) approached A.P. Pollution Control Board on 23.08.2018 for proposed Offshore & Onshore Oil & Gas Exploration, Development & Production in 123 wells (83 Exploration

wells + 40development wells) in existing Ravva (PKGM-1) Offshore Block, off Surasaniyanam in Bay of Bengal, East Godavari District with Terms of Reference (TORs). Copy issued by Ministry of Environment & Forest and Climate Change, along with required number of copies of draft EIA, Executive summaries and requested for conducting Public Hearing as per procedure laid down in Environment Impact Assessment (EIA) Notification, 2006. The District Collector, East Godavari District, Kakinada has nominated the Joint Collector & Addl. District Magistrate, East Godavari District as Chairman of the Panel for conducting the Public Hearing. The Joint Collector, East Godavari District, Kakinada suggested, date, time and venue for conduct of Environmental Public Hearing. After approval and fixation of the same by the Member Secretary, A.P. Pollution Control Board; the Regional Office, Kakinada issued a Paper notification and the same was published on 10.09.2018 in The Hindu and Eenadu daily news papers. He also informed to the public that in the paper notification people are requested to attend the public hearing to express their views, suggestions, objections, comments etc. The required information i.e. Draft EIA report and Executive Summary in Telugu & English both hard & soft copies were kept in the respective places for public access at the offices of District Collector, Zilla Prasishad, District Industries Centre, Kakinada; Revenue Divisional Officer, Amalapuram; Tahsidar, Katrenikona; Tahsildar, Uppalaguptam; Panchayat Secretary, Katrenikona, Chirrayanam & S.Yanam, East Godavari District and also requested for wide publicity about the Public Hearing in the area. The information was also communicated to the Joint Director, MoEF&CC, Regional Office, Chennai; Regional, Zonal, Head Offices of A.P. Pollution Control Board as per the procedure laid in the EIA Notification, 2006 inviting views, objections, suggestions from the public. He also informed that the APPCB on 05.10.2018 addressed letter to the concerned Panchayat Secretary i.e. Katrenikona, Chirrayanam & S.Yanam for giving wide publicity about the proposed Public Hearing by way of Tom Tom/through Public address system. He requested the Joint Collector, East Godavari District and Chairman of the Public Hearing panel to start the proceedings.

The Joint Collector & Addl. District Magistrate, East Godavari District welcomed the general public to the public hearing on the proposed Offshore & Onshore Oil & Gas Exploration, Development & Production in 123 wells (83 Exploration wells + 40 development wells) in existing Ravva (PKGM-1) Offshore Block of Surasaniyanam in Bay of Bengal, East Godavari District. He also informed to the public that the stake holders i.e. representatives of the industry would explain the project details and opportunity would be given to all the general public attended from the proposed three

villages to express their doubts, suggestions. It is an open forum to express views of the public independently. He requested the project authorities of the proposed project to explain about the proposed project in detail.

The Environmental Engineer, A.P. Pollution Control Board requested the project proponent to explain the proposed project in detail.

Sri Srihari Prasad Reddy, Installation Manager, Vedanta Limited welcomed the general public and he informed the following:

- The existing Ravva Offshore & Onshore plant has been operating for the last 24 years at S.Yanam Village to produce crude oil & gas and production gradually decreasing in capacity and developing wells from time to time and proposing new proposal for increasing production capacity.
- The existing plant has been carrying out CSR activities for the past 24 years. The villages in the surrounding areas would be developed only due to production of oil & gas in this area. Due to exploration of oil & gas in India, need not require to buy the crude oil from International market thereby reduces foreign exchange.
- M/s.Vedanta Limited has onshore plant at S.Yanam Village and has 8Nos. of offshore platforms. The total area of the exploration area is 331.26 Sq.Kms. and most of the area is in offshore. The partners of the plant at S.Yanam village are ONGC (40%), Ravva (Singapore based company), Videocon and Vedanta Limited. Vedanta Limited which is partner and operator at present. The production capacity of the Ravva field is 50000 Barrels of crude/day and Gas 2.3MMSCMD. At present, the production capacity is about 15,000 Barrels of Crude/day and Gas production is about 1.4 MMSCMD. The present project is proposed to increase the production capacities of crude oil and gas production.
- **Offshore facilities existing:** 8 Nos. of unmanned platforms, vessels and pipeline network to transport the crude oil/gas from the platforms to Ravva Onshore terminal are existing. A facility at offshore at a distance of about 17Kms., is to support for export of the separated crude oil through Single Point Mooring to the oil tankers.
- **Onshore facilities exiting:** 3 Nos. of trains to refine/separate oil & gas and water from the crude oil received from the offshore unmanned platforms are existing. There are 4Nos. of crude oil storage tanks with capacity of 1000000 Barrels. 4Nos. of captive gas based power generators of capacity of 10MW in

total. The produced water received along with oil & gas is being treated and re-injected into the formation. The facility having 6 Nos. of bore wells approved by WALTA and the saline water drawn from these wells is being treated and injected into the operational wells.

- 3000 m^3/day capacity Effluent Treatment Plant (ETP) is provided to treat the wastewater generated in the plant and has a marine disposal facility to dispose of the treated effluent into Sea at a distance of about 600mtrs.,
- 75 m^3/day capacity Sewage Treatment Plant (STP) is provided to treat the domestic wastewater generated in the plant and living quarters. The treated domestic wastewater is being utilized for onland for gardening without disposing of the same into outside premises. The facility has provided living quarters for 90 peoples.
- **Proposed project details:** Production of the existing plant decreased due to production of oil & gas for the past 24 years. 123 Nos. of drilling wells proposed, out of which 83 Nos. of walls are exploratory wells and 40Nos. of wells are development wells. 59Nos. of wells are standalone drilling wells, which would be drilled outside the platform. 14Nos. of would be drilled from the existing offshore 8Nos. of platforms. The proposed drilling of 123Nos. of wells would be drilled in a phased manner in the next 10years. 7Nos. of onshore well pads would be developed for drilling, out of which 5Nos. of wells pads would be developed within PKGM-1 block and remaining two outside the PKGM-1 block. About 15Kms. pipeline corridor (for laying three pipelines) would be developed to connect the well pads to onshore terminal. The proposed project cost is estimated as Rs.7924 Crores.
- The proposed project requires Environmental Clearance from Ministry of Environment Forest & Climate Change, GoI, as per EIA Notification 2006. The proposed project also requires CRZ clearance as per CRZ Notification 2011. The MoEF&CC, GoI issued Terms of References (TORs) to the proposed project. As per the TORs issued Environment Impact Assessment was carried out for the proposed project. The proposed 7Nos. of onshore well pads, would be developed along the coast, located at a distance ranging from 50 to 500mtrs., and which would not disturb the Sea shore.

- **Baseline study:** Baseline study was carried out in the PKGM-1 block which is existing in between River Gautami on Eastern direction and River Vasista on Western side. About 90% of the area of PKGM-1 Block is existing in Offshore. The climate in the area is semi-arid. Ambient Air Quality Monitoring (AAQM) was conducted during the period from January, 2017 to March, 2018 at 8 locations in the study area, and as per the monitoring reports Ambient Air Quality is within the National prescribed standards. Noise monitoring was also conducted during the period from January, 2017 to March, 2018 at 8 locations in the study area and they are within the prescribed standards. Soil quality was tested in 6 locations and as per the reports, the quality of the soil is similar to the soil quality at sea shore area. No heavy metals detected in the soils tested in the study area. Ground water quality study was conducted at 4 locations, and as per the analysis it was observed that Total Dissolved Salts (TDS) are in higher side, revealing that the ground water could not be used directly without treatment. Surface water quality was conducted in canals, wells and back water creeks and it was revealed that no impact on the surface water quality in the study area. The surface water quality in the study area is in Class-B i.e. water could be used for bathing and Class-D i.e. suitable for wildlife & aquaculture. Sea water samples were also collected at 8 locations at 3 different depths and all the samples meeting the standards prescribed. Impact Assessment was carried out in 2KMs and 10KMs radius in the study area. In the study area there are 15 types of animal species and 7Nos. of tree species were identified. 14 types of fish species were also identified in the study area. Olive ridleys turtle species were also identified in the study area. No National parks, wildlife sanctuary existing within 10Kms radius of PKGM-1 Block area. Very small areas of Reserve Forests existing within the study area. Koringa Wild Life Sanctuary is existing at a distance of about 18 KMs. from the PKGM-1 Block, at which Mangrove Forest, back water lagoons canters, shelters plantations are existing. Three species of Amphibians; 14 species of reptiles; 96 species of birds identified in the study area. Olive redleys turtle, Indian flap shell turtle, Monitor Lizard, Osprey, fishing cat and Indian Pangolin of Schedule – I species were identified in the study area.
- **Socio Economics of the study area:** As per census 2011, population is 5,614 with in 2KMs radius, 1,81,764 from 2 – 10 KMs radius. Literacy in the study area is 63.42% and female literacy is 58.98%. Paddy cultivation is a major occupation engaging 70% of active work force. Fishing non-farming activities i.e. working as

agricultural labour, labour in oil & gas operational business units and local trading in the area. All villages within 5KMs. radius from Ravva Terminal have access to Primary & Secondary schools. All the mandals have operational Primary Health Care Centres with District Hospital at Rajahmundry. Amenities such as electricity supply to all the villages.

- **Impact Assessment:** Under water noise from support vessels, rotation of rig drilling bit, Noise from helicopter vessels, Noise during operation of machineries, equipment, DG Sets anticipated and the impact would be short time and proposed to avoid sudden loud noises maintaining the vehicles in good condition, maintaining minimum in-transit flying altitude for helicopter, regular maintenance of drilling equipment and acoustic enclosures to the DG Sets to mitigate the noise from the proposed activity.
- Treated drilling cuttings, residual water based drilling mud other solid waste such as packaging waste, food waste would be generated and proposed to use water base mud synthetic oil based mud with low toxicity would be used and Unused SBM will be collected and re-used in the next drilling.
- On-Board STP will be provided to treat the wash water and deck drainage for treatment and all offshore wastewater would be treated to International standards (MARPOL).
- Emissions from DG Sets would be controlled by operating low Sulphur diesel as fuel and would provide prover acoustic enclosures for control of noise pollution.
- HDPE lined pits would be provided for storage of drill cuttings, spent mud, drilling wastewater, formation water etc., and Waste Management Plan would be implemented for storage, transportation and disposal as per Hazardous Waste Rules and authorization conditions.
- Water sprinkling at access roads and construction sites to reduce dust emissions would be provided.
- Risk assessment for activities have been undertaken as part of EIA. Oil spill risks have been evaluated, appropriate preventive and mitigation measures would be in place for which Ravva field emergency response plan specifically developed.
- De-commissioning of plan will be developed to the culmination of the life of Ravva operations in accordance with the applicable legislations and guidelines (MoEF&CC, DGH & OISD) and requirements of PSC.

- Compensation would be given to the affected land owners for any loss of land. Environment Management Plan (EMP) would be strictly followed.
- Implementation of IMS, ISO 14001 and OHSAS 18001 would be continued.
- As per guidelines issued by MoEF&CC 0.25% of project cost would be allocated under CER activities under the supervision the District Collector.
- Implementing CER activities for education, skill development, infrastructure creation for drinking water supply, hospitals, roads implemented. About 28.64 Crores spent under CSR programme for the last 6 years for infrastructure development in 46 villages in Uppalaguptam & Amalapuram mandals of East Godavari District.
- Employment was provided 300 people from Surasaniyanam and surrounding villages. Developed 80 Nos. of Micro vendors in Surasaniyanam Village and awarded contracts worth Rs.40.0 Crores. Education programme to Pre-school and un-employed youth with all age groups was provided.
- 50% employment was provided to the local S.Yanam surrounding village people.
- 667 families of S.Yanam Village benefited from the existing Ravva plant out of 1000 families.
- Award of contracts for Micro Vendors increased from Rs.3.6 Crores (2011 – 2012) to Rs.7.6 Crores for the year 2017 – 2018.
- Year wise placements increased from 1 (2014) to 229 (2017) at various companies through CNKCs.

The project proponent requested the public for whole hearted support for the proposed project in the interest of National perspective for the energy security of the country and sustainability of production from declining oil fields in the east coast.

The Environmental Engineer, Kakinada requested the general public to express to their views, suggestions, objections if any one by one.

Sri Nagini Nageswar Rao, ZPTC, Katrenikona expressed his concerns that the promises made in the earlier public hearings by the project authorities such as ONGC, GSPC, Reliance & Vedanta Limited had not been implemented. He questioned the project authorities that whether the project authorities halts the proposed project, if the people oppose the same. He also expressed his concerns that the project authorities had not been implementing the promises made during the public hearing, citing the

example that earlier, during the Sri G.M.C. Balayogi period, CSR fund was earmarked initially to S.Yanam Village only, latter allocation of funds extended to mandal level and further to constituency level. He also expressed his concerns that due to exploration of oil & gas in the area, soil subsidence witnessing in the entire coast, thereby causing earthquakes in the area. He also disagreed that no turtles existing in the area and they were disappeared long back. He also expressed his concerns that due to exploration of oil & gas the sea food wealth was considerably decreased in the area. He also opined that monthly allowance shall be provided to the entire fishermen communities and agriculturalists in this area. He also informed that earlier, they staged dharnas infront of Ravva plant for fish death in this area due to pollution and the project authorities managed the higher officials and got a report stating that fish death in this area was not due to pollution from the plant. He also informed that the people of this area are not against establishment of oil companies. If any proposal established, it would be beneficial for development of this area citing the example of development of S.Yanam Village. He demanded for monthly compensation, as they have been loosing their wealth, similarly given by Reliance Industries @ Rs.6700/- per month and also informed that GSPC announced monthly compensation to about 16000 families till the completion of drilling activities, but, they have given compensation for 6 months only instead of 23 months as per agreement. He also informed that the issue of compensation was brought to the notice of the then District Collector, East Godavari District for solving the issue, but not materialized. He also informed that while establishing the project, the authorities informing that there would not be any pollution problems from the proposed project and questioned that why turtles, disappeared in this area. The project authorities drilled two wells in Gatchakayalapuram and Katrenikona, due to which the roads in this area are completely damaged. The Government sanctioned Rs.8.0 Crores for laying of roads in this area, and apprehended that if the project authorities re-start their activities, again roads would be damaged. He also alleged that due to pollution from the drilling activities, the sea food productivity in this area completely damaged and due this, the youth from the villages are migrating to other areas for their livelihood. He also alleged that earlier, they got about 5Kgs of fish by each fisherman, and now they could not get even ½ kg due to pollution problem. He reiterated that due to pollution from the drilling activities, sea food productivity, agricultural productivity completely damaged in this area and the farmers are converting the fertile agricultural lands into ponds, as no other way. He demanded again for compensation to the lands damaged due to drilling activities, and also

suggested that the project authorities shall adopt the villages for development. He also informed that the impact of drilling activity is not confined to this area only, the impact would be more upto 1000 of KMs in the underground and questioned the project authorities that how many tankers of oil they have been producing and re-injecting how many tankers of water into the well. He also alleged that due to drilling activity, the underground would be loosen further, which may lead to earthquakes in this area. While welcoming the project, he further demanded that a committee shall be constituted with members of Revenue, people representatives, village elders for obtaining concrete proposal for fixation of monthly compensation particularly to the fisherman community and agricultural farmers from the project authorities. He also alleged that no employment was given to locals even for security guards by the existing plants and demanded for employment and livelihood for the locals.

Isukapatla Ravi Babu, R/o. Challapalli, informed to the public that the daily life of people in India interconnected with the oil & gas fuels, which is very precious. The people have different opinions on exploration of oil & gas in this area. About 24years back the existing Ravva plant established in this area. The GoI started the Ravva plant operations with joint venture, and this may be due to non-availability of technology at that time in India. The existing plant changed from combined petroleum, Cairn Energy and finally into Vedanta Limited at present. The oil production decreased to about 15000 Berrals/ day at present from the installed capacity of 50000 Barrals/day. Gas production is also decreased to 1Lakh m^3 from 2 to 3 Lakh m^3/day. The project authorities have proposed about 123 Nos. of Exploratory and development wells to explore oil & gas. The people in this area are ready to co-operate but, the activities that are being taken up by the project authorities are not upto satisfactory level. At present, about 10 Lakh Barrles oil storage facilities exiting in this area. Earlier, the village of S.Yanam is also very similar to Chinra Yanam Village with salt marshes and the lands in these villages were affected due to inundation of salt water and the authorities thinking that after establishment of Ravva field the S.Yanam Village is well developed with all facilities, which is not true. About 2% of the profits shall be earmarked for CSR activities and accordingly, the Ravva plant should earmark at-least Rs.10.0 Crores annually. Initially, during the tenure of elders Sri Dangeti Kotayya, he also staged dharnas for CSR funds and CSR fund allocation started with Rs.1.0 Crore annually and gradually increased to Rs.5.0 – Rs.6.0 Crores at present. He expressed his concerns that the plant operations started way back in 24 years, but, no infrastructure facilities provided in S.Yanam including Challapalli village except laying of roads in S.Yanam Village. He

also expressed his concerns that the Ravva plant authorities could not even supply the drinking water in the villages till today, inspite of huge amounts of CSR funds allocated. People in this villages facing water scarcity and during the summer it is more intensive. He also expressed his concerns that the surrounding villages of Ravva Plant have been witnessing chemical, water and noise pollution due to operations of Ravva Plant. Whenever, the people in this area raised pollution problems due to operation of the Ravva plant, he informed that the project authorities stating no pollution problems due to their operations, monitoring the irrelevant parameters and the operations are being carried out as per the international standards. He also expressed his concerns that due to operation of existing plant, the people in this area have been witnessing health problems such as hair fall, gastric, cancer and pregnancy problems and requested the Government authorities to enquire the people about the same. 24years back the project authorities promised for 24beded hospital in this area, but, it was materialized in the recent past only. The people in this area dreamed that they need not go for medical treatment either to Amalapuram or to Kakinada, after establishment of fully equipped hospital. But, the facilities provided at newly constructed hospital are not fully adequate. As per the then agreement, the project authorities should give 36% of permanent employment to the locals, but, at present, the authorities provided permanent employment to 8 Nos. of local people only, out of 105 employees working, and the project authorities stating that the employment decreased due to low production of oil & gas. At present, the project authorities recruited about 333 local people as contract employees and about 200 people recruited non-local people engaged from about 2000 Kms., of Chennai. He questioned the project authorities that why they engaged non-local people despite availability in the local area. He informed that lot of unemployed youth with fully technical qualification available in this area and requested the project authorities not to engage people from other places and recruit the local people in contract employment, as thousands of crores of wealth from this area has been taken out by the project authorities. He also opined that the S.Yanam village was developed due to establishment of Cairn Energy and certain development activities is happening in this area but not upto the mark. At present, the wells and drilling activities are being carried out in offshore, due to discharge of sludge, oil wastes into Sea, fish breeding capacity has been decreasing. The project authorities shall adopt sage culture and shall support the fisherman community providing latest technology. The project authorities shall also provide mechanized boats, nets to the local fisherman community, as these people depends only on fishing activity. The Konaseema area is covered with sea

mashes, rivers and Sea and hundreds of fisherman families depending on them, because of oil & gas exploration in this area, the local people loosing their livelihood and asked the project authorities are directly or indirectly reason for that. He further requested the project authorities to re-think about the issues raised by the public as people in this area are always co-operative for such projects. As stated by the project authorities, they are always very co-operative for development of India, exploration, production and usage of Oil & Gas locally and also to decrease the imports of Oil & Gas. He re-iterated that the project authorities shall solve the local problems and shall give employment to the locals. He questioned the project authorities that where the greenbelt was developed and how many acres of greenbelt developed for the past 24years. He suggested that if, requisite land is not available for development of greenbelt, the project authorities may take land from local farmers on lease basis for development of greenbelt. He also informed that the project authorities have not been giving employment to other villagers except S.Yanam, citing that that the people of S.Yanam have not been willing to give employment to other villages. He also informed that while explaining the project detail by the authorities stated that about 50% of the employment has been giving to local people and requested the project authorities about 30% employment may be given to S.Yanm Village and 20% to other villages. He questioned the project authorities that during the job mela conducted in the recent past, whom they have given the employment and requested for employment should be given to locals only, as people of this area are prone to accidents due to the exploration activity citing the example of Mamidikuduru accident. Out of thousand families in the village, about 600families are getting benefitted by way of employment, small contracts and he demanded that the project authorities shall pay the current bills, shall provide daily commodities on monthly basis to the remaining 400 un-benefited poor families as monthly package. He informed that they would support the project duly implementing the local issues pertaining to employment, pollution problems, compensation to the poor families raised in the public hearing.

R/o. S.Yanam demanded for monthly compensation of Rs.5000/- per family. He expressed his concerns that they have been facing health problems due to pollution problems from the plant and also informed that earlier, 200 woman protest for medical compensation and all the 200 women arrested during the pretest. Particularly fisherman community in this area has been loosing their livelihood due to the plant operations and many people migrated for work. He also demanded that after giving monthly compensation of Rs.5000/- per family, employment and medical compensation to each

family, only they would allow the proposed project, otherwise, people in this area will protest.

Sri Lanke Bhimaraju, R/o. of S.Yanam informed that the people of S.Yanam Village always co-operative for establishment of industries. While carrying operations, the project authorities shall also taking into consideration of loss to the local people. Fish productivity in this area has been gradually decreasing for the past 30 years due to operations of oil & gas exploration industries. Due to decrease in livelihood to fisherman community, many families migrated to other areas as casual labour and requested the environment department to study the issue in detail. Whether it is a misconception or real, the health problems of cancer and gastric increased in this area for the last 20years and requested the environment department to study the issue in detail and reasons may be found out. The project authorities of Vedanta Limited have been carrying out drilling activities in S.Yanam and Chirra Yanam villages and during operations excess gas would flared and the other wastes such as water, oil if releases in to local water sources and back waters, the lands would not be suit for agriculture and particularly the fisherman community would face inconvenience and if it happened, compensation shall be given to the land owners and fisherman community of the area and same should be incorporated in the activities proposed. He also informed that earlier, the project authorities encouraged education benefits to the local fisherman community, same is slow down gradually in the recent past and suggested that the project authorities shall re-start, continue and increase educational benefits to children of fisherman community of this area under the chairmanship of the District Collector. He also informed that earlier, during the oil & gas exploration activity compensation was given in Yanam Village as well as in Gadimoga Village by the industries and in the same way the project authorities shall give compensation to all the affected villages. While welcoming the project, the project authorities shall take all the measures and shall carry their operations without causing any inconvenience to the local people.

Sri A.Narasimha Murthy, R/o. Chirrayanam, Ex.Sarpanch informed that due to activities of GSPC, fish productivity has been decreasing and turtle nesting grounds, which were existing earlier, were also disappeared due to activities of ONGC. He requested the project authorities to adopt their village i.e. Chirrayanam for solving water problem and shall carryout different development activities. While welcoming the project he requested the project authorities to carry their operations without causing any convenience to the local people.

Sri M.Annavaram, R/o.Chirrayanam, Ex.Sarpanch informed that earlier, the ONGC carried out its operations and promised hospital and CC roads in the village, and completed its operations for 3 – 4 years and not even allocated Rs.1000/- to their village for development. He also informed that no development activities promoted in the village, for which they also staged protest. He also informed that development by the industry confined to the S.Yanam village only, they could not have even transport facilities during the emergency for maternity, and it would take atleast one hour time to reach nearest hospital. He also informed that the roads in this area are completely damaged due to activities of oil & gas exploration industries and minimum three hours time is taking to reach hospital at Amalapuram by auto in the emergency. While welcoming the project, he suggested that the Government authorities shall obtain a concrete proposal from the project authorities pertaining to implementation of CSR activities in the area.

R/o.Katrenikona informed that the ONGC authorities have been carrying its activities in this area since long time. During the drilling activities, the project authorities have been giving very small amount of compensation to the adjacent land owners and there is no mention about the specific amount to be given. After completion of the drilling activity, the un-succeed bore wells are filling with soil of 3 – 4 tractors capacity only, which is in sufficient and the farmer could not carry agricultural activity immediately. He suggested that instead of giving small amount of compensation to the land owners, a fixed amount shall be given equal to the amount lost due to unfavorable condition for agriculture per year. He requested the project authorities that more CSR funds shall be allocated in this area towards education, establishment of play grounds and laboratories, libraries and computers, as they would be help the people. Nobody can stop the activities of oil & gas exploration in this area and these would be explored either by the present management or some other company. He also informed that a special package should be given to each family, besides allocation of more CSR funds for development of infrastructure in this area. He also suggested that monthly package shall be given to poor families in this area. More CSR funds shall be allocated and advised the project authorities that a residential school shall be established for the merit students of Katrenikona & Uppalaguptam mandals, so that all the engineering people required for ONGC would be produced here only. He also suggested that greenbelt shall be developed in these villages duly giving employment to the local people, so that the people in this area developed socio economically.

Sri B.Suri Babu, R/o.Chirrayanam – Gachikayalapuram MPTC expressed his concerns that due to activities of ONGC, Cairn Energy, GSPC and Reliance Sea fish productivity was decreased. He and on behalf of his village opposed the proposed oil & gas exploration activity. Earlier, they protest against the activities of oil & gas exploration due to which Sea fish productivity decreased and the oil companies promised compensation for two years to each fisherman family, but, compensation was given for only 6 months to few people only. He expressed his concerns that they would allow the processing of public hearing only after obtaining concrete proposal from the project authorities. He also alleged that the Government has not been taken care about the endangering of fisherman community in the area and the Government has not showing the interest like protecting wild life to the fisherman community. He suggested that the project authorities shall provide boats & nets to the local fisherman community. Drinking water infrastructure facilities shall also be provided to their fisherman society. 100 Nos. of additional solar lights shall be provided, as they have facing poor visibility of roads particularly during the cyclones. Hospital facility shall also be provided each at Chirrayanam and Gatchakayalapuram panchayaths and shall provide efficient doctors. Similarly, Reliance Industries, arrangements for corporate education to every 10th passed students of this area shall be provided. Employment opportunities to the un-employed youth shall be provided. He also requested for employment to their youth at ONGC, S.Yanam. An amount of Rs.15,000/- shall be given as additional matching grant in addition to the Government's Rs.15,000/- grant for construction of toilets. Similarly by the Reliance Industries Limited, an amount of Rs.1.0 Lakh financial support shall be given to all the fisherman community brides in this area by the project authorities. Financial assistance for daily commodities shall also be given by the project authorities to fisherman community during the declaration of cyclone emergency by the Government. Preference should be given to locals for employment while drilling wells. He also requested that an amount of Rs.1.0 Lakh shall be given by the project authorities as additional matching grant in addition to the Government's Rs.2.0 Lakh for construction of houses for poor. He also requested that the project authorities shall give compensation of Rs.5,000/- per month each fisherman family during the ban of fish catch from April to May every year by the Government. He also requested that project authorities shall give compensation of Rs.2.0 Lakhs to fisherman family, if loose their life due to any accident. He also requested the project authorities that CSR funds of minimum Rs.1.0 Crore shall be allocated every year to Chirrayanam and Katrenikona Villages, until completion of the proposed project.

Sri Jogi Arjuna Rao, R/o.S.Yanam, Ex.MPP, Uppalaguptam informed that the canals which were damaged by ONGC earlier shall be repaired by the present management. He also informed that the people in the S.Yanam village are very poor and they lost a lot of employment opportunities. He expressed his concerns that the Vedanta Limited has been releasing gas during the night time, due to which they have been facing heart problems. They have also been facing lot of health problems due to the nearby plant. He also informed that they have not even getting sufficient drinking water. The canal bund which was damaged by the ONGC authorities shall also be repaired by the present management. The present management has been carrying its operations for the past 20 – 25 years and about 90% of the people in the S.Yanam village are poor and the management has not taken any concrete proposals for development of the village. Rs.50,000/- shall be given by the project authorities to each poor families for construction of houses. He also requested that employment to the local people in any form shall be given.

A Women, R/o. S.Yanam expressed her concerns that the project authorities have not been implementing any development activity for the poor in the village. She also informed that they would not allow the proposed project until implementing any developmental activity to them.

Smt. Satyavathi, R/o. S.Yanam while welcoming the project requested the project authorities that developmental activities such as education to their children, and other facilities shall be provided. No employment opportunities given to them till date. She also informed that they do not have even drinking water facilities. Inspite of the promises made by the project authorities, they have not taking up any development activities.

The Joint Collector & Addl. District Magistrate, East Godavari District requested the project authorities to give the reply to the quarries raised by the general public.

Sri Srihari Prasad Reddy, Installation Manager, Vedanta Limited while giving the reply to the quarries raised by the general public informed that there is no direct provision to give compensation/money to the families/ration cards. As per the company policy, developmental activities would be taken up duly consulting the village elders for improving the livelihood of the people of the villages. They have provision for developmental activities such as skill development, education under CSR activities. About 74% contract employment provided to the Andhra people only, out of which 51% employment from S.Yanam. Out of totel 400 employees, only 71 people recruited from

outside Andhra Pradesh. In the company employment, representation from Andhra is less, due to inexperience and requisite qualification in oil & gas exploration and also safety is the major concern.

The representative of the Environmental Department Ravva Terminal informed that the company carrying its operations for the past 24 years and all the drilling operations, disposal of wastes everything is incompliance with the regulatory departments and specifically all the conditions stipulated in the Andhra Pradesh Pollution Control Board, Central Pollution Control Board clearances and they have been carried out their operations without causing any pollution problems in the surrounding areas and to the nearby people.

Sri Srihari Prasad Reddy, Installation Manager, Vedanta Limited informed that they have already provided employment to 295 locals from S.Yanam Village. He also informed that while carrying the drilling activity in Gatchikalayapuram and Chirrayanam villages, there is possibility of development in that area by way of local employment and CSR activities. He also informed that there are no specific conditions for recruiting security guards from local and non local people and contract would be given to private person for recruiting security guards only. He assured that they would specifically prefer locals while recruiting security guards. He also informed that as per the recommendations of the IB, only Ex. Service Man shall be taken as security guards, as it is a prohibited place. He also informed that there is no need to do the activities by causing water and chemical pollution. The company has been carrying its operations duly complying with all the pollution norms such as APPCB policies, MoEF&CC policies and correct action would be initiated if any pollution caused. He also assured that they would allocate CSR funds for implementation of sage culture. Compensation was given to all the farmers from whom, lands acquired. Constructed PHC at S.Yanam Village and appointed 14Nos. of teachers to the school. A study was carried out by IIT (BHU) regarding land subsidence due to oil & gas exploration and it was reported that no land subsidence occurring due to oil & gas exploration. The existing schools would be developed under CSR activities. Two new RO plants already procured to replace the existing damaged RO plants in S.Yanam village so as to supply drinking water and also informed that one more RO plant sanctioned for Chirrayanam Village and possibilities of installation of RO plants at Gatchakalayapuram & Katrenikona would be examined. The project authorities would carry requisite repairs to the pipeline network supplying

drinking water. They have been planning development of parks for the children. Funds would be allocated under CSR for repair of siphon on canal & drain.

Sri R.Tirupathi Rao, R/o. S.Yanam informed to the public that the people in S.Yanam Village could not even get drinking water till date, though the ONGC operating unit for the past 30years. They could not even breath fresh air, due to air, water pollution from the plant and every family in the village has been suffering with different type of diseases. The plant has not been taking any steps for control of pollution and the concerned authorities have not taken any action. He also informed that it is the responsibility of industries for development of local area as per re-habilitation and re-settlement act. But, the management has not taken any steps for development of local area, even though it has been operating for the past 30 years, citing the example that the management has not even supplying drinking water to the villages till today. He also demanded for release of white paper on the funds released for S.Yanam Village development year wise for the past 30 years, as people of this village have lot of doubts in this regard. He also alleged that due to drilling of deep wells in this area, the entire agriculture land contaminated with salt water intrusion, thereby people of this area lost their livelihood. He also expressed his concerns that due to release of oily water into Sea by the industry, fish productivity completely decreased in the area, thereby fisherman community lost their livelihood. The company management has not provided employment except giving lower grade employment. He also alleged that the PHC constructed by the project authorities handed over to Government instead of maintaining the same. He also informed that only 14Nos. of teachers appointed and demanded for education facilities to all the villages to be provided by the project authorities from KG to PG. He suggested that the Government authorities and project authorities shall consider the issues raised by the general public and then only start the expansion proposal. Similar type of public hearing presided by the Joint Collector earlier, but, no action taken against the industry on the issues raised by the public.

The Joint Collector & Addl. District Magistrate, East Godavari District informed that the proposed project is exploration of oil & gas by drilling 123 wells and it would take atleast 1 ½ – 2 years for production of oil & gas. Hence, in the mean time, the project authorities could not generate any employment opportunities and it is not correct to wait such a long time for employment and suggested that the bio data from the impacted villages should be collected and shall provide 3 – 4 months training for placements for eligible un-employed youth in 1st phase. He also suggested that eligible

candidates with required experience from the affected villages available, the project authorities shall consider their candidature after successful production of oil & gas after 1 ½ to 2 years time, for which an affidavit would be taken from project authorities along with in principle appointment and bio datas of eligible candidates within 30days. He also informed to the public that an affidavit would be taken on Rs.100/- non-judicial stamp paper from the project authorities, stating the CSR activities that would be taken up in these three villages in the next 3 – 4 months. He also suggested that Gram Sabha in every village shall be conducted once in a year in presence of the Revenue Divisional Officer to monitor the progress on CSR activities committed by the project authorities. He suggested that proper sports infrastructure facilities, libraries, E-Centre with facilities like provision of computers, internet, parks for walkers and children shall be provided by the project authorities within 3 – 4 months as the amount required for these facilities very less and instructed the project authorities to furnish affidavit duly incorporating the above issues. He also opined that if any well drilled is uneconomical, it is the responsibility of the project authorities for safe closure of well. He enquired about the greenbelt developed by the project authorities and informed that about 110 Acres of Casuarina plantation developed by the industry and instructed the project authorities to inform the area of greenbelt that has to be developed as per norms. He also enquired about the greenbelt development in the village, which could be economically helpful to the villagers. He also instructed the project authorities that a study should be conducted on development of greenbelt, in such a way that the extent of greenbelt required to be developed, to minimize the impact on the surrounding people due to oil & gas exploration activity and progress of implementation of greenbelt development shall be informed. He instructed the RDO to serve a notice under section 133 Cr.PC to industry, if the drinking water is not meeting the standards required. He also suggested to the project authorities that the pipeline network for supply of hygienic drinking water shall be repaired and maintain properly. He also suggested that preference should be given to the locals particularly from the three villages of S.Yanam, Chinrayanam and Katrenikona. He also instructed the project authorities to assess the local infrastructure facilities required duly consulting the villagers. He informed to the public that the project authorities shall earmark 2% of profits under CSR for development of local villages. While concluding the public hearing, the Joint Collector, East Godavari District opined that most of the activities that are being taken up by the project authorities are not permanent and suggested the project authorities that giving the scholarships to merit

children from all communities of this area may be more beneficial particularly to the individual, their families and as well as to the nation.

The following are the representations received during public hearing process by the Panel on the dais, and the same are kept as **Annexure 'B'.**

S.No.	Name and address of the person
1.	Sri H.Madhubabu, President REEHAS, Rural Environment Education and Health Awareness Society) D.No.1-7-495/9, Musheerabad, Hyderabad.
2.	Sri Y.Chenna Kesava Reddy, Trust Chairman, T.Sunkesula (Village & Post), Yerraguntla Mandal, Y.S.R. District
3.	Vootkuri Sunanda Reddy, Environmentalist Dharithri Paryavarana Parirakshana Samastha, D.No.6-7-414, Shivaji Nagar, Nalgonda District
4.	Sri M.Maruthi Prasad, Journalist President/Chairman Ujwala Environment Protection and R D Society (Regd), D.No.25-27-32, Sai Nagar, 1st Lane Nallapadu Road, Guntur
5.	Sri M.Srinu, S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
6.	Smt. Patta Durga, S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
7.	Sri A. Naveen Kumar, S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
8.	Smt. Naga Lakshmi, S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
9.	Sri A.Ashok Kumar S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
10.	Sri P. Lakshmi Vara Prasad, S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
11.	Smt. B.Ratna Kumari S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
12.	Smy. D. Ratnabhai S.Yanam Village, Uppalaguptam Mandal, East Godavari District.

13.	Smt. L.Bhagya Lakshmi S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
14.	Smt. M.Bhavani S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
15.	Smt. Ch.Priyanka, S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
16.	Smt. M.Sandhya Rani S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
17.	Sri P.Koridala Rao S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
18.	Smt.V.Adi Lakshmi, S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
19.	Sri P.Venkateswarao S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
20.	Smt. P.M. Kalyani S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
21.	Smt. P.Kanaka Durga Devi, S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
22.	Smt. G. Kamakshi, S.Yanam Village, Uppalaguptam Mandal, East Godavari District.
23.	Smt. D.Baby S.Yanam Village, Uppalaguptam Mandal, East Godavari District.

Joint Collector & Addl. District Magistrate
East Godavari District.

Environmental Engineer
A.P. Pollution Control Board,
Regional Office: Kakinada.

M/s.Vedanta Limited (Cairn Oil & Gas) has proposed Offshore & Onshore Oil & Gas Exploration, Development & Production in 123 wells (83 Exploration wells + 40development wells) in existing Ravva (PKGM-1) Offshore Block, of Surasaniyanam Village, Uppalaguptam Mandal of East Godavari District

Environmental Public Hearing on 11.10.2018.

Venue: At Beach Front, Surasani Yanam Beach Road, Near the sites of proposed onshore well pads - 1,2 & 3, Surasani Yanam(V), Uppalaguptam(M), East Godavari District

ATTENDANCE SHEET

S.No.	Name	Village	Mobile No	Signature
1	[illegible]	[illegible]	9866238168	[illegible]
2	[illegible] Bhushanam	"	9704389082	[illegible]
3	Angani Narasimharaj	Chinyanam	9963820718	[illegible]
4	[illegible]	"	9704186840	[illegible]
5	K Ramalaxmi	S.Yanam	9849679566	
6	[illegible]	S.Yanam		
7	[illegible]		917768[illegible]85	
8	H. Madhubabu	Environment volunteer (Ayy)	9908612657	[illegible]
9	A. Satyanarayana	GK PRO	7702525776	A. Satyanarayana
10	[illegible]	"	9949425481	[illegible]
11	Mude Naga Raju	"	8979832747	M. [illegible]
12	M. [illegible]	"	9866946052	M. [illegible]
13	[illegible]	"	994938[illegible]	[illegible]
14	L [illegible]	"	8790787797	L [illegible]
15	P.L.V. Prasad	S.Yanam	9848427852	P. L.V. [illegible]
16	A. Ashok kumar	S. yanam	8897789683	[illegible]

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ATTENDANCE SHEET

S.No.	Name	Village	Mobile No	Signature
17.	[illegible]	[illegible]	9705227466	[illegible]
18	[illegible]	[illegible]	7893146924	[illegible]
19	A.T.P.Singh	S. YANAM	9949304607	A.T.P.Singh
20.	[illegible]	[illegible]	9550716127	[illegible]
21.	[illegible]	S. [illegible]	9676919518	[illegible]
22	[illegible]	S. [illegible]	9177926	[illegible]
23	[illegible]	G.K PORA	9177952941	[illegible]
24	[illegible]	G.K PORA	9866843182	[illegible]
25.	[illegible]	[illegible]	9885232651	[illegible]
26.	B. [illegible]	[illegible]	7396583730	B. [illegible]
27.	K.S.N. [illegible]	G.K. PORA	8885638143	K.S.N. [illegible]
28	[illegible]	[illegible]	9542164871	[illegible]
29	[illegible] G. Satya [illegible]	[illegible]		[illegible]
30.	G. Satya [illegible]	S. [illegible]	9000163525	G. Satya [illegible]
31.	[illegible]	S. [illegible]	9959487888	[illegible]
32	[illegible]	[illegible]	9533489494	[illegible]

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ATTENDANCE SHEET

S.No.	Name	Village	Mobile No	Signature
33.	[illegible]	[illegible]	9177685604	[illegible]
34.	[illegible]	[illegible]	9866525[illegible]	[illegible]
35.	[illegible]	చిర్రయం	7659845839	[illegible]
36.	[illegible]	[illegible]	9701942332	[illegible]
37.	[illegible]	[illegible]	9989817842	[illegible]
38	[illegible]	[illegible]	9705635[illegible]	[illegible]
39.	[illegible]	[illegible]		[illegible]
40.	L. KRISHNA		9666785512	L. KRISHNA
41.	[illegible]		7660891	[illegible]
42.	[illegible]	[illegible]	9133764195	[illegible]
43	[illegible]	[illegible]	9959430330	[illegible]
44	[illegible]	[illegible]	9912328735	[illegible]
45	[illegible]	[illegible]	8463928165	
46	[illegible]	[illegible]	7026500944	[illegible]
47	[illegible]	[illegible]	7093976[illegible]	[illegible]
48	A. P. Naidu	[illegible]	8106219342	[illegible]

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ATTENDANCE SHEET

S.No.	Name	Village	Mobile No	Signature
49	T. Hari krishna	S.Yanam	9701089990	[signature]
50.	[illegible]	S.Yanam		[signature]
51	A. Phani Babu	S.Yanam		[signature]
52	V. Maheshwara Rao	S.Yanam	9550983406	V.Maheswarao
53.	[illegible]	S.Yanam	9989849527	
54	[illegible]	S.[illegible]		[signature]
55	A Bala Raju	S Yanam	9573924[illegible]	[signature]
56	MADR Prasad	Kotipallikaja	8186920103	[signature]
57.	K [illegible]	[illegible]	95[illegible]287[illegible]	
58.	[illegible]	S.[illegible]	984997711	[signature]
59.	[illegible]	S.[illegible]		
60.	P. R. [illegible]	S.yanam	9701251581	[signature]
61	[illegible]	"	9000151595	[signature]
62	P.Siva	"	9000163708	Siva
63	D. Pandu	S.Yanam	9704781398	[signature]
64	M. Durga prasad	S.Yanam		[signature]

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ATTENDANCE SHEET

S.No.	Name	Village	Mobile No	Signature
65.	M.Gan[illegible]	S.Yanam	965231105	M [illegible] RO
66.	G [illegible]	"	7893037152	G [illegible]
67	[illegible]	[illegible]	7702562944	[illegible]
68	D. [illegible]	S.[illegible]	9701188507	D [illegible]
~~69~~	~~[illegible]~~	~~S.[illegible]~~	~~99638[illegible]~~	~~[illegible]~~
70	[illegible]	S.[illegible]	9553215007	[illegible]
71	[illegible]	S.[illegible]	9848894742	[illegible]
72	K.[illegible]	S.[illegible]	950235[illegible]	K.[illegible]
73	[illegible]	S.[illegible]	9704816323	K.[illegible]
74	[illegible]	//		[illegible]
75	S.Venkata Rao	P.S. K.Kona & Chirrayanam	9441768862	[illegible]
76	G.[illegible]	Chirrayanam	9912474963	[illegible] VRO

M/s.Vedanta Limited (Cairn Oil & Gas) has proposed Offshore & Onshore Oil & Gas Exploration, Development & Production in 123 wells (83 Exploration wells + 40development wells) in existing Ravva (PKGM-1) Offshore Block, of Surasaniyanam Village, Uppalaguptam Mandal of East Godavari District

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ATTENDANCE SHEET

S.No.	Name	Village	Mobile No	Signature
	T. Rama Krishna	S. Yanam	9866604319?	[illegible]
1.	Pallaprolu Tata Rao	Gatchakayalapora	9989820272?	Pallaprolu Tata Rao
2.	B. Mallipa Raju	Gatchakayala pora	7702525036?	[illegible]
3.	D. Nagalingam	Vettapalem	9441862795	[illegible]
4	M. Krishna	Vettapalem	9440476159	[illegible]
5	RNS Narayana	[illegible]	9553417764?	[illegible]
6	[illegible]	S.యానాం	9618382281?	[illegible]
7	Y. Chenna Kesava	[illegible]	9491883009?	[illegible]
8	[illegible]	[illegible]	8790658981?	[illegible]
9	[illegible]	[illegible]	7032846692?	[illegible]
10.	[illegible]	[illegible]	7337279953	
11.	[illegible]	[illegible]	9550997168?	
12.	V. Narai	[illegible]	9676432446	[illegible]
13.	M. Kuthalam Rao	"	9010032490	
14	[illegible]	[illegible]	8106663074?	[illegible]
15	G. Raju	GKP	9676908005?	[illegible]

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ATTENDANCE SHEET

S.No.	Name	Village	Mobile No	Signature
	[illegible]	S. Yanam	984939276[illegible]	[signature]
	L BHIMARAJU	S. yanam	9652358999	[signature]
	P PADMANABHAM	"	9849855181	[signature]
	C. RAMBABU	S. yanam	9949730042	CRB
	[illegible]	[illegible]	8790534345	
	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	9989108130	[signature]
	[illegible]	[illegible]	9542667310	[signature]
	[illegible]	"	[illegible]	[signature]
	N. Srinivas [illegible]	Nero	99854[illegible]	[signature]
	S. Venkateswarlu	NGO	929205533[illegible]	[signature]
	P.L.N. RAO	social worker	9949966708	[signature]
	SREKANTH	SOCIAL WORKER	8801999911	[signature]
	B. Yesu Babu	Gatchakayala pitta	9701752169	[signature]
	S. [illegible]	"	9704220205	[signature]
	S. [illegible]	[illegible]	98661[illegible]	S. P. [illegible]

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ATTENDANCE SHEET

S.No.	Name	Village	Mobile No	Signature
16	S.D.D. Nouh	Gatchakayala pora	9440927877	[signature]
17	L. Bh. Mahnanaran	S yanam	8332781235	[signature]
18	G. Anurleema	S Yanam	9502242342	[signature]
19	O Samuel	S. yanam	9908443378	O. Samuel
20	P. Subba Rayu Yanam	S. yanam	9100451443	[signature]
21	Lanka. Venkata Ramana	S. yanam	9849891821	[signature]
22	L. Srinivasa	S. Yanam	9550981652	[signature]
23	M. Rama Krishna	S. Yanam	9640128853	MRK
24	S.H.K. manikanta	Gatchakayalapora	8333893233	[signature]
25	L. Durga Prasad	S. yanam	9918323780	[signature]
26	L. Nagaraju	S. yanam	9559201531	[signature]
27	L. Ramana	S. yanam	9866782403	[signature]
28	Akula. Raju.	S. yanam	9640807315	A. Raju
29	S. Satish	S. Yanam	8571470293	S. Satish
30	L. Tatha Rao	S. yanam	9848092451	L. Rao
31	L. Lovaraju	S. Yanam	9951632623	[signature]

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S.No.	Name	Village	Mobile No	Signature
	[illegible]	[illegible]	8106598297	
	[illegible]	"		
	[illegible]	"	9989368845	
	L. Sahadeb Rao	S.yanam	817997736	L. Sahadeb Rao
	Angani Yedukondalu	G.K. Pora	9949051127	A. Yedukondalu
	[illegible]	"	8790484538	A. [illegible]
	K L Varma	G.K. Pora	9908478468	K.L. Varma
	[illegible]	"	9000719707	[illegible]
	[illegible]	S. [illegible]	9866794130	[illegible]
	[illegible]	[illegible]	9704994277	[illegible]
	[illegible]		9576463755	
	[illegible]	[illegible]	8790245281	
	O. Rama Raju	G.K.Pora	9618363646	O. Rama Raju
	M Venkatesh	G.Kpora	7799765278	M Venkatesh
	M [illegible]	G.K PRR	8374716373	[illegible]
	[illegible]	"	9704161019	[illegible]

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ATTENDANCE SHEET

S.No.	Name	Village	Mobile No	Signature
32	K naga Rai	S. Yanam	9100521772	K. Rai
33	G. kamakshi	S. yanam	9704053489	G.kam
34	Y. Harika	S. yanam	9618643350	Harika
35	K Santhi	S. Yanam	9718643357	Santi
36.	L. Srisha	S. yanam	9959755498	L Sirisha
37.	L. Bhagya sai	S. yanam	7702242393	L Bhagya sai
38	P [illegible]	S. Yanam	7702242393	P [illegible]
39.	J [illegible]	S. yanam	—	[illegible]
40.	L [illegible]	S. yanam	—	L [illegible]
41.	L [illegible]	S. yanam	—	L [illegible]
42.	L naga malleswari	S. yanam	9000632657	naga Malleswari

vedanta
transforming elements

CAIRN

DRO/APPCB
Pl stock pile the agreements and release a copy to Public of all villages through tahsildars
JC, EG

JOINT COLLECTOR
KAKINADA
East Godavari District

Date: 23 October 2018

L. No: RV/18/IM/DC/154

To,
The Joint Collector & Addl.District Magistrate,
East Godavari District,
Kakinada, AP

Sub: Commitment of CSR activities.

Ref: Public Hearing held at S. Yanam Beach on 11/Oct/2018 for grant of EC.

Dear Sir,

At the outset, we extend our sincere thanks to you for conducting a smooth Public Hearing at S Yanam Beach on 11/Oct/2018 convened in connection with grant of Environment Clearance for further Exploration & Development activities.

We have taken note of the discussions held in the Public hearing on the CSR initiatives to be carried in the area.

We would like to take this opportunity to apprise you of the developments in the Ravva oil & gas block and of our initiatives to support the CSR activities in S Yanam area.

1. The Ravva oil and gas block is Joint Venture between Vedanta Limited, ONGC, Videocon Industries Limited and Ravva Oil (Singapore) Pte Limited as mentioned below :

Sr No	Name of the JV partners of Ravva Block	Participating Interest Held (%age)
1	Vedanta Limited	22.5
2	ONGC	40
3	Videocon Industries Limited	25
4	Ravva Oil (Singapore) Pte Limited	12.5

2. The Production Sharing Contract ("**Ravva PSC**") for Ravva oil and gas field was signed on 28 October, 1994 between the President of India, Oil & Natural Gas Corporation Limited ("**ONGC**"), Videocon Industries Limited ("**VIL**"), Vedanta Limited (erstwhile Cairn India Limited) ("**Vedanta**") and Ravva Oil (Singapore) Pte Limited ("**ROS**"). The Current PSC expires on 27 October, 2019.

3. The Ravva PSC has been and continues to be one of the most successful PSCs awarded by the Government of India ("**GoI**"), primarily due to the sustained efforts made by ONGC, VIL, Vedanta and ROS to explore, develop and produce the petroleum resources contained within the Ravva Block under the guidance of the Management Committee, Directorate General of Hydrocarbons and the Ministry of Petroleum & Natural Gas.

4. The Block has exhibited robust production with low operating cost (present OPEX ~ US$7/bbl). As compared to its initial estimates of 100 mmboe, the Block has far outperformed the expectations and already produced 290.7MMBBL of crude & 356.4BSCF sales gas as on 30/Sep/2018, contributing towards the energy security of the Nation and saving valuable foreign exchange.

   Effective reservoir management by continuous surveillance and adopting sound engineering practices has helped in sustaining oil production, arresting natural decline and achieving close to 50% recovery.

   The Block has till date contributed approx. US$ 8.67 billion to the Government exchequer in the form of Profit Petroleum, Royalty and Cess apart from taxes.

5. In addition to making efforts towards maximizing production from the Bock, the Ravva Joint Venture has always endeavored to maintain high standards in Health Safety & Environment ("**HSE**") compliances. The Block operation's sincere commitment towards HSE and excellent performance has helped in earning several HSE awards in the past for the Ravva Joint Venture.

6. Currently production from Ravva block has declined to ~15,000 BOPD due to depletion of the field. In order to sustain the production and to ensure economic feasibility of operations, Ravva JV is planning to carry out drilling of 123 Nos of exploratory & development wells (onshore and offshore) and other associated facilities. These would be carried out over a period of ten years for which we have applied for the Environment Clearance (EC) with MOEFCC. The Public Hearing held at S. Yanam Beach on 11/Oct/2018 was part of the process for issuance of EC.

7. We would also like to reiterate that the Ravva JV remains committed to support community development works for the local community. The Ravva JV is currently contributing INR 6.0 Cr per year towards development of local community and reacted initiatives.

   INR 5.0 Cr (appx.) is deposited with District Collector to facilitate community development works / projects. With this number of infrastructure projects / works have been executed in S. Yanam village and surrounding villages which include

   - Setting up of Potable water system (storage pond, filtration unit, over-head tanks, piping network covering houses)
   - Construction of concrete roads, bridges
   - construction of hospital building (PHC), ambulance
   - Installation of 50 solar lights etc.
   - Provision of mini truck for the collection & disposal of waste as part of "Swatch Bharat" initiative

   Recently, a "job mela" was arranged for unemployed youth in Amalapuram and more than 2,500 unemployed youth participated in this event.

   INR 1.0 Cr (appx.) is being spent by Ravva JV towards supporting additional teachers in village schools as per the requirement of villagers (engaged through contractors), pension for widows and physically disabled persons (payment made to RDO), bus passes for students from local villages(through RTC), maintenance of RO plants & potable water plant. Also, Ravva JV supports women empowerment programs, skill development program for unemployed youth etc.

8. As part of the aforesaid contribution, the Ravva JV will support the following CSR initiatives.
   8.1. Providing sports kits for all schools is already in progress. Creating Basket Ball, Volley

Ball and Cricket Pitch along with required sports kits at all three villages by next six months of time (subjected to suitable land availability). (Already sanctioned play material for all S.Yanam schools and Anganwadis. 4 more Schools in Katrenikona Mandal. Ref: Proceedings No.878/DYSO/Plg.I/2017 Dated:14-09-2018).

8.2. Establishment of libraries with weekly & monthly magazines in all three villages in next six months. A total no 200 Mini Libraries supported to the Government Primary schools. Out of 200 Libraries 50 Libraries Distributed to Uppalaguptam Mandal and Katrenikona Mandal Schools (Ref: Proceedings No.822/DYSO/Plg.I/2017 Dated: 05-03-2018)

8.3. Providing sports kits for all schools is already in progress. Creating Basket Ball, Volley Ball and Cricket Pitch along with required sports kits at all three villages by next six months of time (subjected to suitable land availability). (Already sanctioned play material for all S.Yanam schools and Anganwadis. 4 more Schools in Katrenikona Mandal. Ref: Proceedings No.878/DYSO/Plg.I/2017 Dated:14-09-2018).

8.4. Establishment of libraries with weekly & monthly magazines in all three villages in next six months. A total no 200 Mini Libraries supported to the Government Primary schools. Out of 200 Libraries 50 Libraries Distributed to Uppalaguptam Mandal and Katrenikona Mandal Schools (Ref: Proceedings No.822/DYSO/Plg.I/2017 Dated: 05-03-2018).

8.5. Develop IT training Centers in each of three villages with computers for organizing training for the youth in basic use of the computers and internet by next 3 months.

8.6. Develop parks with gravel walking tracks of 150-200 m length, Grass, sprinkler system. Subjected to land availability this will be completed within 9 Months of time.

8.7. Development of green belt in the villages with green cover by planting 5,000 saplings in next 12 months.(Already contract awarded to local vendor for 2100 well grown fruit bearing plants and Tree Guards. Ref: Contract copy)

8.8. Proper plugging of unsuccessful drill holes and restoration of unsuccessful well sites, as and when required and before the handing over of the site back to land owners.

8.9. Supporting the District administration in provision of clean drinking water to the villages. Two RO Plants replaced in S.Yanam and one new RO plant sanctioned for Chirrayanam village (Ref: Proceedings No.912/DYSO/Plg.I/2018 Dated: 05-10-2018).

8.10. Provide scholarships to the meritorious students of affected villages (Scheme for criteria, scholarship amount and qty will be formalized with coordination with DA), by next six months.

8.11. Carry out an assessment of infrastructure development projects to be undertaken in the effected villages. Survey of S. Yanam village has already carried out through Smart Village Foundation of AP and survey of other two villages will be carried out by next six months.

8.12. Provision of 50 Nos of solar lights for S.Yanam, Chirrayanam and Gachakayalapora villages (Ref: Proceedings No.878/DYSO/Plg.I/ 2017, Dated: 05-10-2018).

As we understand some of the amount contributed by Ravva JV in the past years still needs to be utilized towards the ongoing CSR projects. We would humbly request you to have the said un-used funds allocated to the CSR projects for which they were contributed and provide us with the funds utilization certificates at the earliest.

OUR PRAYER

Further processing of EC will be done only after the Minutes of Public Hearing is submitted to Environment Ministry. Also, we need to carry-out number of preparatory activities before mobilizing the Rig for drilling.

In view of the above, we humbly request your good office to kindly grant your approval for Minutes of Meeting of Public Hearing conducted on 11/Oct/2018 at S. Yanam beach, so that the Environment Clearance (EC) approval will be processed by MOEFCC at the earliest.

Thanking you.
Yours sincerely,

K. Snhariprasadreddy
Installation Manager - Ravva

Annex 23

- NOC from Andhra Pradesh Coastal Zone Management Authority;
- Summary Report on CRZ mapping by National Centre for Sustainable Coastal Management (NCSCM), Chennai. from Andhra Pradesh Coastal Zone Management Authority

O/C

Andhra Pradesh Coastal Zone Management Authority (APCZMA)
Andhra Pradesh
Ministry of Environment Forests & Climate Change
Government of India
D.No.33-26-14 D/2, Near Sunrise Hospital, Pushpa Hotel Centre,
Chalamavari Street, Kasturibaipet, Vijayawada -520010

Letter No. 138/APCZMA/CRZ/IND/2019 92 **Dated:03-04-2019.**

From:
Sri G. Anantharamu, IAS,
Principal Secretary to Government,
E. F. S & T. Department,
Interim Government Secretariat,
Amaravathi.

To
The Secretary,
Ministry of Environment and Forests and Climate Change,
Indira Paryavaran Bhavan, Jorbagh Road,
New Delhi – 110 003.

Sir,

Sub:- M/s. Vedanta Limited (Division: Cairn Oil & Gas) , Expansion of Offshore and onshore Oil and gas Exploration, Development and Production in existing Ravva (PKGM-1) Block, near Surasniyanam Village (S.Yanam), Krishna – Godavari basin, East Godavari District, Andhra Pradesh.– Environmental clearance – Requested - Regarding.

06.05.19 DESPATCHED

Ref:-1. Letter No: CRZ/RV/GGN/22112018/01 dated 22 November 2018, from Mr.Pankaj Jain,President Offshore SBU, M/s.Vedanta Limited (Division: Cairn Oil & Gas), DLF Atria, Phase – 2, Jacaranda Marg, DLF City, Gurgaon – 122002. Haryana, India.
2. From the Director, IA-II Division, Ministry of Environment and Forests, Government of India, New Delhi Terms of Reference (ToR) Letter No. J-11011/41/2018-IA-II(I), dated 24.03.2018..

- - - - - -

In the reference 1st cited , M/s. Vedanta Limited (Division: Cairn Oil & Gas) submitted the proposal for expansion of Offshore and Onshore Oil and gas Exploration, Development and Production in existing Ravva(PKGM-1) Block, near Surasniyanam Village (S.Yanam), Krishna - Godavari basin, East Godavari District, Andhra Pradesh. In order to enhance hydrocarbon production, M/s. Vedanta Limited (Division: Cairn Oil & Gas) has proposed expansion of Offshore & Onshore Oil & Gas Exploration, Development & Production within the existing Ravva (PKGM - 1) Offshore Block. The proposal includes the drilling of 83 Nos.

exploratory and appraisal wells (59 Nos. from standalone offshore locations & 14 Nos. from existing offshore platforms and 10 Nos. from proposed onshore well pads) to assess presence of hydrocarbons in prospects identified. Drilling of 40 Nos. development (production) wells (17 Nos. from the existing offshore platforms and 23 Nos. from proposed onshore well pads). Development of onshore surface facilities including 7 Nos. of well pads and laying of 15km(approx.) of pipeline corridor (for accommodating three pipelines) connecting onshore well pads with the existing onshore oil & gas processing terminal. A pipeline corridor (to accommodate three pipelines) of ~15 m Right of Use (RoU) width, and suitable access roads of ~10m width connecting to the proposed onshore well pads. The estimated cost of the project is Rs.7924 Crores.

2. In the reference 2nd cited, the Ministry of Environment and Forests, Government of India, New Delhi issued Terms of Reference (ToR) vide F.No. J-11011/41/2018-IA-II(I) dated 24.03.2018. wherein, the project proponent was directed to furnish the recommendations of the APCZMA as part of fulfillment of requirement for considering the proposal for environmental clearance along with other conditions. The NOC from APPCB was obtained vide Order No. 281/APPCB/CFE/RO-KKD/HO/2015 dated. 11.05.2018 to obtain clearance under CRZ Notification, 2011.

3. The area on the shore is classified as CRZ-III followed by Inter-tidal zone as CRZ-I(B) and water area in the sea as CRZ-IV(A) as per the approved Coastal Zone Management Plan (CZMP) of East Godavari District. The CRZ demarcation was carried out by National Centre for Sustainable Coastal Management (NCSCM), Chennai an authorised agency of Government of India and CRZ map has been prepared for the project study area in accordance to the CRZ Notification, 2011. The proposed wells are located in the coastal area and fall within the Coastal Regulation Zone (CRZ). The CRZ Mapping indicates that majority of the Ravva Block falls within the Bay of Bengal (CRZ IVA) while part of the block falls within CRZ I(B), CRZ III and CRZ IV(B). The offshore well location fall within CRZ IV(A) while the onshore well pads are located within CRZ I(B) and CRZ III. The connecting roads for access to the onshore well pads and the pipelines for transportation of well fluids from well pads to Ravva Terminal are located within CRZ I(B), CRZ III and CRZ IV(B). No development under the project is proposed in CRZ I(A).

4. The exploration and extraction of oil and natural gas and all associated activities and facilities thereto is a permitted activity as per the paragraph 3(ii), 3 (x)(b) of CRZ Notification 2011. The exploration of natural gas and oil is a regulated activity as provided in paragraph 4.(ii)(d) and (e) of CRZ Notification 2011.

5. The proposal was examined by the APCZMA in the meting held on 19-02-2019. The authority recommended the proposal to the MoEF&CC for clearance subject to the fulfillment of safety regulations including guidelines issued by the Oil Industry Safety Directorate in the Ministry of Petroleum and Natural Gas and guidelines issued by Ministry of Environment and Forests, Government of India and subject to further terms and conditions for implementation of ameliorative and restorative measures in relation to environment.

6. It is, therefore, requested to examine the proposal under paragraph 3(ii) 3 (x)(b) and 4 (i) (d) and (e) of CRZ Notification, dated 06-01-2011 and clearance may please be accorded for the expansion of Offshore and Onshore Oil and gas Exploration, Development and Production in existing Ravva(PKGM-1) Block, near Surasniyanam Village (S.Yanam), Krishna - Godavari basin, East Godavari District, Andhra Pradesh at an early date.

Yours faithfully,

Sd/-
CHAIRMAN
APCZMA

CRZ Form-1
Environmental Monitoring reports,
Environmental Management and Monitoring Plan,
Disaster Management Plan including Quantitative Risk Assessment Plan,
LTL- HTL and CRZ demarcation report

//T.C.F.B.O//

P. Muna Swamy Reddy
Senior Environmental Engineer (EE)

HIGH TIDE LINE, LOW TIDE LINE AND CRZ STATUS REPORT FOR THE PROPOSED OIL & GAS EXPLORATION DEVELOPMENT AND PRODUCTION PROJECT IN THE RAVVA BLOCK, ANDHRA PRADESH

for

M/s Vedanta Limited (Cairn Oil & Gas)

Prepared By

National Centre for Sustainable Coastal Management
Ministry of Environment, Forest & Climate Change
Government of India

January 2019

HIGH TIDE LINE, LOW TIDE LINE AND CRZ STATUS REPORT FOR THE PROPOSED OIL & GAS EXPLORATION DEVELOPMENT AND PRODUCTION PROJECT IN THE RAVVA BLOCK, ANDHRA PRADESH

for

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National Centre for Sustainable Coastal Management
Ministry of Environment, Forest & Climate Change
Government of India

January 2019

DOCUMENTATION SHEET

1	Authorised Institute with Letter No & Date	National Centre for Sustainable Coastal Management J-17011/8/92-IA-III dt 14th March, 2014
2	Report No.	Report No. NCSCM/ GEO/CRZ/2019/1
3	Client's/Institute Name	M/s Vedanta Limited (Cairn Oil & Gas)
4	Authors Principal-Investigator Co-Investigators Project Staff	 Badarees KO Manik Mahapatra Vimal KC, Balaguru and Karunanidhi
4	Type of Report	CRZ Status Report
5	Title	HIGH TIDE LINE, LOW TIDE LINE AND CRZ STATUS REPORT FOR THE PROPOSED OIL & GAS EXPLORATION DEVELOPMENT AND PRODUCTION PROJECT IN THE RAVVA BLOCK, ANDHRA PRADESH
6	Key words	Coastal Regulation Zone, cadastral map. land use, High Tide Line (HTL), Low Tide Line (LTL), CRZ IB, CRZ III, CRZ IV
7	Abstract	The PKGM-1 Block also referred to as Ravva block or oil and gas field is located in the Bay of Bengal in the Krishna-Godavari Basin near Surasaniyanam Village, Uppalaguptam Mandal in East Godavari District, Andhra Pradesh On behalf of Ravva Joint Venture, Vedanta Limited - Cairn Oil & Gas has been carrying out oil and gas operations in the PKGM-1 Block. Vedanta Limited through their consultant ERM India Private Limited has requested the National Centre for Sustainable Coastal Zone Management (NCSCM), Government of India, Chennai to prepare a project level Coastal Regulation Zone (CRZ) map by demarcating the High Tide Line (HTL), Low Tide Line (LTL), Coastal Regulation Zone (CRZ) and Ecological Sensitive Areas (ESAs) for the above area. Demarcation of the HTL, LTL, ESAs and identification of Coastal Regulation Zones (CRZ) have been carried out in cadastral level (1:4000 scale) to provide detailed information on the CRZ categories with respect to the project site. Majority of the Ravva block site boundary falls within the Bay of Bengal (CRZ IVA) where as part of the site boundary falls within the CRZ IB and CRZ IVB. Part of the proposed pipeline corridor passes through the CRZ IB, CRZ III and CRZ IVB category and part of the proposed approach road to the well locations passes through the CRZ IB and CRZ III Category (Refer Sheet No. 1 to 68).
8	Distribution Statement	Not for Circulation

CONTENTS

	Page No.
1.0 Introduction	1
2.0 Objective	1
3.0 Location	2
4.0 Approach & Methodology	2
4.1 Base map	4
4.2 Data Source	4
4.3 Tide	5
4.4 Field investigation	5
5.0 Landuse	6
6.0 HTL/LTL with respect to the site	6
6.0.1 Coastal Regulation Zone for the site	6
7.0 SUMMARY AND CONCLUSIONS	7
References	

PLATES

Plate 1: Existing well pad location

Plate 2: Bund with waterbody

FIGURES/SHEETS

Fig 1: Location Map

Sheet No 1 to 68

HIGH TIDE LINE, LOW TIDE LINE AND CRZ STATUS REPORT FOR THE PROPOSED OIL & GAS EXPLORATION DEVELOPMENT AND PRODUCTION PROJECT IN THE RAVVA BLOCK, ANDHRA PRADESH

1.0 Introduction

The PKGM-1 Block also referred to as Ravva block or oil and gas field is located in the Bay of Bengal in the Krishna-Godavari Basin near Surasaniyanam Village, Uppalaguptam Mandal in East Godavari District, Andhra Pradesh. On behalf of Ravva Joint Venture, Vedanta Limited - Cairn Oil & Gas has been carrying out oil and gas operations in the PKGM-1 Block. Krishna Godavari Basin is a pericratonic passive margin basin in India. Krishna Godavari basin comprises of upland plains, coastal plains, recent flood and delta plains. M/s Vedanta Limited (Cairn Oil & Gas) is proposing exploratory, development and production wells in the onshore and offshore regions of the block. To prepare the status report of these well locations within the CRZ areas, Vedanta Limited through their consultant ERM India Private Limited has requested the National Centre for Sustainable Coastal Zone Management (NCSCM), Government of India, Chennai to prepare a project level Coastal Regulation Zone (CRZ) map by demarcating the High Tide Line (HTL), Low Tide Line (LTL), Coastal Regulation Zone (CRZ) and Ecological Sensitive Areas (ESAs) for the above area. Demarcation of the HTL, LTL, ESAs and identification of Coastal Regulation Zones (CRZ) have been carried out in cadastral level (1:4000 scale) to provide detailed information on the CRZ categories with respect to the project site.

2.0 Objective

The objectives of the study are:

- Identification and demarcation of HTL ,LTL and ESAs for the proposed project area
- Demarcation of Coastal Regulation Zones
- CRZ categorization.

3.0 Location

The proposed development area is located on the east coast of the Bay of Bengal at Ravva Block of Krishna-Godavari Basin of Andhra Pradesh. The project site located within the Lat. Long. of 82°7'17.005"E 16°20'48.341"N and 82°18'29.345"E 16°33'28.197"N (Fig. 1).

Fig. 1: Location map

4.0 Approach & Methodology

The Government of India Notification [S.O.19 (E) dated 6.1.2011] under Section 3(1) and Section 3(2)(v) of the Environment (Protection) Act, 1986 and Rule 5(3)(d) of Environment (Protection) Rules, 1986 declares 'the coastal stretches of the country and

the water area upto its territorial water limit as Coastal Regulation Zone (CRZ)' (MoEF & CC, 2011). All developmental activities in the CRZ are regulated through the CRZ Notification (MoEF & CC, 2011).

The CRZ consists of the following:

1. Land area from High Tide Line (HTL) to 500 m on the landward side along the sea front.
2. Land area from HTL to 100 m or width of the creek whichever is less on the landward side along the tidal influenced water bodies that are connected to the sea and the distance up to which development along such tidal influenced water bodies is to be regulated are governed by the distance upto which the tidal effects are experienced which is determined based on salinity concentration of 5 parts per thousand (ppt) measured during the driest period of the year and distance up to which tidal effects are experienced would be clearly identified and demarcated accordingly in the Coastal Zone Management Plans (CZMPs). Tidal influenced water bodies means the water bodies influenced by tidal effects from sea, in the bays, estuaries, rivers, creeks, backwaters, lagoons, ponds connected to the sea or creeks and the like.
3. Land area falling between the hazard line and 500 m from HTL on the landward side, in case of seafront and between the hazard line and 100 m line in case of tidal influenced water body. The word 'hazard line' denotes the line demarcated by Ministry of Environment and Forests & Climate Change (MoEF & CC) through the Survey of India (SOI) taking into account tides, waves, sea level rise and shoreline changes.
4. Land area between HTL and Low Tide Line (LTL) which will be termed as the intertidal zone.
5. The water and the bed area from the LTL to the territorial water limit (12 Nm) in case of sea and the water and the bed area from LTL at the bank to the LTL on the opposite side of the bank, of tidal influenced water bodies.

According to the CRZ Notification, 2011, the tidal influenced water body has been defined as bays, estuaries, rivers, creeks, backwaters, lagoons and ponds connected to the sea or creeks and the like. The distance from the HTL shall apply to both sides of the tidal

- Hydrographic charts of Naval Hydrographic Office
- Toposheets of Survey of India
- Aerial Photos
- Satellite image
- Field investigation

4.3 Tide

Coastal regulation zone are restricted to the seacoast and banks of water bodies influenced by tidal action. Tidal range is an important parameter that decides the landward extent of the reach of seawater into the land and the location of the HTL including the extent of CRZ. The distance up to which development along rivers, creeks and backwaters is regulated depends on the landward extent of tidal influence. The tidal levels as per Naval Hydrographic Chart No. INT 7405 355 of Sacramento Shoal coast is given in Table 1.

Table 1: Tidal range at Sacramento Shoal Coast (NHO Chart No. INT 7405 355)

S. No.	Tide Type	Sacramento Shoal (m)
1	Mean High Water Spring	1,3
2	Mean High Water Neap	1.0
3	Mean Sea Level	0,8
4	Mean Low Water Neap	0,5
5	Mean Low Water Spring	0,2

4.4 Field investigation

Field investigations were carried out during July 2018. HTL was identified from Aerial photo and verified at field based on geomorphologic features and other features such as embankments, landward boundaries of intertidal zone (MoEF & CC, 2011). HTL was plotted with respect to reference points identified in the field as well as Aerial photo and located in the cadastral map. An appraisal of existing land use / landform in the project area was also carried out. The distance and positions of HTL to control points which was extracted from the aerial photographs were verified in the field using high precision Trimble GPS.

7.0 SUMMARY AND CONCLUSIONS

- ✓ The HTL, LTL and CRZ categories are presented in 1:4000 scale cadastral maps with survey plot information.
- ✓ The HTL and LTL are demarcated from aerial photographs/satellite images by taking into consideration different signatures such as boundaries of embankments, vegetation and bunds as existed at the aerial photo/satellite image.
- ✓ Mangroves, which are CRZ IA, are present at the project site boundary - Ravva Block. No proposed development is proposed in CRZ IA.
- ✓ Majority of the Ravva block site boundary falls within the Bay of Bengal (CRZ IVA) where as part of the site boundary falls within the CRZ IB and CRZ IVB. Part of the proposed pipeline corridor passes through the CRZ IB, CRZ III and CRZ IVB category and part of the proposed approach road to the well locations passes through the CRZ IB and CRZ III Category.
- ✓ Majority of the proposed well pad locations fall within the CRZ IVA category whereas few proposed well pad locations falls within the CRZ IB and CRZ III
- ✓ The categorization of CRZ in the approved CZMP may be followed for CRZ categorization.
- ✓ Layout plan of the proposed well locations, proposed approach road, proposed pipeline corridor and existing platforms, outfall points, etc within the project site boundary - Ravva Block and outside of the Ravva block is incorporated in the CRZ map.

References

MoEF, 1991. Notification No.S.0114 dated 19th February, 1991, Ministry of Environment and Forest, Government of India, New Delhi.

MoEF, 1996. Letter No. Letter No.J-17011/8/95-IA-III, dated 27-9-1996 dated 27th September 1996 to the Chief Secretary, Govt. of Maharashtra. Ministry of Environment and Forest, Government of India, New Delhi.

MoEF, 2011. Notification No. S.O.19 (E) dated 6.1.2011, Ministry of Environment and Forest, Government of India, New Delhi.

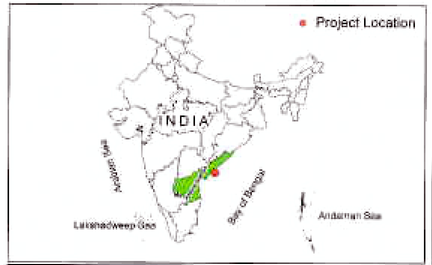
PLATES

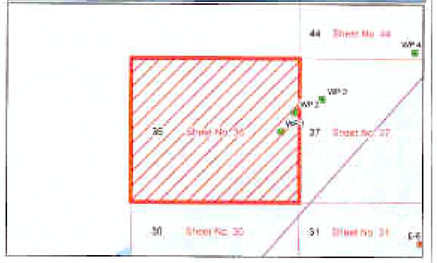
Plate 1: Existing well pad location

Plate 2: Bund with waterbody

SHEET NO: 36 of 68

(Refer for details Report No. NCSCM/ GEO/CRZ/2018/1)





Scale

0 100 200

Meters

1:4,000

Legend

- Site Boundary
- Proposed Onshore Well Pad Location
- Proposed Offshore Well Pad Location
- Road
- Proposed Road
- Proposed Pipeline Corridor
- High Tide Line
- Low Tide Line
- 200 m CRZ line
- 500 m CRZ line
- CRZ line for River or Creek
- Project Site Boundary - Ravva Block
- Sandy Plain
- 50m Mangrove Buffer - CRZ IA
- Reserve Forests - CRZ IA
- Mangroves - CRZ IA
- Mudflats - CRZ IA
- Salt Marshes - CRZ IA
- Saltpan or Aquaculture Area - CRZ IB
- Sand Dune CRZ IA
- Turtle Nesting Grounds - CRZ IA
- CRZ landward of HTL - CRZ III
- Intertidal Zone - CRZ IB
- Waterbody - CRZ IVA
- Waterbody - CRZ IVB

Existing Features - Given by Vedanta Ltd.

- Existing Platform RA
- Existing Marine Outfall Point
- Existing Ravva Terminal
- Existing Single Point Mooring (SPM)
- Existing Offshore Platform

HTL, LTL AND CRZ MAPPING FOR EXPANSION OF OFFSHORE & ONSHORE OIL AND GAS EXPLORATION AND DEVELOPMENT PROJECT IN RAVVA BLOCK OF KRISHNA GODAVARI BASIN, EAST GODAVARI DISTRICT, ANDHRA PRADESH

Verified by	*Approved by*

Prepared by

NCSCM

National Centre for Sustainable Coastal Management

(Ministry of Environment, Forest & Climate Change)

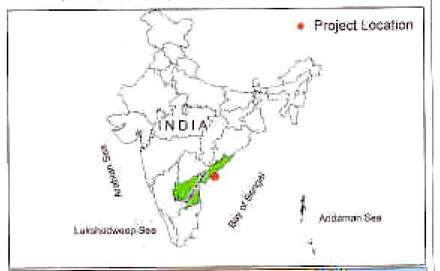
Chennai - 25

Prepared for

M/s Vedanta Limited (Cairn Oil & Gas)

SHEET NO: 37 of 68

(Refer for details Report No. NCSCM/ GEO/CRZ/2019/1)



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Legend

- Site Boundary
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- CRZ landward of HTL - CRZ II
- Intertidal Zone - CRZ IB
- Waterbody - CRZ IVA
- Waterbody - CRZ IVB

Existing Features - Given by Vedanta Ltd.

- Existing Platform RA
- Existing Marine Outfall Point
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- Existing Single Point Mooring (SPM)
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HTL, LTL AND CRZ MAPPING FOR EXPANSION OF OFFSHORE & ONSHORE OIL AND GAS EXPLORATION AND DEVELOPMENT PROJECT IN RAVVA BLOCK OF KRISHNA GODAVARI BASIN, EAST GODAVARI DISTRICT, ANDHRA PRADESH

Verified by	Approved by

Prepared by

NCSCM

National Centre for Sustainable Coastal Management

(Ministry of Environment, Forest & Climate Change)

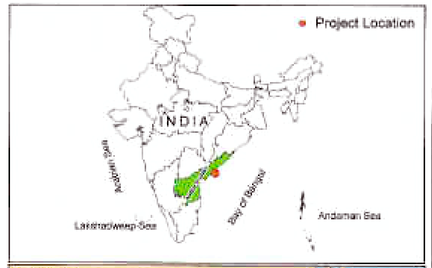
Chennai - 25

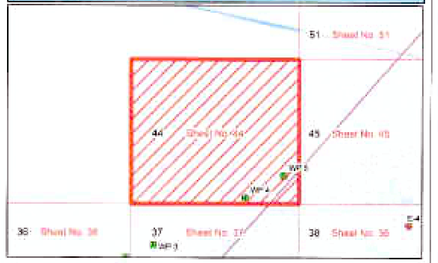
Prepared for

M/s Vedanta Limited (Cairn Oil & Gas)

SHEET NO: 44 of 68

(Refer for details Report No. NCSCM/ GEO/CRZ/2018/1)





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Chennai - 25

Prepared for

M/s Vedanta Limited (Cairn Oil & Gas)

SHEET NO: 46 of 68

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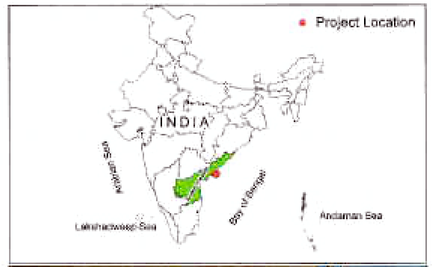

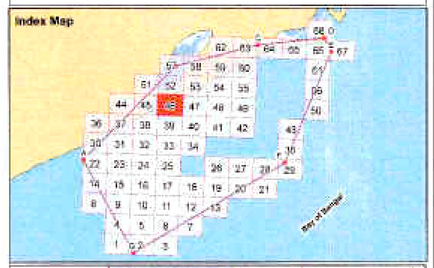

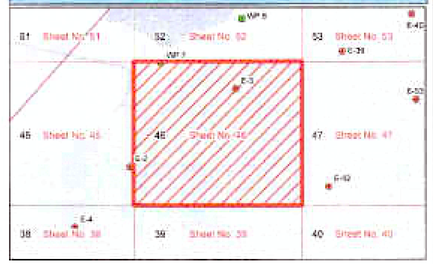

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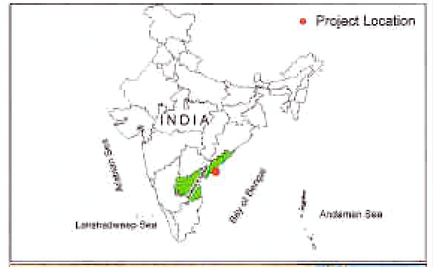
Chennai - 25

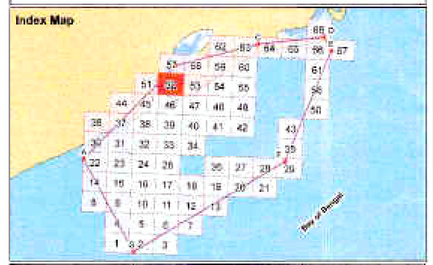
Prepared for

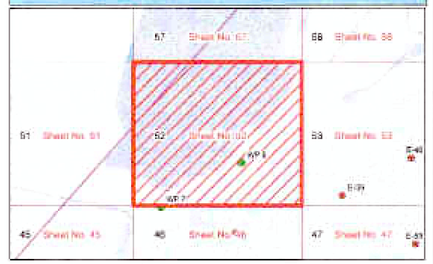
M/s Vedanta Limited (Cairn Oil & Gas)

SHEET NO: 52 of 68

(Refer for details Report No: NCSCM/ GEO/CRZ/2018/1)







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Chennai - 25

Prepared for

M/s Vedanta Limited (Cairn Oil & Gas)

Annex 24

Copy of the Agreement with OIL SPILL RESPONSE LIMITED (OSRL)

THIS AGREEMENT is made the 22nd day of Jan 2020
BETWEEN:

(1) **OIL SPILL RESPONSE LIMITED** a company incorporated in United Kingdom registered in Singapore, UEN T06FC6915A and whose registered office is at 25C Loyang Crescent Singapore 506818 (hereinafter referred to as "the Company") and

(2) **VEDANTA LIMITED** a corporation organised and existing under the laws India, which has its registered office at First Floor, C Wing, Unit 103, Corporate Avenue, Atul Projects, Chakala Andheri (East), Mumbai – 400 093 (hereinafter referred to as "the Associate")

WHEREBY IT IS AGREED as follows:-

1. DEFINITIONS
In this Agreement unless the context otherwise requires:

.1 An "Affiliate" of any company means any company, which is owned by, which owns, or is under common ownership with, that company. For this purpose "ownership" may be direct or indirect; direct ownership being through holding more than fifty per cent of the shares carrying rights to vote at a general meeting of the company (or its equivalent) or holding ordinary shares carrying a majority of votes at a general meeting (or its equivalent) of the company and indirect ownership being through a series of companies each being directly owned by one or (by aggregate shareholdings) more of the previous companies in the series. Any Affiliate which shall at any time cease to own, be owned by, or be under common ownership with the company concerned as aforesaid shall cease at such time to be an Affiliate of that company;

.2 "Associate's Installation" means 2-5 sites with total cumulative annual Oil exposure less than 40 thousand barrels per day, which shall only include;

- Block No. PKGM-1 (Ravva), along Bay of Bengal;
- Block No. CB/OS-2 in the Gulf of Cambay;
- Adani Hazira Port, Surat;
- Cairn India Limited Terminal, Bhogat, Gulf of Kachchh;
- KG-OSN-2009/3 Block, Bay of Bengal & PR-OSN-2004/1 (Palar) Block, Bay of Bengal drilling program, only;

.3 "Available Equipment" has the meaning ascribed to it in Clause 3.1;

.4 "Available Staff" has the meaning ascribed to it in Clause 3.1;

.5 "the Base" means the Company's base at Southampton or at such other convenient location or locations in the United Kingdom, Singapore or elsewhere as may be notified by the Company to the Associate;

.6 "Contractors" means any person, firm or company or persons, firms or companies for the time being engaged by the Company to provide any services to the Company;

.7 "Contract Year" means a period of twelve (12) months following the Start Date or anniversary of the Start Date

.8 "Malpractice" includes giving or receiving any financial or other advantage that may be construed as a bribe or planning, making arrangements or agreeing to receive any financial or other advantage that may be construed as a bribe;

.9 "Oil" means crude petroleum oil or any fraction thereof or any liquid petroleum products;

.10 "Parties" means the parties to this Agreement and "party" shall mean either of them, for or on behalf of itself and/or its Affiliates;

.11 "Service Level Agreement" means the service level agreement for the operation of the Base, which is attached to this Agreement as Schedule 2, as from time to time adopted and amended from time to time by the Company;

.12 "State Entity" means an organisation or company which is owned or part owned by the government of the country in which it is registered.

.13 "Participants" means any company, which is party to a participant's agreement with the Company, holding ordinary shares in the Company and maintaining the right to vote at the Company's general meetings

References in this Agreement to "Clause" or "Schedule" are references to clauses of this Agreement and schedules to this Agreement.

2. PERIOD

This Agreement shall come into force no later than 5 February 2020 ("the Start Date") and shall, subject to the provisions for earlier termination herein contained, have a duration of 3 years terminating no later than 4 February 2023 but may be renewed by agreement in writing between the parties.

3. RIGHTS OF THE ASSOCIATE

.1 In consideration of the payments to be made hereunder and the other undertakings herein entered into, the Associate shall subject to Clause 3.4, be entitled only for the purposes set out in Clause 3.2 and during the continuance of this Agreement, and in accordance with the terms hereof and the terms of the Service Level Agreement to call upon and hire such of the Company's equipment which at the time of request to hire is to be found at the Base and has not been otherwise allocated ("Available Equipment") and such of the Company's operating staff who at the time of request to hire are employed at the Base and have not otherwise been allocated ("Available Staff") (or such lesser amount of equipment or number of staff as the Associate may request).

.2 The Available Equipment and Available Staff may be called upon and hired by the Associate in exercise of the Associate's rights under Clause 3.1 for the purpose of dealing with an oil spill or oil discharge or escape occurring or about to occur at or from the Associate's Installation which includes, without limitation, an oil discharge from a pipeline into the sea, any waterway or onto land. The parties shall together plan appropriate emergency responses to oil spills at or from the Associate's Installation.

.3 The Company may at its discretion from time to time hire or supply to the Associate for use by the Associate at the Associate's Installation any equipment and/or operating staff requested by the Associate and available at the Base, in addition to the equipment and operating staff to which the Associate is entitled under Clause 3.1 and 3.2. The provisions of this Agreement shall apply in respect of such additional hiring and supply unless otherwise agreed between the Company and the Associate, except as to the rate of hire, which will be determined in accordance with Clause 5.7.

.4 The Company gives no undertaking and shall bear no liability whatsoever in respect of the quantity of equipment which shall be found available at the Base or the number of the Company staff available at any time and reserves the right to allocate any equipment or staff as it considers fit.

.5 The Company may at any time decline to supply, provide or make available any of the equipment, personnel, facilities or other services which are the subject of this Agreement or to follow or carry out any request of the Associate pursuant to this Agreement if to do so would in the opinion of the Company be prejudicial to the future availability of equipment and operating staff at the Base or to the viability of the Base.

4. ANNUAL FEE

.1 Prior to the Start Date and in consideration of the rights granted to the Associate hereunder, the Associate shall pay to the Company the sum of US$73,212 (United States Dollars Seventy Three Thousand Two Hundred and Twelve only) net of all taxes by electronic bank transfer to the Company's account No 260-532304-178, Swift Code HSBCSGSG at HSBC Singapore, Collyer Quay Branch, 21 Collyer Quay #01-01, HSBC Building, Singapore 049320. The Annual Fee shall be paid in respect of the period of twelve (12) consecutive months following the Start Date. The parties shall agree an annual fee to be paid by the Associate in respect of any renewal of this Agreement pursuant to Clause 2 prior to the date of such renewal.

.2 The Annual Fee ("the Annual Fee") payable for subsequent Contract Year(s) will be the annual published rate applicable for the twelve (12) months immediately thereafter as approved by the Participants from time to time. If no new rate has been approved the Annual Fee shall remain that last approved.

.3 The Associate shall reconfirm or update the Associate Installation (Clause 1.2 hereof) prior to the renewal of any Contract Year and shall pay an annual fee calculated on the band within which the Company determine Associate's membership fee obligations shall fall as a result.

5. CALL OUT FEES

.1 The Associate shall pay to the Company in respect of each item of equipment hired or made available under sub-Clause 3.1 in the circumstances set out in sub-Clause 3.2 a fee calculated at the rates which appear in Schedule 1 either in respect of any period during which the equipment is in use (and not in transit or on standby) or in respect of any period during the period of hire in which the equipment is not in use.

.2 Such rates are per day or for part of a day and for the purposes of this Clause a "day" shall mean a period of twenty four (24) hours from the time that notice is received that the Associate requires the equipment for its use, and any subsequent period of twenty four (24) hours.

.3 When on account of the provision of additional equipment or the replacement of certain equipment with other equipment, there appears in Schedule 1 no rate for the equipment in question, the rate which the Associate shall pay to the Company in respect thereof shall be that rate which is notified in writing by the Company to the Associate as soon as practicable following the receipt of the Associate's notice of requirements.

.4 Where the equipment hired hereunder is in any one day part of the time in use and part of the time not in use then in respect of that day the higher rate shall apply.

.5 In respect of personnel supplied hereunder the Associate shall pay to the Company the rates stipulated in Schedule 1. The Company shall have absolute discretion in determining the personnel which the Company shall provide under this Agreement. The Company expressly reserves the right at its sole discretion to at any time (including during a response) substitute the personnel provided under this Agreement.

.6 The rates specified in Schedule 1 shall be reviewed as of each 1st January by the Shareholders of the Company. The parties agree that the new rates following the review shall automatically apply to this Agreement.

.7 In respect of additional equipment and operating staff hired or made available to the Associate under Clause 3.3 the Associate shall pay to the Company fees at the rate specified by the Company at the time the said equipment and/or operating staff is made available or hired.

6. OBLIGATIONS OF THE COMPANY

Except as expressly provided herein, the Company hereby undertakes during the term of this Agreement that it and/or its Affiliates shall base at the Base such reasonable level of equipment and such reasonable number of operating staff as the Company shall consider appropriate bearing in mind the Company's commitment to its members. The Company shall arrange that such equipment be kept in good working order, that such staff shall be thoroughly familiar with and knowledgeable in the operation of all equipment to be made available for hire pursuant to this Agreement and the procedures set out in the Service Level Agreement and will operate and maintain the equipment in the field under the direction of the Associate, subject to the rights of the Company provided in Clause 7.

7. CONTROL OF OPERATIONS AND EQUIPMENT

.1 The responsibility for the control of all matters at the location of the clean-up operation shall be that of the Associate provided that the Company or any of its employees may decline to carry out any instruction and take any action it or they see fit in any situation where the safety of personnel may be at risk and as to whether any such situation exists shall be at the sole discretion of the Company and those of the Company's employees who are present at the clean-up operations.

.2 During the period of hire of any equipment hereunder the Associate shall:-

.1 take all reasonable steps necessary on its part to protect and preserve such equipment in good working order;

.2 keep the Company fully informed of the location of the equipment and of any malfunctioning thereof or loss of or damage thereto;

.3 not part with possession of the equipment without the prior consent of the Company;

.4 permit the Company or the Contractors or the employees or agents of either of them such access to such equipment as they may reasonably request;

.5 take all such steps as may be necessary to keep such equipment free from all liens, charges and encumbrances, and to prevent such equipment becoming the property of any person other than the Company or the Contractors;

.6 not make or allow to be made any modification or alteration to any of such equipment otherwise than by personnel provided by the Company hereunder or with the prior consent of the Company or the Contractors; and

.7 be responsible for complying with and obtaining any necessary permissions under any laws for the time being applying in any country in which such equipment may be during the period of hire and relating to the operation of such equipment or the work of personnel provided under this Agreement and for dealing with any customs formalities entry permits or other matters in connection with use or return of such equipment hereunder and the personnel provided hereunder. All taxes, duties, custom bonds or other fiscal imposts shall be the responsibility of the Associate and the Associate shall indemnify the Company in accordance with Clause 10.8.

8. TRANSPORT

Unless otherwise agreed with the Company, the Company shall deliver the equipment to Chennai and/or Mumbai as determined by the Associate during each call out ("the Port"). Transportation from the Port to the site of operations and all travel arrangements for personnel shall be the responsibility of the Associate. The Associate shall consult with the Company and keep the Company fully informed of all such arrangements.

9. EXPENSES

In addition to the other charges provided for in this Agreement, the Associate shall, upon receipt of proper invoices, make payment to the Company in respect of:

.1 all transport and travel made as a consequence of the hire of equipment and personnel made available hereunder including the costs of transportation to the Port and any other costs incurred by the Company;

.2 reasonable accommodation and living expenses incurred by the Company in respect of the personnel made available hereunder;

.3 the cost of cleaning and rehabilitating equipment hired hereunder. For this purpose materials and services will be charged at cost and work at man/hour rates to be specified for personnel from time to time by the Company.

10. LIABILITY AND INDEMNITIES

The parties hereto recognise and acknowledge that many varying factors affect the success or otherwise of an oil spill clean-up operation and the performance of the equipment involved and that success in any event can be relative and accordingly agree that any condition warranty or representation as to the quality or fitness for purpose of any equipment to be found at the Base or as to the effect of any advice given is inappropriate **NOW THEREFORE**:-

.1 All representations conditions and warranties in respect of the equipment which is the subject of this Agreement relating to its quality, fitness for purpose, or otherwise whether implied by statute or by common law or otherwise are hereby excluded;

.2 Any advice offered is to be construed as a statement of opinion only and not as a representation of any kind as to the effects of following such advice;

.3 The Company shall exercise reasonable skill, care and diligence in the discharge of its obligations under or arising out of the performance of this Agreement but in respect of any loss or damage of whatsoever nature or howsoever caused which in any way arises out of or is connected with the performance, mis-performance or non-performance by or on behalf of the Company of such obligations or the equipment or staff supplied hereunder;

.1 the liability of the Company, its Affiliates, and its or their employees, contractors or agents (whether in contract or in tort) shall be limited to any case of negligence or wilful misconduct on their part and shall then not exceed the amount of daily fees paid under this Agreement for the item or items of equipment or members of staff concerned to the exclusion of all other liability;

.2 the Associate agrees that it shall take no proceedings against any employee, shareholder, Affiliate, contractor or agent of the Company or any employee or agent of any of them, but shall look solely to the Company under the provisions of Clause 10.3.1 above;

.4 Subject to Clause 10.3, the Associate shall at all times during and after the term of this Agreement, keep the Company, its Affiliates and its and their employees, Contractors and agents indemnified against any claim, demand, action, proceeding or liability of whatsoever nature arising out of or in any way connected with this Agreement or the performance, mis-performance or non- performance (whether negligent or otherwise, and howsoever a head of damage may be formulated and including any claim, demand, action or proceeding in respect of the equipment supplied) by or on behalf of the Company of its obligations under or arising out of this Agreement, brought or instituted against the Company or its Affiliates or its or their employees, Contractors or agents by any third party (including any claims from the Contractors);

.5 For the purposes of this Clause 10:

.1 The Company shall be deemed to be acting as agent for and on behalf of its Affiliates and its and their employees and agents and the benefit of the provisions of this Clause 10 shall extend to all such Affiliates, employees and agents.

.2 The Associate shall during and after the period of this Agreement keep the Company and its Affiliates and its and their employees and agents indemnified against all claims, demands, actions or proceedings brought by or on behalf of any or all the Affiliates of the Associate or its and their employees and agents, arising from any matter related to or connected with this Agreement to the extent that such claim, demand, action or proceeding could not, by virtue of this Clause 10 be brought by the Associate;

.3 The term "agent" or "agents" where used in Clauses 10.3, 10.4 and 10.5 shall include where appropriate the employees of the agent or agents referred to.

.6 The Associate undertakes to maintain in full force and effect insurance policies which shall provide cover for and against any liability arising out of or in connection with any oil spill or escape of oil or other hydrocarbons, waste or other hazardous materials from the Associate's Installation (including, without limitation, the costs of cleaning up such a spill or escape) and in respect of all of the Associate's liabilities under this Agreement. Such insurance policies shall provide at least the minimum level of cover agreed between the parties. The Associate undertakes to have the Company noted on the relevant policies as an additional insured party.

.7 At the Company's request, the Associate shall provide appropriate evidence of its compliance with the requirements of Clause 10.6 and shall provide the Company with certified copies of the relevant certificates of insurance.

.8 The Associate shall indemnify and keep indemnified the Company against all forms of taxation and fiscal imposts of whatsoever nature levied upon or against the Company in any jurisdiction other than the United Kingdom arising out of or in connection with the Company's performance of this Agreement, including, without limitation, taxation, any other withholdings and any customs or import or export duties or customs bonds.

11. LOSS OR DAMAGE

The Associate shall indemnify and reimburse the Company in respect of any loss or damage to the equipment supplied hereunder (other than normal wear and tear) and shall maintain a policy or policies of insurance in such amount as may be approved by the Company in respect of any loss of or damage to the equipment which is the subject of this Agreement from the time of delivery of such equipment to the nominated port or airport until the return of such equipment to the Base at the end of the period of hire. At the request of the Company, at any time the Associate will furnish the Company with such evidence of such insurance cover as the Company may request.

12. RETURN OF EQUIPMENT

.1 The Associate shall be responsible for the return of the equipment, which is the subject of this Agreement to the Base at the end of the period of hire. The period of hire includes the time from which the equipment leaves the Base until the equipment is returned to the Base.

.2 Notwithstanding any of the other provisions hereof, in the event that any equipment which is the subject of this Agreement, is not returned to the Base at the end of the period of hire or is lost or damaged other than by normal wear and tear until such time as the equipment in question is returned or has been replaced by substitute equipment as the case may be, the Associate shall pay to the Company in respect thereof the fees calculated at the rate set out in Schedule 1 and the period of hire shall be deemed to continue for such purpose.

.3 Notwithstanding Clause 15.3, the Company shall be entitled to retain any monies belonging to the Associate held by the Company and to set-off against any payments due to the Associate by the Company hereunder any amounts which the Company considers reasonable in order to fully compensate the Company against the consequences of any breach of this Clause 12 or any other provision of this Agreement by the Associate.

13. PAYMENT OF FEES AND OTHER CHARGES

Payments to be made hereunder shall be made by the Associate within thirty (30)

days of the date of receipt of the invoice (other than the Annual Fee which shall be paid on or prior to the Start Date) and without prejudice to the Company's other rights, payments outstanding after that period (or in the case of the Annual Fee, after the Start Date) shall bear interest until payment at three (3) per cent above the HSBC Bank base rate current from time to time during the period in question. If any deduction or withholding in respect of tax or otherwise is required by law to be made from any sums payable by the Associate to the Company, the Associate shall be obliged to pay to the Company such greater sum as will, after such deduction or withholding is made, leave the Company with a payment for the same amount as it would have been entitled to receive in the absence of any requirement to make such reduction or withholding.

14. FRAUD, BRIBERY AND CORRUPTION

.1 Both Parties shall:

.1 comply with all laws, regulations, codes and sanctions relating to anti-bribery and anti-corruption including but not limited to the United Kingdom Bribery Act 2010 ("the Bribery Act 2010"), the U.S. Foreign Corrupt Practices Act ("FCPA"), and anti-corruption laws of other countries applicable to the Associate (collectively, "Relevant Requirements");

.2 not engage in any activity, practice or conduct which would constitute an offence under the Bribery Act 2010 if such activity, practice or conduct had been carried out in the UK;

.3 comply with the Company's Anti-bribery and Corruption Policies notified to the Associate from time to time ("Relevant Policies");

.4 have and shall maintain in place throughout the term of this Agreement its own policies and procedures, including but not limited to adequate procedures under the Bribery Act 2010, to ensure compliance with the Relevant Requirements, the Relevant Policies and this Clause 14, and will enforce them;

.5 promptly report to the Company any request or demand for any undue financial or other advantage of any kind received by the Associate in connection with the performance of this Agreement;

.6 immediately notify the Company if a foreign public official becomes an officer or employee of the Associate or acquires a direct or indirect interest in the Associate (and the Associate warrants that it has no foreign public officials as officers, employees or direct or indirect owners at the date hereof) it being acknowledged by the Parties that merely contracting with a State Entity or subsidiary or affiliate thereof, absent any breach of the Bribery Act 2010, is not in itself a breach of this Clause 14;

.7 upon signature hereof and annually thereafter on renewal of this Agreement, certify to the Company in writing signed by a duly authorised officer of the Associate, compliance with this Clause 14 by the Associate and all persons associated with it and all other persons for whom the Associate is responsible under this Agreement. Accordingly, the Associate shall sign and return the enclosed Annual Certificate of Compliance appended to this Agreement under Schedule 3.

.2 The Associate shall ensure that any person associated with the Associate who is performing services or is otherwise involved in connection with this Agreement does so only on the basis of a written contract which imposes on and secures from such person terms equivalent to those imposed on the Associate by this Clause 14 ("Relevant Terms"). The Associate shall be responsible for the observance and performance by such persons of the Relevant Terms, and shall be directly liable to the Company for any breach by such persons of any of the Relevant Terms.

.3 For the purpose of this Clause 14, the meaning of adequate procedures and foreign public official and whether a person is associated with another person shall be determined by reference to the Bribery Act 2010 and any guidance issued in connection with the Bribery Act 2010.

.4 Without prejudice to any other remedy it may have, if the Company has reasonable grounds to believe that any persons associated with the Associate within the meaning of the Bribery Act 2010 has committed any fraud or Malpractice, the Company may, in its absolute discretion, suspend this Agreement.

.5 In the event that this Agreement is suspended in accordance with Clause 14.4 above, this Agreement will be resumed if the Associate is able to establish to the reasonable satisfaction of the Company that no person associated with the Associate within the meaning of the Bribery Act 2010 was responsible for any fraud or Malpractice.

15. TERMINATION OR SUSPENSION

.1 Notwithstanding anything to the contrary express or implied elsewhere in this Agreement, the Company (without prejudice to its other rights) may at its sole discretion either terminate this Agreement forthwith or forthwith suspend the provision of services under this Agreement until further notice on notifying the Associate either orally (confirming such notification in writing) or by notice in writing in the event that:

.1 a liquidator (other than for the purpose of amalgamation or reconstruction), trustee in bankruptcy, receiver or receiver and manager is appointed in respect of the assets and/or undertaking of the Associate or any Affiliate of the Associate, or the Associate or any Affiliate of the Associate enters into an arrangement or composition with its creditors, or any similar appointment, arrangement or composition is made under any applicable law, or if the Company has reason to anticipate any such appointment, arrangement or composition (but with respect to any Affiliate of the Associate, only where the occurrence of any of the foregoing events would or might adversely affect the performance by the Associate of any of its obligations or responsibilities hereunder); or

.2 the Associate or any Affiliate of the Associate fails to make any payment due to the Company under this Agreement punctually by the due date or commits any breach of this Agreement and fails to make such payment or remedy such breach within thirty (30) days of being advised by the Company that such payment is due and has not been made or such breach has been committed;

.3 the facilities, equipment or operating staff at the Base cease to be available to the Company for reasons beyond the reasonable control of the Company.

.4 the Associate or any Affiliate of the Associate or any party for whom either is responsible (as therein contemplated) under the terms of Clause 14, is in breach of Clause 14.

.2 In the event that this Agreement shall have been terminated or the provision of services hereunder suspended by the Company pursuant to Clauses 15.1.1 or 15.1.2, the Associate shall reimburse the Company all costs and expenses incurred as a consequence of such termination or suspension.

.3 Subject to Clause 12.3, in the event that this Agreement shall have been terminated pursuant to Clause 15.1.3, the Company shall reimburse to the Associate the appropriate pro rata proportion of the Annual Fee in respect of the number of days of the term of this Agreement remaining unexpired at the date of such termination.

.4 Upon any termination or expiry of this Agreement the Associate shall immediately return to the Company all equipment and operating staff provided to the Associate under this Agreement and all provisions of this Agreement relating to such equipment and staff shall be deemed to remain in force until the Associate shall have fully performed all its obligations hereunder in respect of such equipment or staff. The provisions of Clauses 10 and 11 shall survive any termination or expiry of this Agreement.

16. ASSIGNMENT AND DELEGATION

.1 Neither party shall transfer or assign its rights or obligations under this Agreement without the prior written consent of the other party.

.2 Notwithstanding Clause 16.1, the Company shall be free to arrange for all or any of its obligations hereunder to be performed in whole or in part by any Contractors.

17. FORCE MAJEURE

.1 No failure or omission by either party to carry out or observe any of the terms or conditions of this Agreement shall, except in relation to obligations to make payments hereunder or failure to return equipment due to customs, fiscal or other governmental regulations or interdictions, give rise to any claim against the party in question or be deemed a breach of this Agreement if such failure or omission arises from any cause reasonably beyond the control of that party ("force majeure"). Such obligations (other than obligations to make payments of money as provided in this Agreement) shall be suspended whilst such party is prevented or hindered from complying therewith.

.2 In the event that a force majeure causes a suspension of the obligations of either party, such party shall promptly give notice of such suspension to the other party stating the extent of such suspension and the nature of the force majeure. The party whose obligations have been suspended as a result of the force majeure shall, where appropriate resume the performance of such obligations promptly after the removal of the force majeure and shall notify the other party when the force majeure has ended.

18. NOTICES

.1 Any communications by either party to the other shall, unless otherwise provided herein, be sufficiently made if sent by post (by airmail where airmail is possible), postage paid, or by facsimile transmission to the address hereinafter specified.

Unless otherwise specified by not less than fifteen (15) days' notice in writing by the party in question, the address to which communications shall be sent:-

To the Company:

By mail:	Oil Spill Response Limited 25C Loyang Crescent BLK 503 TOPS Avenue 3 Singapore 506818
By facsimile:	+65 6266 2312

To the Associate:

By mail:	Vedanta Limited, Cairn Oil & Gas, DLF Atria, Phase 2, Jacaranda marg, DLF City, Gurugram – 122002, Haryana, India
By facsimile:	+91 124 414 5612

.2 Any notices given to the Associate shall be deemed served on all Affiliates of the Associate and the Company shall be entitled to rely on all notices, consents, requests and the like given to or by the Associate or any Affiliate of the Associate as binding on the Associate and all other Affiliates of the Associate.

.3 Notwithstanding the above provisions, communications which relate to emergency response only shall be sufficiently made if made by telephone, facsimile or electronic communication and if the telephone communication is confirmed by facsimile or electronic communication provided that they are so made by nominated persons the identity of whom shall be agreed in writing between the parties and such emergency communications are made to telephone or facsimile numbers and or electronic addresses similarly agreed in writing.

19. WAIVER

No waiver by either party of any provision of this Agreement shall be binding unless made expressly and expressly confirmed in writing. Further, any such waiver shall relate only to such matter, non-compliance or breach as it expressly relates to and shall not apply to any subsequent or other matter, non-compliance or breach.

20. LAW

The construction, validity and performance of this Agreement shall be governed by English Law, and the parties hereby submit to the exclusive jurisdiction of the English courts.

21. TAXATION

Any Value Added Tax or any other taxes chargeable on any payments made under this Agreement shall be added to the relevant sums due under this Agreement. If any deduction or withholding in respect of tax or otherwise is required by law to be made from any sums payable by the Associate to the Company, the Associate shall be obliged to pay to the Company such greater sum as will, after such deduction or withholding is made, leave the Company with a payment for the same amount as it would have been entitled to receive in the absence of any requirement to make such reduction or withholding.

22. SEVERABILITY

The invalidity or unenforceability of any provisions of this Agreement shall not affect the validity or enforceability of the remainder.

AS WITNESS the hands of the duly authorised representatives of the parties hereto the day and year first above written

SIGNED for and on behalf of

OIL SPILL RESPONSE LIMITED

By: Darren Waterman

Regional Director

SIGNED for and on behalf of

VEDANTA LIMITED

VEDANTA LIMITED
Cairn Oil & Gas

By: Shobhit Tiwari

Chief HSEQ & Sustainability Officer