ENVIRONMENTAL IMPACT ASSESSMENT

FOR

THE PROPOSED GREENFIELD COPPER REFINERY PROJECT (1.0 MTPA) AT ADANI PORT SPECIAL ECONOMIC ZONE LAND IN VILLAGES SIRACHA AND NAVINAL, TALUKA MUNDRA, DISTRICT KUTCH, GUJARAT

REPLY TO EAC OBSERVATIONS MEETING ON 24TH DECEMBER 2019

Sponsor :

M/s. Adani Enterprises Limited (AEL)

Siracha and Navinal Villages, Taluka Mundra, District Kutch, Gujarat

Prepared by :

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(NABL Accredited and ISO 17025 Certified Laboratory, Recognized by MoEF&CC, New Delhi)

February 2020

PREFACE

M/s. Adani Enterprises Limited (AEL)

Siracha and Navinal Villages, Taluka Mundra,
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REPLY TO EAC OBSERVATIONS MEETING ON 24TH DECEMBER 2019

For and on behalf of VIMTA Labs Limited

Approved by : **M. Janardhan**

Signed :

Position : **Head & Vice President (Env)**

Date : 5th February, 2020

The report has been prepared inline with the prescribed TORs issued vide letter No.J-11011/113/2016-IA.II(I) dated 21st June 2016 of Ministry of Environment, Forests and Climate Change, New Delhi.

This report has been prepared by **Vimta Labs Limited** with all reasonable skill, care and diligence within the terms of the contract with the client, incorporating our General Terms and Conditions of Business and taking account of the resources devoted to it by agreement with the client.

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adani

Ref:AEL/Copper/MoEF&CC/2020/Feb-05

Date: 5th Feb 2020

To,
Director
I.A. Division – Industry I
Ministry of Environment Forest & CC
Indira Paryavaran Bhavan,
Jor Bagh Road, Aliganj,
New Delhi – 110003

Subject: Request to increase the size of attachment to 70 MB at PARIVESH Portal for EC application & ADS submission.

Reference: SW/ 83372/2018, and Proposal No.**IA/GJ/IND/86812/2016** for Environmental Clearance application of 1 (One) million Ton per annum (MTPA) Copper Refinery Plant, Proposed by M/s. Adani Enterprises Ltd. at Mundra, Dist. Bhuj, Gujarat.

Sir,

Above referred project has been appraised 3 times by EAC, i.e. during the month Jan 2019, August 2019 and Dec 2019.

We have received ADS dated 3rd Feb 2020 and for your information, we are able to upload our responses and study reports in compliance to the EAC MOM dated 24th Dec 2019 only, due to limitation for attachment file size at PARIVESH Portal. Hence we are keeping our responses to EAC MOM dated 23rd August 2019 on Google Drive and also providing link **(https://drive.google.com/open?id=1S4jujCQ4ea4cwFbcT6VpaYaIaTGoTKw5)**, till EC is granted by MoEF & CC, while submission to ADS reply at PARIVESH Portal.

We request you to increase the attachments size at PARIVESH Portal to 70 MB for this project, so that we can upload total responses against MOM dated 23rd Aug 2019 and 24th Dec 2019; together. If increase in the size of the attachment at PARIVESH PORTAL is not possible, we are able to upload responses to EAC MOM dated 24th Dec 2019.

Kindly advice to us, if any alternate action is required from our end; apart from keeping our responses against EAC MOM 23rd August 2019 at Google Drive, till EC is granted by MoEF & CC.

Authorized Signatory

(Prasad Suryarao)
Adani Enterprises Ltd.

CC: Member Secretary EAC – Industry I

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UPDATES OF EAC OBSERVATION OF MEETING ON 23RD AUGUST 2019

UPDATE ON THE OBSERVATIONS OF THE SUB-COMMITTEE AND ADS POST SITE VISIT AND DISCUSSION WITH PROJECT PROPONENT

Sr. No.	ADS Point - Aug 2019	Out Come of the Discussions - Post Site Visit	Responses - Feb 2020
1	According to the EIA report, the land requirement for the project is 256.58 ha. Out of 256.58 ha, 154.19 ha is APSEZ area and 102.39 ha is a Forest land. The land use conversion plan of 154.19 ha for industrial purpose has not been obtained from the Competent Authority concerned. Further, PP has obtained stage I forest land diversion approval for 1576.81 ha in the name of M/s. Adani Ports and SEZ Limited. The factual agreement between M/s. Adani Enterprises Limited and M/s. Adani Ports and SEZ Limited for the utilization of 102.39 ha is a Forest land is not clear.	The committee found that ADS reply given is satisfactory in view of the fact that entire land proposed for the project 256.58 ha is within the APSEZ out of which 154.19 ha is already notified as SEZ and the balance land of 102.39 ha is under process of forest diversion. There is an agreement through MoU between APSEZ and Adani Enterprises Ltd (AEL).	-
2	CRZ map inter-alia including demarcation of HTL/LTL/CRZ land classification along with super imposition of plant site through competent agencies has not been submitted.	CRZ map was prepared by Centre of Earth Science Studies (CESS), Thiruvanthapuram. Site is outside the CRZ, geographically separated by road and railway track. This CRZ map is awaiting finalization as part of ICZMP which is in the process by Govt. of Gujarat.	This CRZ map as part of ICZMP which is in the process approval with MoEF&CC.
3	Source of copper ore concentrate, characteristics, mode of transportation from source to plant EAC, confirmed ore linkage document has not been submitted.	The indicative figures of weight fractions of copper concentrate from the various sources were discussed. However, there is no such analysis report is available on the records. The mode of transport from port to the plant and transit covered storage at port, conveyor, storage at plant ensured without leakage and safe handling. AEL has already got commercial enquiries from copper concentrate suppliers: 1) Mitsubishi Corporation Rtm International Pte, Singapore 2) Transmine Trading SA 3) Trifigura India Pvt Ltd	The responses covered in the EAC observation No. 1 reply.

UPDATE ON THE OBSERVATIONS OF THE SUB-COMMITTEE AND ADS POST SITE VISIT AND DISCUSSION WITH PROJECT PROPONENT

Sr. No.	ADS Point - Aug 2019	Out Come of the Discussions - Post Site Visit	Responses - Feb 2020
		4) MITSUI & Co, Japan It seems, the origin copper concentrate may be Australia and South America Continent.	
4	Water consumption of 10 LTPA Copper smelter is 32790 KLD whereas the water requirement for existing 4.5 LTPA copper smelter unit is only 10,000 KLD. Hence, water requirement for the proposed plant has to be reworked out.	In comparison to existing plant of M/s Vedanta Ltd, the water consumption will be more as the cooling system proposed is wet cooling tower which has specific consumption 8.7 m 3/T of copper that of radiator type air cooler (dry cooling). It is found the energy requirement for fans in case of dry cooling system will be more in turn more carbon footprint.	Water Balance for the proposed Copper refinery project has been revised. Water requirement has been reduced from 32,800 KLD to 29,678 KLD; resulting in reduction of specific water consumption from 8.7 m^3/ t copper to 7.8 m^3/ t copper. Detailed technical comparison between the wet cooling tower and the radiator type air-cooler with their references in the various sulfuric acid plants, is covered in EAC observation No.2 response.
5	According to the EIA records, Dhaneshwari river is passing through the project site and the mangrove reserve forest is existing within the project site. Quantification of these mangroves and conservation measures for mangroves and the river stream has not been submitted.	No mangroves are present in the plant site. Presence of the mangroves are sighted on the southern side, along the Kodti Creek. It is informed that the company appointed ecological expert who is working on the monitoring of the mangroves and conservation of the same in the identified patches of coastal areas in consultation with the State Forest Department. Further, report on Wildlife Conservation plan /Mangrove Conservation Plan was discussed at a length in terms of biodiversity, socio-economic values for the locals, monitoring mechanism etc. Mud flats were not mapped in the CRZ map.	The responses covered in the EAC observation No. 8 response.
6	Storage arrangements made for the raw materials are found to be not adequate. Open storage of raw materials such as coal, limestone etc., shall be avoided.	AEL explained the Engineering drawings of covered storage yards for raw material storage.	-

UPDATE ON THE OBSERVATIONS OF THE SUB-COMMITTEE AND ADS POST SITE VISIT AND DISCUSSION WITH PROJECT PROPONENT

Sr. No.	ADS Point - Aug 2019	Out Come of the Discussions - Post Site Visit	Responses - Feb 2020
7	Sulphur balance of the copper smelter unit has not been submitted.	The sources of SO2 (97%), Copper Concentrate, Furnace Oil and Met Coke were taken into account. Fixation of Sulphur in copper slag, Chemical gypsum, ETP Sludge and residual off gas from SAP and FGD system. **SAP:** Catalytic converter bed with DCDA with conversion of 99.92% and cesium sulphuric acid catalyst in final bed catalytic converter for greater conversion efficiency at temperature lower than 400^{o}C. Tail gas scrubbing to scrub the residual gases coming out of the final absorption tower. **FGD:** Scrubber with amine technology for treating off gas for smelting furnace, electric furnace and PS converter and slag cleaning furnace. Lime scrubber is proposed for treating fugitive off gas from anode furnace and scrap melting furnace.	Sulphur Balance is submitted as a part of ADS as **Attachment-I**.
8	Copper slag disposal site co-ordinates, concrete mode of utilization, maximum time frame envisaged for the storage at the disposal yard i.e., one month (or) 15 days has not been submitted.	Slag disposal storage was proposed for three months. Complete reuse of the copper slag is yet to be explored to draw action plan.	The Copper slag disposal site co-ordinates are given in site observation No. 5 response. The utilization plan for the copper slag with details of the storage yard is covered in EAC observation No. 6 response.
9	Phospo-gypsum disposal site co-ordinates, concrete mode of utilization, maximum time frame envisaged for the storage at the disposal yard i.e., one month (or) 15 days has not been submitted.	To be revised in accordance with location / lay out plan	The Phospo-gypsum disposal site co-ordinates are given in site observation No. 5 response. The utilization plan for the Phospo-gypsum with details of the storage yard is covered in EAC observation No. 6 response.

UPDATE ON THE OBSERVATIONS OF THE SUB-COMMITTEE AND ADS POST SITE VISIT AND DISCUSSION WITH PROJECT PROPONENT

Sr. No.	ADS Point - Aug 2019	Out Come of the Discussions - Post Site Visit	Responses - Feb 2020
10	Lining details for Phospo-gypsum disposal yard, leachate collection system envisaged, and details of piezo-well installation has not been made available.	To be revised in accordance with location / lay out plan	The responses covered in the EAC observation No. 6 response.
11	Secured land fill EAC co-ordinates, lining details, leachate collection system envisaged, and details of piezo-well installation has not been made available.	After reviewing the layout plan, the committee felt SLF shall be designed at one location only with adequate facilities for sampling and testing instead of two locations in the layout. The layout area of SLF shall not be made congested. Adequate space shall be earmarked for safe handling and movement of vehicles.	The responses covered in the EAC observation No. 5 response.
12	Baseline health status of the people living in the study area of the project site has not been collected.	Baseline health survey was conducted by M/s TALEEM Foundation Ahmedabad. The general issues identified are live birthe and infants' survival, anaemia, disrrheoa etc,	-
13	Details regarding disposal of arsenic bearing sludge has not been submitted.	Arsenic sludge generated from the ETP after tertiary treatment, will be sent to SLF. The general chemical characteristics of the arsenic bearing sludge is given in ADS reply. However, the same may be required in the EMP in the post project monitoring.	The responses covered in the EAC observation No. 8 response.
14	Mercury in ambient air has not been monitored.	Mercury monitoring was carried out which was found to be <0.5 ng/Nm3	-
15	Conservation plan prepared for the Schedule-I species is not meeting the requirement of the conservation of the species that are identified. Therefore, the plan shall be revised considering the requirements of the conservation of the species identified and shall be approved by the competent authority concerned.	To be discussed in the EAC	The responses covered in the EAC observation No. 8 response.
16	Collection of runoff water from the raw material storage area, slag and gypsum	Storm water management plan is to be revised based on the peak rainfall.	The responses covered in the EAC observation No. 9 response.

UPDATE ON THE OBSERVATIONS OF THE SUB-COMMITTEE AND ADS POST SITE VISIT AND DISCUSSION WITH PROJECT PROPONENT

Sr. No.	ADS Point - Aug 2019	Out Come of the Discussions - Post Site Visit	Responses - Feb 2020
	storage yard and its treatment has not been submitted.		
17	Study on installation of rainwater harvesting structure based on annual rain fall pattern and details regarding amount of water to be conserved has not made available.	Rainwater harvesting structures shall be designed as per the quantification of the rainwater runoff based on the average rainfall in the region.	The responses covered in the EAC observation No. 9 response.
18	Impact on hydro geology regime of the project site has not submitted.	Stage of development shall be defined based on the hydro logical survey as the APSEZ and ADANI Power Ltd is operating since long.	Submitted as a part of ADS as **Attachment-II.**
19	Occupational health assessment envisaged for the employees and workers has not been submitted.	Occupational health survey was conducted by ICMR-NIOSH. Monitoring mechanism as per the is not clear in the report.	The responses covered in the EAC observation No. 10 response.
20	As per the Public hearing proceedings, it is noted that there are strong oppositions from the stake holders against the installation of copper smelter unit. Consolidated list of pointwise issues raised and response provided along with action plan for implementation has not been submitted.	To be revised	The responses covered in the EAC observation No. 11 response.
21	The Chapter-5 consists of only listing of alternative technologies. The committee opened that the PP shall select out of alternative technologies available, based on the selection of the technology, the impact prediction shall be made and mitigation measures shall be proposed.	Outotec Flash melting furnace is selected for the proposed project due to Operational ease and Environmental friendly. Copper concentrate, flux additives need to have moisture content below 0.3 %. Rotary steam dryer is used for drying.	-
22	Quantitative representation of mitigation measures was not presented.	All the process flow, outlet and inlet flows shall be mentioned in the same unit system. Stack height (20m) of anode casting may be revised.	The responses covered in the EAC observation No. 14 response.
23	Revised water balance shall be submitted.	Water balance diagram is illegible.	The responses covered in the EAC observation No. 13 response.

UPDATE ON THE OBSERVATIONS OF THE SUB-COMMITTEE AND ADS POST SITE VISIT AND DISCUSSION WITH PROJECT PROPONENT

Sr. No.	ADS Point - Aug 2019	Out Come of the Discussions - Post Site Visit	Responses - Feb 2020
24	HIRA shall be prepared for worst case scenario	HIRA is inadequate	The responses covered in the EAC observation No. 15 response.
25	Management of white ash shall be spelled out	To be discussed in EAC	Management of white ash is submitted as a part of ADS **Attachment-III**.
26	Material balance shall be revised.	Satisfactory	-
27	The involvement of geological expert shall be provided.	Hydrogeological expert was involved.	-
28	The compliance of specific conditions of the environmental clearance of the SEZ shall be provided.	Satisfactory	-
29	The reply to TOR point No. (4) is not proper.	Satisfactory	-
30	The data retrieved from the LULC studies shall be utilized for the prediction of impacts and mitigation measures.	To be revised	The responses covered in the EAC observation No. 12 response.
31	The Air Quality modelling studies shall be re-worked out including the mercury and keeping the mixing height in view.	Suitability of model used as per the EAC characteristics in view of complex atmospheric conditions of coastal line.	The responses covered in the EAC observation No. 12 response.
32	The Environmental Policy of the Organization is not meeting the requirements given in ToR Point No. 9(i), 9(ii), 9(iii), 9(iv).	Environmental Policy was not furnished. Reporting system of non-compliances/ violation is also not in place.	The responses covered in the EAC observation No. 16 response.
33	The CER shall be calculated on the slab rates as per the Office memorandum issued on 1st May,2018.	CER shall be revised explicitly on SIA/Need based Assessment and issues raised iin the Public Hearing	The responses covered in the EAC observation No. 11 response.

ATTACHMENT-I

EAC OBSERVATION No-7:

Sulphur balance of the copper smelter unit has not been submitted.

REPLY:

Sulphur is one of the major ingredient in the copper concentrate. Sulphur from the copper concentrate will be largely converted as Sulphur DI- Oxide during smelting process which will be input raw material for Sulphuric Acid plant for production of Sulphuric Acid with 98% concentration. Sulphuric Acid plant is designed to convert 99.92% of SO_2 into concentrated Sulphuric Acid.

A detail sulphur balance has been reworked out considering various input and output material characteristics. Sulphur from various sources such as Copper concentrate, Furnace Oil, Met Coke will largely (~ 97%) converted into concentrated Sulphuric Acid and rest will be available in by product (Copper slag) and waste material such as chemical gypsum and ETP sludge. Residual Off- gas from Sulphuric Acid plant and Flue Gas Desulphurization system will have SO_2 ~ 300 mg/Nm^3.

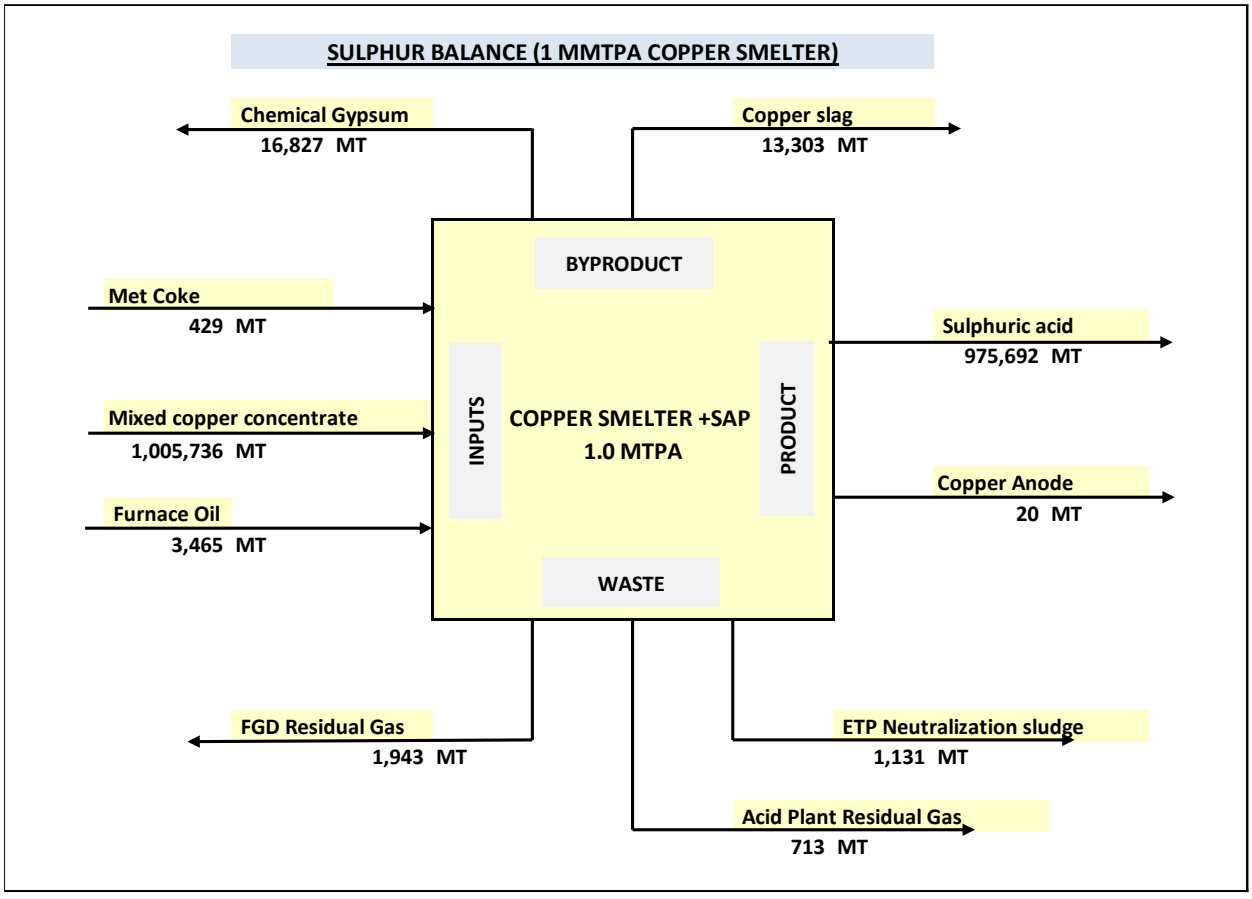
The following pollution control measures are proposed to reduce SO_2 around ~300 mg/Nm^3 from Sulphuric Acid Plant (SAP) and Flue Gas Desulphurization (FGD):

SAP	FGD
SO_2 emission of ~300 mg/Nm^3 from the residual off-gases coming out of sulphuric acid plant stack will be achieved by: a) Catalytic converter bed configuration of 3+2 with Double Conversion Double Absorption (DCDA) process, for the sulphuric acid plant; with SO_2 conversion efficiency of 99.92%. b) Use of super cesium sulphuric acid catalyst in the final bed of the catalytic converter, which has better conversion efficiency at a temperature lower than 400 ^{0}C. c) Tail gas scrubber to scrub the residual gases coming out of the final absorption tower.	SO_2 emission of ~300 mg/Nm^3 from the residual off-gases coming from Flue Gas Desulphurization system connected to treat smelter secondary off gases, following system will be achieved by: a) Scrubber with amine technology will be installed for treating secondary off gases from smelting furnace, PS converter and slag cleaning furnace. b) Lime scrubber will be installed for treating secondary off gases from electric furnace, anode Furnace and scrap melting furnace.

ATTACHMENT-I

Sulphur Balance - for 1 MTPA copper plant					
No.	**Material description**	**Qty. (t/a)**	**S content (%)**	**S amount (t/a)**	**% Distribution**
A	**Input**				
1	Mixed copper concentrate	3,142,924	32.00	1,005,736	99.61%
2	Furnace Oil	99,000	3.5	3,465	0.34%
3	Met Coke	33,000	1.3	429	0.04%
	Total	**3,274,924**	**30.83**	**1,009,630**	**100.00%**
B	**Output**				
1	Sulphuric acid	2,988,058	32.65	975,692	96.64%
2	Copper Anode	1,003,009	0.002	20	0.00%
3	Copper slag	1,900,373	0.70	13,303	1.32%
4	Chemical Gypsum	156,968	10.72	16,827	1.67%
5	ETP Neutralization sludge	43,348	2.61	1,131	0.11%
6	FGD Residual Gas	~ 1,643,038 Nm3/hr	300 mg/Nm3*	1,943	0.19%
7	Acid Plant Residual Gas	~ 603,040 Nm3/hr	300 mg/Nm3*	713	0.07%
	Total			**1,009,630**	**100.00%**

* Denotes SO_2 Content



ATTACHMENT-II

EAC OBSERVATION No-18:

Impact on hydro geology regime of the project site has not submitted.

REPLY:

Stage of Ground Water Development:

The study area forms part of Mundra and Mandvi blocks of Kachchh district. The average stage of ground water development in these blocks as per CGWB assessment is 82.26% and categorized as "Semi-critical" (Mundra at 63.28% as "Safe" and Mandvi at 101.23% as "Over-exploited").

No ground water is being used or proposed for APSEZ and Adani Power Ltd. The ground water abstraction in the study area is mainly for domestic and irrigation purposes. The present stage of ground water development in the study area is estimated as 102.73% and can be categorized as "Over-exploited".

"Mundra falls under "dark" category as ground water development is between 85-100%. Mandvi is categorized as "OE" (Over Exploited) meaning the ground water is over exploited to the extent of development above 100% (GIDE, 2000)".

Salinity/Sea Water Intrusion:

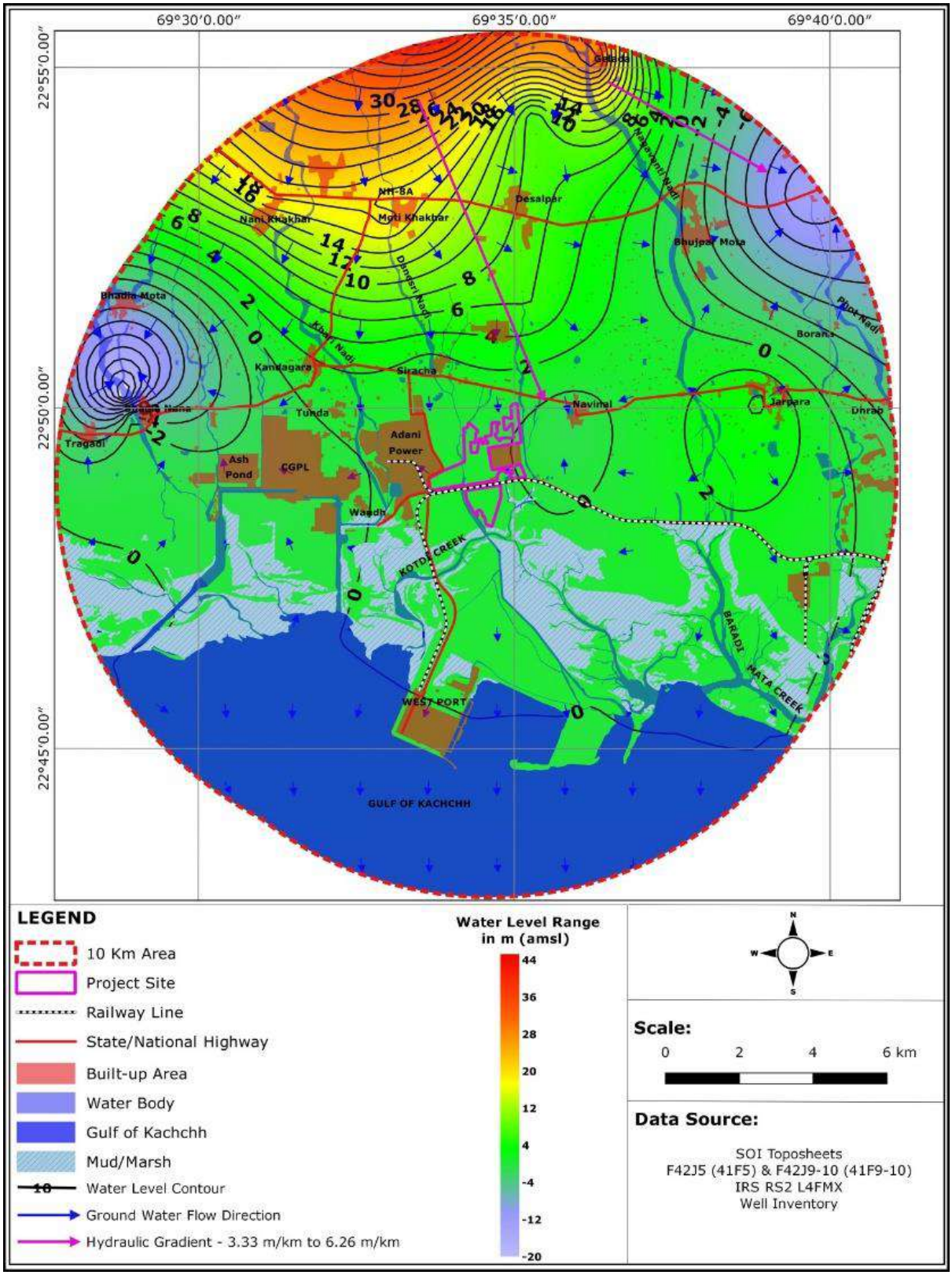
Water level contours prepared based on the well inventory during field study during February 2019 for the study area indicate that the water levels in and around Tragadi, Bhadia Nana, CGPL, Wandh, Navinal and Jarpara are below mean sea level and these areas are prone to saline water intrusion.

Salinity in water is usually defined by the Total Dissolved Solids content (TDS, mg/l or g/l) or the Chloride content (Cl, mg/l) although the Chloride ion comprises only a fraction of the total dissolved salts in water. The classification of ground water based on TDS suggests four categories as given below:

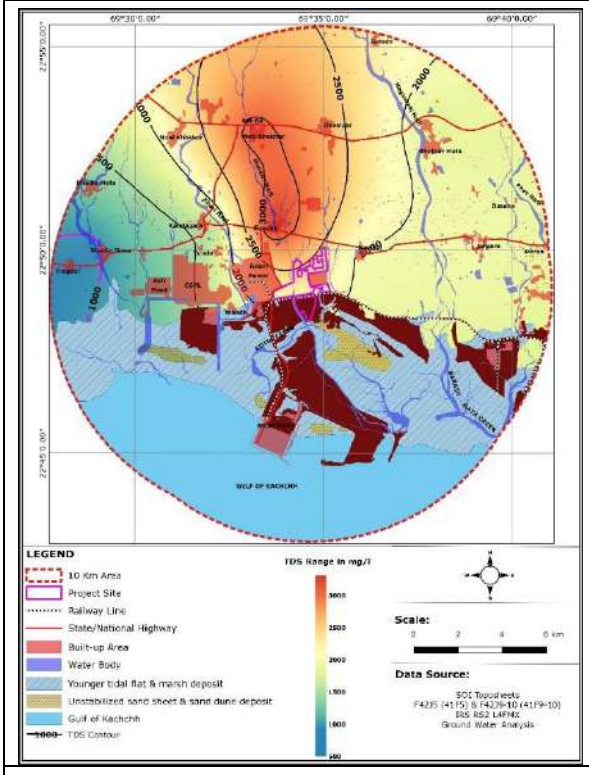
Water Type	TDS Range (mg/l)
Fresh water	0 - 1000
Brackish	1000 - 10,000
Saline	10,000 - 1,00,000
Brine	>1,00,000

A review of maps showing TDS and Chloride distribution in ground water in the inland area reveal that the TDS and Chloride distribution in the inland area show similar pattern and the ground water in entire area except around Tragadi and Bhadia Nana is moderately brackish with TDS more than 1000 mg/l. TDS and Chloride values of more than 3000 mg/l and 1000 mg/l respectively around Siracha and Moti Khakhar does not show any continuity from coast line and appears to be native to the deeper aquifers/formations.

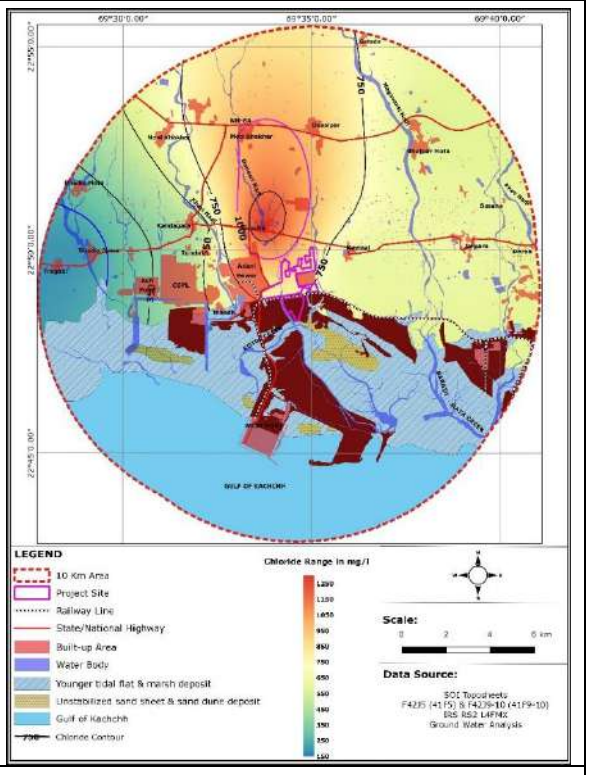
ATTACHMENT-II



WATER LEVEL CONTOURS

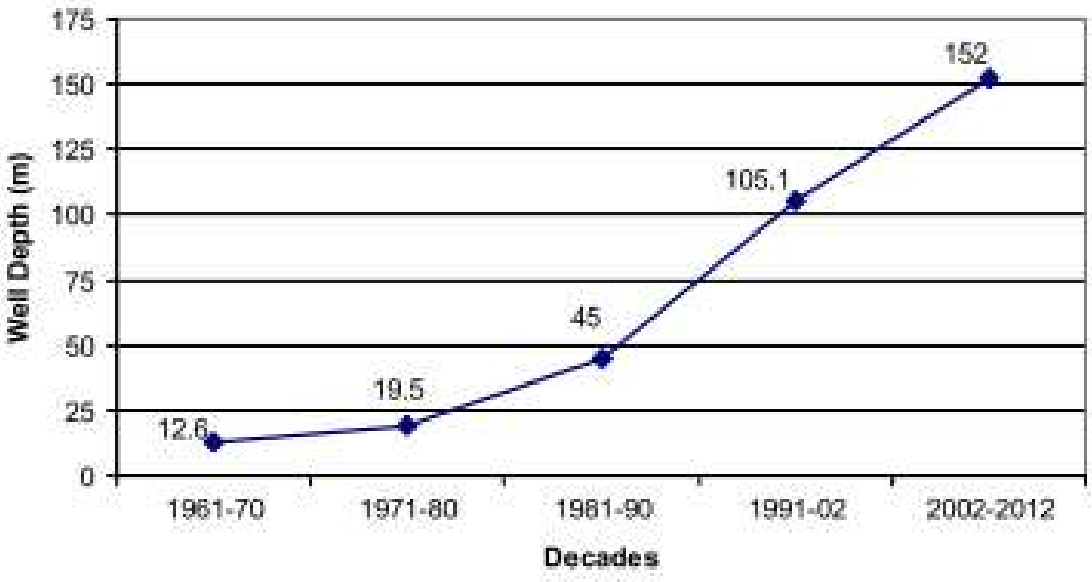


TDS in mg/l



Chloride in mg/l

The sandstone is the only deep and potential aquifer in the coastal region. Maximum observed depth of bore well in the study area is 180 m. The sandstone is intercalated with impervious clay lenses. The study carried out by Raju (2003) based on bore hole records has revealed that the clays are embedded within Kankavati formation have tapering thickness varying from 10 to 25 m at thinner end and maximum of 50 m at centre. The clay lenses are observed at various depths. He has also reported that ground water extraction from this potential aquifer has gone down from 30 m to 150 m below ground level in last three decades and this over exploitation has led to its quality deterioration too. This exceptional lowering of water levels after 1990, has probably initiated the problem of sea water intrusion leading to ground water quality deterioration. Decadal change in well depths of wells is presented below:



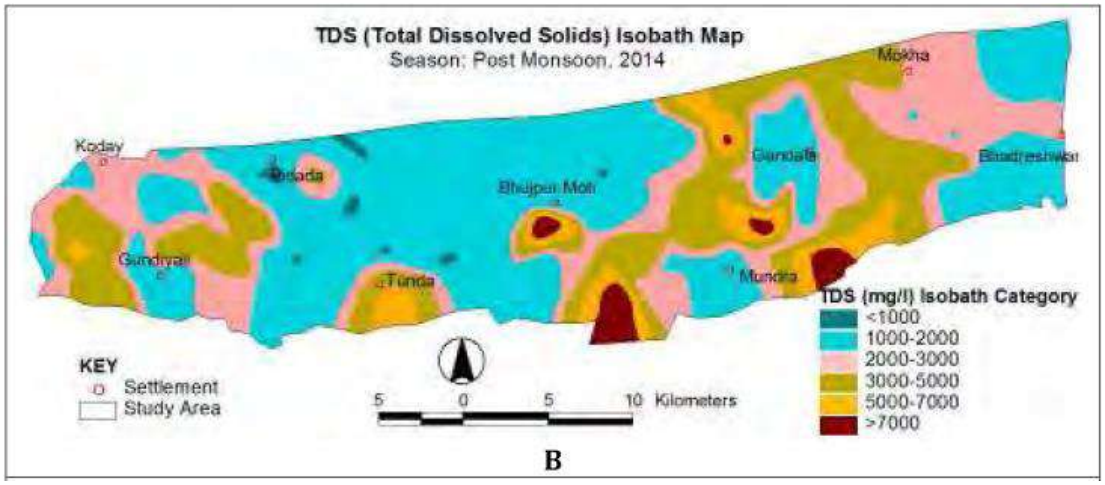
Gujarat Institute of Desert Ecology (GUIDE) Observations:

GUIDE had conducted geo-hydrological investigations in coastal belt of Mandvi and Mundra regions of Kachchh district covering the coastal area of 50 km length from Bhadreshwar to Mandvi between March 2014 and February 2015 with emphasis on saline water intrusion in ground water in the area.

The ground water salinity in the study area has both the characters i.e., coastal salinity and inherent salinity. Along with this, the region is characterized as arid to semi-arid region, where evaporation salinity also exists. Ground water salinity aspects have been studied for seasonal and long-term duration based on primary and historic ground water quality data.

The TDS content generally increases in some of the study area but on the contrary, there are some areas where TDS content has also decreased like Bharapar, Deshalpar, Gundala, Mundra, Nani Bhujpar, Tunda and Zarpara of the study area. The Chloride content has also increased in the study area, but on the contrary, there are some areas where Chloride content has decreased like Bharapar, Deshalpar, Nani Bhujpar and Ragha. Examining the study area and its ground water quality from the above-mentioned data, it indicated that there is a salt water ingress in the coastal areas and especially in the study area.

From the TDS (salinity) range, it can be said that the ground water in the study area is mainly brackish water as the TDS (salinity) values fall in 1,000-10,000 mg/l range, but some areas are having fresh ground water as the TDS values are below 1,000 mg/l. Pre and post monsoon seasons of 2014, TDS analysis shows there is about 4% area that has highly saline areas around villages of Tunda and Mundra.



CEIA:

The overall quality of water is excellent. Marginal degradation in water quality in localized areas around industrial and urban centre is possible. But such changes are subsided by semi-diurnal tidal flushings associated with moderate to strong tidal currents.

ATTACHMENT-III

EAC OBSERVATION No-25:

Management of white ash shall be spelled out.

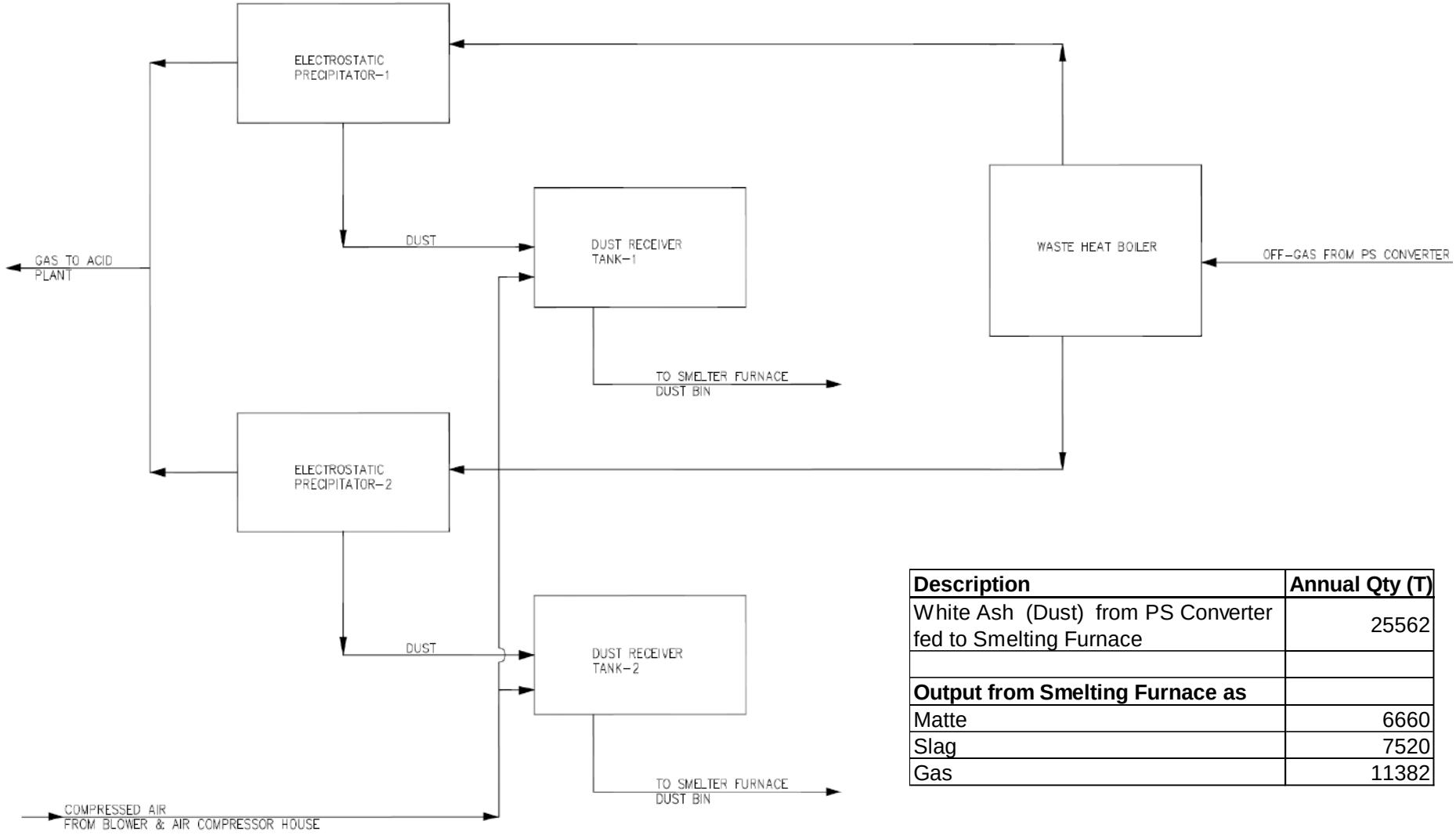
REPLY:

White Ash (Dust) Management:

- High temperature dust-laden gas ~1200^{0}C from Peirce Smith Converter (PSC) goes to the waste heat boiler to recover waste heat and produce steam and cool itself down to about 360^{0}C; while allowing much of the dust entrained in the gas to settle down at the same time; the dust-laden gas from all waste heat boilers reports in the balloon gas duct before it goes to the dust chamber for precipitation and then the ESP for dust removal.
- Dust-removed gas is sent by high temperature exhaust fan to the Sulphuric Acid Plant. The dust captured in the ESP is also called as white dust.
- This dust contains copper along-with impurities such as Lead, Zinc, etc.
- Dust captured in the PSC ESP is delivered by chain conveyor to the white dust bin. Pneumatic conveying system is used to send white dust to smelting furnace dust bin for blended with copper concentrate.
- Total amount of white dust collected will be 25,562 TPA
- Recycled white dust gets converted in the form of matte 6660 TPA, slag 7520 TPA and gas 11382 TPA.

ATTACHMENT-III

BLOCK FLOW DIAGRAM: WHITE DUST (ASH) MANAGEMENT



Description	Annual Qty (T)
White Ash (Dust) from PS Converter fed to Smelting Furnace	25562
Output from Smelting Furnace as	
Matte	6660
Slag	7520
Gas	11382

RESPONSE TO EAC OBSERVATION OF MEETING ON 24TH DECEMBER 2019

EAC OBSERVATION NO.-1

EAC OBSERVATION:

Provide chemical characteristics of the sourcing Copper concentrate.

REPLY:

Adani will be sourcing copper concentrate from various mines present across the World. Hence, the sourcing range of the copper ore concentrate will vary mine to mine. The typical copper ore concentrate sourcing range and smelting input range is shown below:

Parameter	Unit	Sourcing Range	Smelting Input Range
Cu	Wt%	17-46	24 - 28
Fe	Wt%	15-35	24 - 29
S	Wt%	15-40	30 - 34
SiO_2	Wt%	0.5-14	< 10
CaO	Wt%	0.05-7.0	< 1.0
MgO	Wt%	0.03-1.5	< 1.0
Al_2O_3	Wt%	0.03-6.0	< 2
Zn	Wt%	0.001-8.0	< 3
Pb	Wt%	0.005-4.1	< 1.5
Fe_3O_4	Wt%	<1.9	< 1.5
H_2O	Wt%	5.0-10.0	< 8
As	g/t	10-18,000	< 2500
Se	g/t	3-23,000	< 300
Bi	g/t	9-10,000	< 200
Sb	g/t	4-5,000	< 150
Ni	g/t	10-8,000	< 350
Te	g/t	0.9-100	< 100
Cd	g/t	1-250	< 20
Cr	g/t	10-1,000	< 45
Cl	g/t	4-1,000	< 400
F	g/t	20-9,000	< 1500
Hg	g/t	0.4-100.0	< 40

The copper ore concentrate will be blended with various sourced copper ore concentrate within the copper smelter blending facility constituting of number of bins holding various source copper concentrate. Bins are fitted with automatic weighing system to effectively mix copper ore concentrate and required fluxes (silica & limestone) as required to suite copper smelting input range.

The prospective Copper ore concentrate supplier have provided broad specifications for copper ore concentrate. The respective letter have been enclosed as **Annexure-1.**

MITSUI & CO.,LTD.
1-3, Marunouchi 1-chome,
Chiyoda-ku, Tokyo, 100-8631, Japan
Tel: +81-3-3285-3398

MITSUI & CO.

Date. Jan 15th, 2020
In reply please Address to
Base Metals div.

Mr. Prasad A. Suryarao
Adani Enterprises Ltd
Adani Corporate House, Shantigram,
Ground Floor – South Block
Nr. Vaishnodevi Circle, SG Highway,
Ahmedabad – 382421, Gujarat, India

Dear Mr. Suryarao,

Indicative assays of Copper Concentrate

We are pleased to know that your project is in the final stage of getting environmental approvals.

MITSUI & CO., LTD. reiterate their interest to be associated with the proposed Adani Copper Plant as a prospective supplier of Copper Concentrate. We have our own equity off-take and also trade many other qualities of Concentrates. Based on our current book, these are the indicative assays:

Element	UOM	Min	Max	Typical
Copper	%	18	46	27
Iron	%	18	30	24
Sulphur	%	22	40	33
Al_2O_3	%	0.3	5	2
SiO_2	%	1	10	6
Zinc	%	0.01	4.5	2
Lead	%	0.5	3.5	1
MgO	%	0.4	1	0.2
CaO	%	0.2	2	0.7
Arsenic	%	0.01	1.5	0.4
Bismuth	%	0.01	0.2	0.05
Antimony	%	0.01	0.2	0.02
Chlorine	ppm	10	900	600
Fluorine	ppm	50	3000	1000
Nickel	ppm	50	1000	800
Cobalt	ppm	20	800	600
Chromium	ppm	10	500	80
Selenium	ppm	15	2000	200
Tellurium	ppm	9	100	30
Mercury	ppm	1	100	20
Cadmium	ppm	1	200	100

Kindly note that these indicative assay ranges are combined range of various copper concentrates in the market and these assays and actual assays which might vary from shipment to shipment. Kindly note that assays undergo changes from time to time depending upon the mining plan and other mining disruptions. Further, our profile of the qualities we trade also changes year on year. Consequently, the assay range will keep on getting refreshed from time to time.

Please note that above indicative assay should be considered as a reliable indication only, and we are looking forward to discussing more in detail at an appropriate timing.

Best Regards,

MITSUI & CO., LTD.

Tatsuhiro Torikai
General Manager
Raw Material Marketing Dept.
Base Metals Div.

Mitsubishi Corporation RtM International

3 Temasek Avenue #32-01, Centennial Tower, Singapore 039190
Co.Reg.No. 201230103M ABN 22 609 587 715

www.mitsubishicorprtm.com/global

January 10, 2020

Mr. Prasad A. Suryarao
Adani Enterprises Ltd.
Adani Corporate House, Shantigram,
Nr. Vaishnodevi Circle, SG Highway,
Ahmedabad 382421
Gujarat, India.

Dear Mr. Rao,

Indicative assays of Copper Concentrate

We are quite pleased to know that the esteemed project is now well into the final phase of getting approvals.

Mitsubishi Corporation RtM International Pte Ltd (RtMI) reiterate their interest to be associated with the proposed Adani Copper smelter as a reliable supplier of Copper Concentrate.

We have our own equity off-take and also trade many other qualities of Concentrates. Based on our current book, these are the indicative assays:

	Assay Range	Typical
Cu	18–45%	26%
S	15 – 40	32%
Fe	15 – 35%	25%
As	0.1 – 1.5%	0.30%
SiO2	0.5–10%	3%
Al2O3	0.03–5.0%	2%
MgO	0.03%–0.2%	0.10%
Ca	0.05–3.0%	1.50%
Pb	0.05–3.0%	1.50%
Sn	0.01 – 0.5%	0.10%
H2O	5 – 12%	8%
Bi	0.01–1.0%	0.10%
Zn	0.5–8.0%	3%
Sb	<0.5%	0.20%
Cl	<0.1%	0.05%
F	0.01 – 0.2%	0.03%
Hg	1 – 100ppm	10ppm
Ni	<0.1%	<0.1%
Co	<0.1%	<0.1%

Mitsubishi Corporation RtM International

3 Temasek Avenue #32-01, Centennial Tower, Singapore 039190
Co.Reg.No. 201230103M ABN 22 609 587 715

www.mitsubishicorprtm.com/global

Please be advised that the above specifications should be considered as a reliable indication only. It is well known that assays undergo changes from time to time depending upon the mining plan. Further, our profile of the qualities we trade also changes year on year. Consequently, the assay range will keep on getting refreshed from time to time.

Looking forward to discuss in greater detail once all the approvals are in the place.

Kindly keep us posted on the progress. Thanks

Best regards,

Mamoru Nakatsu

Mitsubishi Corporation
RtM International Pte Ltd.

ANNEXURE-1

TRANSAMINE
TRADING SA

Date : Jan 6th , 2020

M/s Adani Enterprises
Ahmedabad

Kind Attention : Mr Prasad Surya Rao

Dear Sir

This is with reference to our various discussions on the subject of Copper concentrates supplies to your proposed Copper Smelter project at Mundra. Kindly also refer to our letter dated 1st Feb 2019 on the same subject.

As you are aware the Copper concentrates as produced and traded, have chemical compositions depending on the mineralogy of the ore body from where the same is extracted and beneficiated. However broadly, you can expect the below ranges for the main composition.

UOM		Min	Max	Typical
%	Al2o3	0.17	6	1.92
%	As	0.001	1.5	0.4
ppm	Bi	9	500	100
%	CaO	0.08	7	1.19
ppm	Cd	1	250	100
ppm	Cl	4	800	165
ppm	Co	30	700	200
ppm	Cr	10	1000	100
%	Cu	17	45	26
%	F	0.002	0.9	0.04
%	Fe	17.8	33	25.81
%	Fe3O4	1.9	1.9	1.9
ppm	Hg	0.4	85	6.89
%	MgO	0.066	1.5	0.53
%	Ni	0.001	0.8	0.08
%	Pb	0.005	4.1	0.36
%	S	18	36	30
%	Sb	0.0004	0.4	0.04
%	Se	0.0003	0.23	0.02
%	SiO2	0.0024	20	10
%	Sn	0.0009	0.3	0.05
ppm	Te	0.9	100	37
%	Zn	0.001	5.05	0.77

Thanks and Regards

On behalf of Transamine Trading S.A.

Somnath Ghosh

ANNEXURE-1

From: Amol Mehra <Amol.Mehra@trafigura.com>
Date: 22 January 2020 at 8:39:56 AM IST
To: Prasad Suryarao <Prasad.Suryarao@adani.com>
Subject: RE: [EXTERNAL] RE: Copper Project

Dear Prasad Sir,

Happy to hear regarding status of the project .

As mentioned earlier as per enclosed letter of ours . We reiterate we would be interested to be associated with the proposed Adani Copper Plant as a prospective supplier of Copper Concentrate.

As you are aware - We are one of the biggest Trader for Copper Concentrate .Based on your request indicative assays are as under :

Element	UOM	Min	Max
Copper	%	20	42
Iron	%	19	28
Sulphur	%	26	38
Al2O3	%	0.4	4
SiO2	%	3	14
Zinc	%	0.05	3.7
Lead	%	0.5	2.9
MgO	%	0.4	1.1
CaO	%	0.2	2.5
Chlorine	ppm	50	800
Fluorine	ppm	40	4100
Arsenic	%	0.01	1.8
Bismuth	%	0.01	0.15
Antimony	%	0.01	0.15
Selenium	ppm	45	1000
Tellurium	ppm	15	80
Nickel	ppm	100	800
Cobalt	ppm	15	500
Chromium	ppm	20	375
Cadmium	ppm	2	100
Mercury	ppm	1	70
Moisture	%	5	9

Kindly note that these indicative assay range are combined range of various copper concentrates in the market and these assays and actual assays might vary from shipment to shipment. It is well known that assays undergo changes from time to time depending upon the mining plan and other mining disruptions.

Further, our profile of the qualities we trade also changes year on year. Consequently, the assay range will keep on getting refreshed from time to time.

Kindly note that these indicative assay should be considered as a reliable indication only.

Looking forward to discuss in greater detail once all the approvals are in the place.

Wishing you best always.

Rgds,amol

EAC OBSERVATION NO.-2

EAC OBSERVATION:

Justification for installation of Water-Cooling Condenser (WCC)

REPLY:

Sulphuric acid plant requires circulating water for meeting cooling requirement of various auxiliaries. Heat from various auxiliaries is gained by circulating water, which is rejected to the atmosphere through cooling tower.

The heat can be rejected from the circulating cooling water either through wet cooling tower or dry cooling tower (i.e., radiator type air cooler, which is water to air cooler).

Wet cooling towers (or open circuit cooling towers) operate on the principle of evaporative cooling. The cooling water from the plant is pumped to a height of about 10 m and distributed over the cooling tower fill, cascading down the fill to the well at the bottom. In this type of cooling tower, some water is lost due to evaporation and drift which is about 2% of circulation rate. Also, in order to keep the dissolved solids in water under control, blow down is taken from the water. To make-up for this loss (~2.5%), water needs to be continuously added into the system.

Radiator type Air Coolers (or Dry cooling towers) work on the principle of convection and conduction to dissipate heat from process fluid to the air stream created by the fans mounted on it. Dry coolers are closed loop systems which eliminate any kind of water loss and thus eliminating the continuous requirement of make-up water.

A comparative study is done with respect to the wet and dry cooling towers for the sulphuric acid plant for Mundra Copper Complex and same is presented below in this note.

Technical Comparison:

Technical comparison of different technical parameters between Water-Cooled Condenser (WCC)/ Wet Cooling tower and the Air-Cooled Condenser (ACC) / Radiator type Air Coolers (or Dry cooling towers) are presented in the table below considering the circulating water requirement for a 1500 KTPA (100% H_2SO_4) of sulphuric acid plant for each phase.

Sr. No.	Description	Unit	WCC	ACC
1	Heat Load	kW	148615	148615
2	Hot Water Inlet Temp	deg. C	42	80
3	Cold Water Outlet Temp	deg. C	32	65
4	Water Quality	-	Desalinated Water	Passivated DM
5	Total Circulating Water	m^3/hr	12781	8521
6	Temperature Range	deg. C	10	15
7	Cycles of Concentration, C		6	0
8	CT evaporation loss, E	m^3/hr	196	0
9	Total CT evaporation loss per day	m^3/day	4693	0
10	CT drift loss @ 0.01% (D) of total CW flow	m^3/hr	1	0
11	Total CT drift loss per day	m^3/day	31	0
12	CT blow down (B) B = (E / C-1) -D, where C = Cycles of Concentration,	m^3/hr	38	0

EAC OBSERVATION NO.-2

Sr. No.	Description	Unit	WCC	ACC
13	Total CT blow down per day	m³/day	908	0
14	CT make-up total (M) M = E* (C /(C-1))	m³/hr	235	0
15	Total CT make up water required per day for each phase (1500 KTPA SAP)	m³/day	5632	0
16	**Total CT make up water required per day for both phase (3000 KTPA SAP)**	**m³/day**	**11264**	**0**
17	Power Consumption to produce desalinate water	kW	1056	0
18	Power Consumption Fans	kW	465	3772
19	Power Consumption for CW Pumps	kW	1786	1191
20	Total Power Consumption for each phase (1500 KTPA SAP)	kW	3307	4963
21	Total Power Consumption for both phase (3000 KTPA SAP)	**kW**	**6614**	**9926**
22	Footprint each phase (1500 KTPA SAP)	m2	808	3614
23	**Area for each phase (1500 KTPA SAP)**	**acre**	**0.200**	**0.893**
24	**Area for the both phase (3000 KTPA SAP)**	**acre**	**0.399**	**1.786**
25	**CO_2 Emission each phase (1500 KTPA SAP)**	**kg**	**936**	**1405**
26	**CO_2 Emission both phase (3000 KTPA SAP)**	**kg**	**1872**	**2810**

Detailed comparison of the water-cooled condenser (WCC) and the air-cooled condenser (ACC) based on the main indicator of choice for the sulphuric acid plant.

Parameter	Water Cooling Condenser	Air Cooling Condenser
Circulating water quality	Desalinated water	Passivated DM water
Water consumption	For both phases, approx. **11,264 m³/hr** make-up water will be required	The water circulates in closed loop, hence make-up water requirement is not there (negligible, as only leakages have to be topped-up)
Power consumption	Approx. 6,614 kW power will be consumed.	Approx. 9,926 kW power will be consumed, **which is 33.5 % higher than WCC**
Footprint area	Approx. 0.399 acre area will be required	Approx. 1.786 acre area will be required, **which is 77% higher than WCC**
Carbon emission*	Approx. 1872 kg/day CO_2 Emission.	Whereas, Approx. 2810 kg/day CO_2 Emission, **which is 33.5% higher than WCC**
Material of construction	FRP can be used for cooling tower casing and PP/ PVC materials can be used in wet cooling tower for fills & drift eliminators	Radiator type cooler casing/ structure shall be carbon steel with epoxy painting and finned tubes shall be of Stainless steel
Efficiency	High	**Low;** due to the corrosive environment present in the coastal area of the Mundra, which lead to tube leakages.

** In our calculations, we convert kWh to kg of carbon saved based on Greenhouse gas reporting: conversion factors from Department for Business, Energy and Industrial Strategy. The conversion factor is 0.28307 kg CO_2 saved for each kWh produced from a carbon free source. The factor is based on the carbon emissions generated by the current UK power stations per kWh generated. This factor includes other greenhouse gasses such as methane and nitrous oxide which are converted to their carbon dioxide equivalents so the value is really kg CO_2 eq. per kWh.*

EAC OBSERVATION NO.-2

Most of the Sulphuric acid plant uses water cooling system. Selection is largely depend upon the availability of the water. The list of various sulphuric acid plant available with type of cooling system is attached as **Annexure-2.**

Conclusion:

Water-cooled condenser (WCC)/ Wet Cooling Tower is recommended due to the following as detailed above:

1) Lower power consumption 33.5 %
2) Lower carbon footprint by 33.5%
3) Lower land requirement by 77%
4) No need of DM water
5) Reliable performance as no issues of fouling being an open system

***

Prasad Suryarao

From: Hannes Storch <hannes.storch@outotec.com>
Sent: Tuesday, January 28, 2020 2:46 PM
To: Prasad Suryarao
Cc: Kanjanabha Bhattacharyya; Manidipa Bose; Stefan Mohsler
Subject: RE: SAP Cooling tower
Attachments: Outotec_cooling_water_Systems_used_in_recent_plants_for_adani_copper_smelter_information-rev00.pdf

Dear Surya,
good to hear from you and I trust this email finds you well.
Please find attached the information you requested from us with regard to cooling tower concepts. This list is covering the our latest references only. Please note, that the selection of the cooling system is pre-defined by client and usually the drivers are : availability of cooling water source, temperature of cooling water and allowable temperature increase (in case from sea- or river-water), quality of cooling water, energy cost etc.
Based on such information, Outotec can support in the financial evaluation for selecting the solutions, that will result in best ROI for the entire installation. Please let us know if we can assist you here.

Looking forward to talk to you soon, best regards

Hannes

Dr. Hannes Storch

Managing Director

Vice President
Metals and Chemicals Processing

Tel.: +49-6171-9693-182
Mobile: +49-172-6889-027
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Outotec

TECHNICAL INFORMATION
Rev 00

Adani Cu Smelter

AO / Stefan Mohsler

27 Jan 2020

INFORMATION ON COOLING WATER SYSTEMS FROM RECENT COMMISSIONED OUTOTEC PLANTS

The table below shows the cooling water systems Outotec (or responsible partner) installed for recently commissioned Outotec Acid plants. It is prepared for the Adani Copper Smelter project.

It is difficult to give a Basis of selection, as this is always a customer decision (taking the local conditions of the site into account). Where the driver for the solution was clear the table shows “Availability” and else “by customer”.

Note that gas cleaning in metallurgical sulphuric acid plants needs suitable low cooling water temperatures for cooling.

Name of the Plant	Place & Country	Sulphur Based/ Metallurgical based (Cu/ Zn/ Ni)	Capacity of the Plant (TPD)	Year of Commissioning	Type of Cooling tower (Water Cooled CT/ Air Cooled Condenser/ Fin Fan Cooler/ Sea water based CT)	Basis of Selection
Almalyk	Almalyk, Usbekistan	Cu	2300	2015	Water Cooled CT	by customer
Boliden Harjavalta	Harjavalta, Finnland	Cu/Ni	2240	2018	River water cooling closed loop	Availability
Boliden Rönnskär	Rönnskär, Sweden	Cu/Pb (revamp)	2000	2019 (Absorption)	brackish seawater	Availability
Codelco MMH	Calama, Chile	Cu	915	2014	Water cooled CT	by customer
Eti Bakir - Mazidagi	Mazidagi, Turkey	Pyrite	2082	2018	Water cooled CT for Acid & GC plant, Air Cooled Condensor for Steam Turbine	by customer
Eti Bakir - Samsun	Samsun, Turkey	Cu	1315	2017	Seawater	Availability
Kansanshi	Solwezi, Zambia	Cu	4500	2015	Water Cooled CT based on river water	Availability
Ma'aden	Raz a Zwar, Saudi Arabia	3xS-burning	3x5000	2011	Seawater	Availability
Namibia Customs Smelter	Tsumeb, Namibia	Cu	1540	2015	Fin-Fan cooler for ~50% of GC plant (weak acid cooling) and ~95% of SAP strong acid cooling. Other cooling by water cooled CT (ground water)	limited availabilty of water
NCIC	Ain Sohkna, Egypt	2xS-burning	2x1900	2019	Water Cooled CT	by customer
Noracid PAM	Mejillones, Chile	S-burning	2060	2011	Fin-Fan Cooler for SAP and turbine, (except for product acid coling)	by customer

This document is prepared to enable Mundra Copper take a decision on Cooling Media for Acid Coolers

MECS has designed and built over 650 Sulphuric Acid plants globally, with around 40% of these plants above 2000 MTPD capacity. These plants require Strong Acid Coolers to take out the heat from system. Some of plants like Metallurgical Off Gas and Spent Acid based plant need additional Weak Acid Coolers in Gas Cleaning Section.

Cooling Tower Water is the preferred media for cooling in these coolers from operational and maintenance perspective. But some customers chose to have Sea Water Or Closed Loop Fin Fan system. This selection is based on the availability of sources of water.

For Metallurgical Off Gas and Spent Acid plants, cooling media used is always Cooling Tower Water for Weak Acid Coolers due to low temperature requirements in process. Similarly, most of the Product Acid Coolers are on Cooling Tower to meet the storage temperature requirement of 40 degC or lower.

The list below is the partial reference list of the plants designed by MECS and the type of Cooling media used in Acid Coolers. **The selection of cooling media is solely done on the basis of availability and overall site requirements.**

Name and Location	Capacity, MTPD	Type of Plant	Year Of Commissioning	Media used in Acid Coolers
Paradeep Phosphates, India	2000	Sulphur Burning	2016	Cooling Tower Water
Hindalco Industries, India	1800	Copper Smelter Off Gas	1997	Cooling Tower Water
Hindalco Industries, India	2800	Copper Smelter Off Gas	2005	Cooling Tower Water
Reliance Industries, India	1000	Spent Acid Regeneration	2007	Cooling Tower Water
Kennecott Copper, USA	3700	Copper Smelter Off Gas		Cooling Tower Water
GCT, Tunisia	Various Plants of >2000 MTPD	Sulphur Burning	2002 to 2012	Sea Water
OCP, Morocco	Various Plants of >2000 MTPD	Sulphur Burning	2008 to 2019	Sea Water
LS Nikko, South Korea	2700	Copper Smelter Off Gas	2005	Cooling Tower Water
LS Nikko, South Korea	2700	Copper Smelter Off Gas	2008	Cooling Tower Water
Magma Copper, USA	2000	Copper Smelter Off Gas	1995	Cooling Tower Water

ANNEXURE-2

Plant in Zambia	2350	Copper Smelter Off Gas	2014	Cooling Tower Water
Plant in GCC	Various Plants of >2000 MTPD	Sulphur Burning	2016 to 2018	Fin Fan Cooler
Kazzink, Kazakhstan	1800	Copper Smelter Off Gas	2011	Cooling Tower Water
Guixi, China	2474	Copper Smelter Off Gas	2007	Cooling Tower Water
Guixi, China	1900	Copper Smelter Off Gas	1997	Cooling Tower Water
Plant in China	4820	Copper Smelter Off Gas	2015	Cooling Tower Water

03 FEB 2020

NEERAJ AHUJA

BUSINESS MANAGER-SALES

EAC OBSERVATION NO.-3

EAC OBSERVATION:

Provide details for proposed flue gas desulfurization.

REPLY:

Two type of FGD systems have been proposed in the copper refinery plant for abatement of the SO_2 coming from secondary gases coming from Copper smelter unit and Sulphuric acid plant tail gases.

1. Regenerable Amine Based SO_2 Scrubbing System:

The secondary gases from flash smelting furnace, PS converter and tail gases from the Sulphuric acid plant are treated in this system. This process helps to convert lean SO_2 secondary gases (~ 2000 mg/Nm^3) into production of concentrated Sulphur dioxide (~ 85%) and fed to proposed Sulphuric acid plant for production of Sulphuric Acid. This will help to **reduce the solid waste generation quantity by ~ 70%** and produce valuable Sulphuric acid and thereby **increasing acid ratio by ~ 1%.**

2. Lime slurry based Scrubber:

The combustion gases from Anode Furnace, Slag Cleaning Furnace and Scrap melting Furnace go into the lime based scrubbing for SO_2 abatement system. Post scrubbing, scrubbed slurry will be aerated to make $CaSO_3$ into $CaSO_4$. This will help to produce **high quality chemical gypsum suitable to cement industries**.

Amine based SO_2 Scrubbing System for Metals Smelting and Refining applications needs:

The dominant gas desulfurization technology today is limestone or lime-based scrubbing in various forms, produce large quantities of solid waste products; i.e. chemical grade-gypsum. Demand for resource recovery and recycling / regenerable type SO_2 removal processes are becoming increasingly more desirable. But, for many industries the preferred byproducts are SO_2, elemental sulfur or sulfuric acid. This needs addresses by the diamine based SO_2 Scrubbing System; selectively absorbing SO_2 and regenerating a pure by-product without consuming reagents or creating waste.

EAC OBSERVATION NO.-3

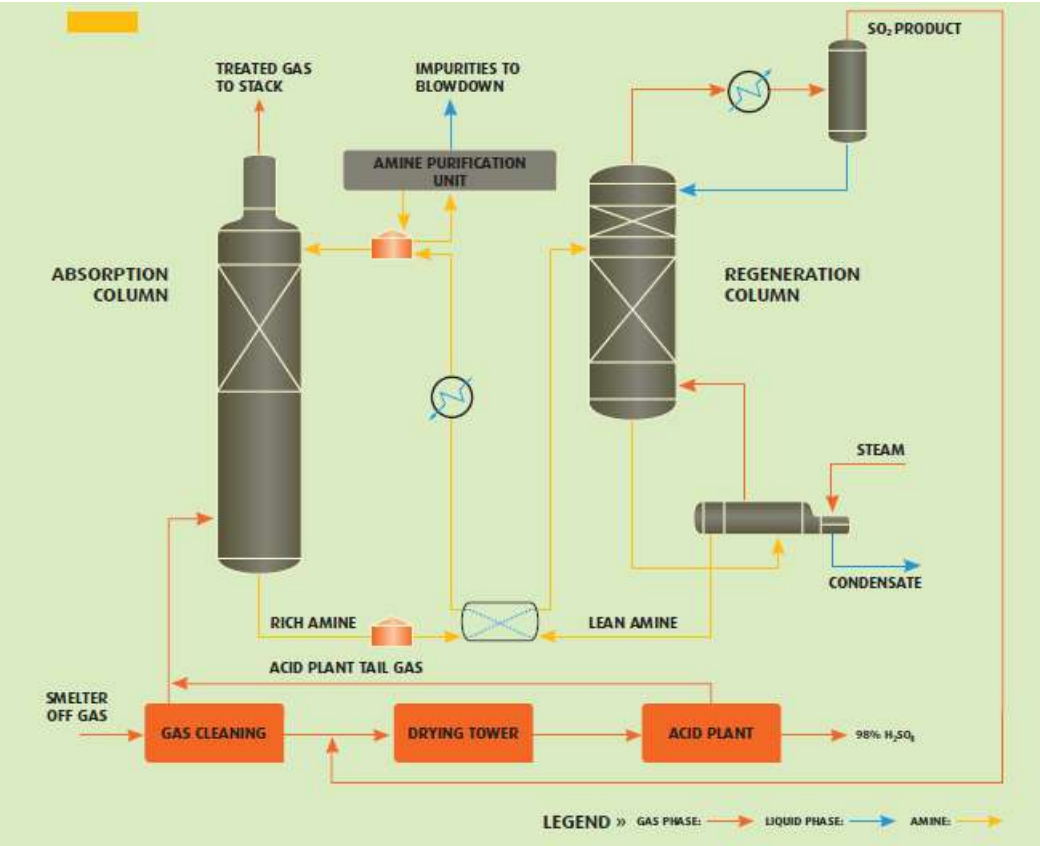


FIGURE-1:
PROCESS FLOW DIAGRAM OF THE AMINE BASED SO_2 SCRUBBING

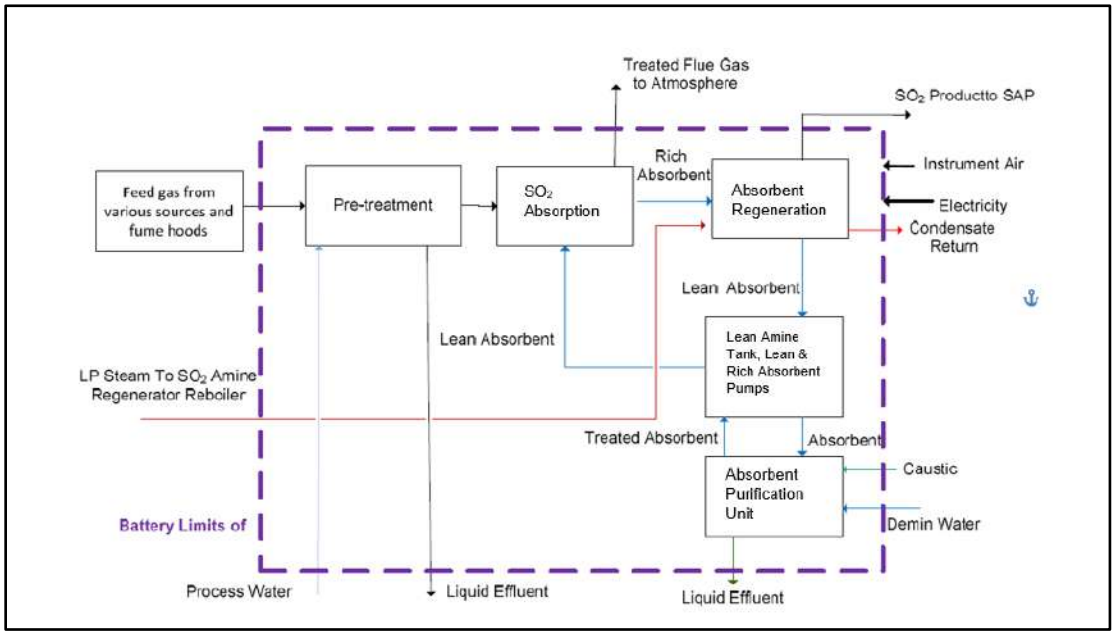


FIGURE-2:
PRELIMINARY - BLOCK FLOW DIAGRAM OF THE AMINE BASED SO_2 SCRUBBING

EAC OBSERVATION NO.-3

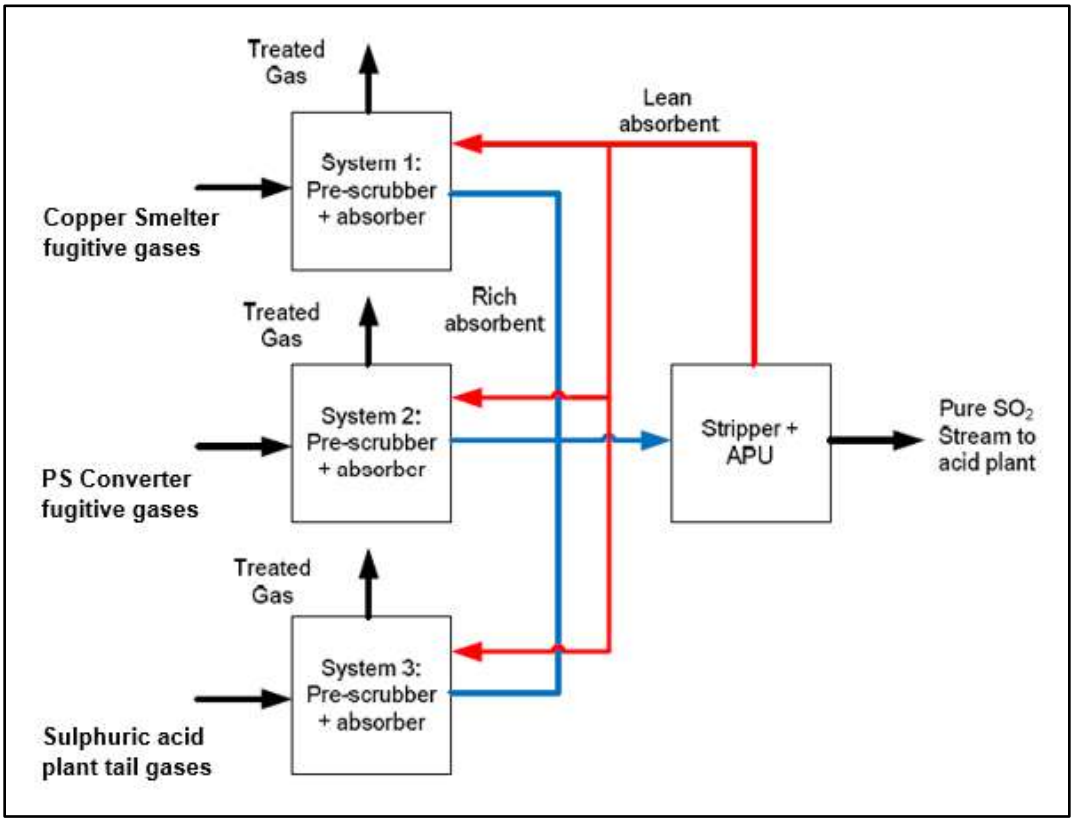


FIGURE-3:
PRELIMINARY SECONDARY AND TAIL GASES FLOW IN THE AMINE BASED SO_2 SCRUBBING

Process Descriptions:

Gas Pre-Treatment Unit:

1. The Gas Pre-Treatment Unit installed upstream of the SO_2 Scrubbing System cools the secondary gases from copper smelter and converter and Sulphuric acid plant tail gases to its adiabatic saturation temperature and removes some of the acid mist and particulate matter coming with the incoming gas. The unit includes an open spray hot gas quench and associated water circulation pumps. The quenched gas leaving the Gas Pre-Treatment unit is directed towards the bottom of the SO_2 Absorber.

SO_2 Absorption and Regeneration:

1. Gas from the Pre-treatment unit is routed to the bottom of the SO_2 Absorber. The SO_2 is first absorbed from the flue gas by counter-current contact with the amine absorbent introduced from the top of the SO_2 absorption section packing.
2. The amine absorbent rich in SO_2 is collected in the SO_2 absorber sump and pumped by the rich amine absorbent pumps to the SO_2 stripper for regeneration via the lean/rich exchanger on level control. The treated gas exits the absorber with an SO_2 content as low as 300 mg/Nm^3, depending on design parameters.
3. The rich amine absorbent is stripped in the SO_2 stripper in a counter current way by steam generated in the stripper reboiler. The overhead vapour product is directed

towards the Air cooled condensers, where it is partially condensed. The mixed phase stream is separated in the reflux accumulator. The gas phase exiting the reflux accumulator, which is typically 85-95% by volume SO_2 saturated with water, is delivered to the downstream acid plant drying tower (expected destination). The liquid phase from the reflux accumulator is pumped to the top rectification bed of the SO_2 stripper by reflux pumps.

4. The stripped absorbent (lean absorbent) leaving the bottom of the SO_2 stripper is pumped by the lean absorbent pumps to the lean absorbent tank through the lean/rich exchanger and the lean absorbent cooler on level control. From the lean absorbent tank, the lean absorbent is pumped by the lean absorbent feed pump to the top of the SO_2 absorber thereby completing the cycle.
5. A separate stream of lean absorbent leaves the lean absorbent tank through the absorbent filter feed pumps and is sent to the absorbent filtration unit. This unit is comprised of activated carbon filter with its after-filter for particulate removal.
6. The filtered absorbent is either directed to the lean absorbent tank or sent intermittently through the Absorbent Purification Unit (APU), which removes heat stable salts (HSS).

Absorbent Purification Unit (APU):

The Absorbent Purification Unit is designed to remove heat stable salts (HSS) from the absorbent. These salts are continuously formed within the absorbent, rendering it inactive for further SO_2 absorption if salt levels are too high. HSS are not heat-regenerable and, as a result, will not be removed from absorbent through steam stripping. Although a certain level of HSS is desirable within the absorbent, any excess HSS must thus be removed.

Ion exchange (IX) is a reversible process in which ions are exchanged between the absorbent solution and the resin. The reaction occurs in an ion exchange column, a vessel containing the resin. The absorbent is passed through the column, where a portion of the undesired HSS is adsorbed onto the ion exchange resin sites. The absorbent exiting the column thus contains a lower concentration of HSS.

Amine Absorbents provide significant advantages:

1. Since the amine absorbent is always present in the process as a salt, it is totally Non-volatile and equilibrium vapor phase losses of solvent to the **treated gas are Zero**
2. High thermal and chemical stability
3. Low foaming tendency
4. Inhibition of SO_2 oxidation by oxygen to sulfate
5. High water solubility, giving a homogeneous liquid absorbent

Regenerative SO_2 abatement scrubber - Amine-based				
No. of System: 2				
Description	**UOM**	**Source - 1**	**Source - 2**	**Source - 3**
Gas Source		**Smelting Furnace Secondary Gases**	**PS Converter Secondary Gases**	**Sulphuric Acid Plant Tail Gases**
Preliminary - Gas Volume	Nm^3/Hr	168,796	345,900	301,520
Preliminary - IN-SO_2 Content	mg/Nm^3	1,500	3,000	600
Residual gas SO_2	mg/Nm^3	300	300	300

EAC OBSERVATION NO.-3

Lime slurry based Scrubber:

The combustion gases from Anode Furnace, Slag Cleaning Furnace and Scrap melting Furnace goes to the wet lime slurry based scrubber for SO_2 abatement.

Process Description:

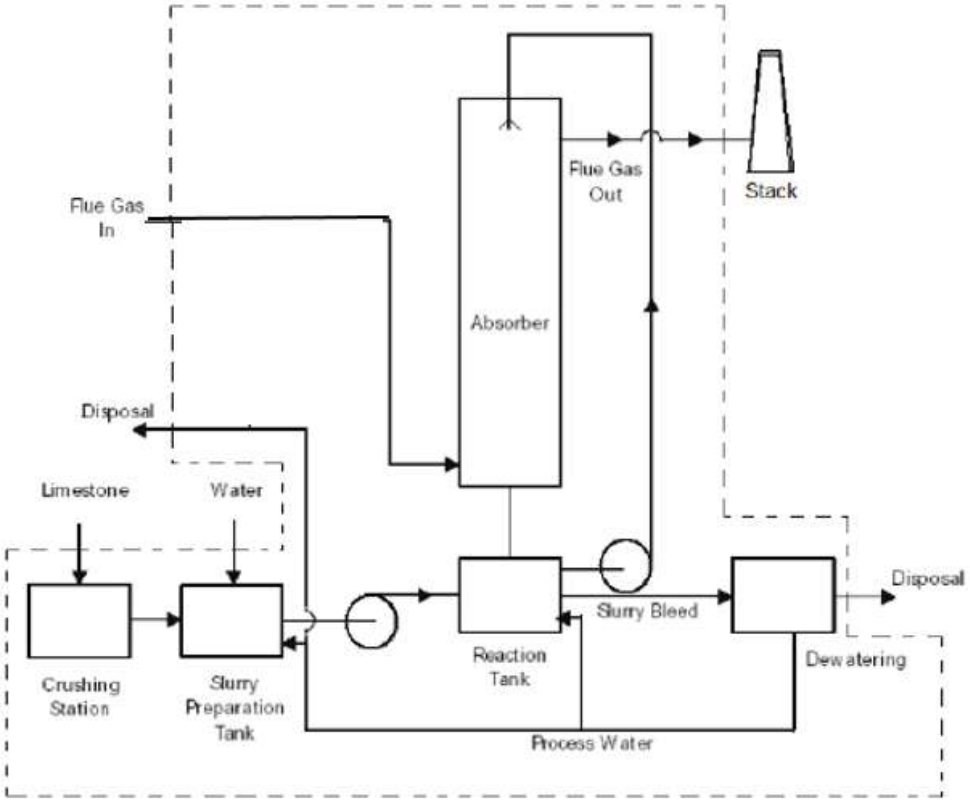


FIGURE-4:
PRELIMINARY SECONDARY GASES FLOW IN THE LIMESTONE BASED SO2 SCRUBBING

1. Feeding of the limestone slurry to the scrubber.
2. The limestone slurry is recirculated in the scrubber by the pump from the scrubber sump.
3. Gas from the anode furnace & Casting and Slag Cleaning Furnace is routed to the bottom of the SO_2 scrubber. The SO_2 is first absorbed from the flue gas by counter-current contact with the lime based sorbent introduced from the top of the scrubber by the sprays/ nozzle.
4. Formation of the calcium sulphite ($CaSO_3$) as result of the desulphurization process.

   After combining many of the intermediate steps, the net reaction is:

   $$SO_2 + Ca(OH)_2 \rightarrow CaSO_3 + H_2O$$

5. The calcium sulfite product is a suspended solid. Because of its crystal structure, calcium sulfite ($CaSO_3$) cannot be filtered. To facilitate the disposal and handling of the by-products, the calcium sulfite must be further oxidized to calcium sulfate ($CaSO_4$) as follows:

   $$CaSO_3 + 1/2O_2 \rightarrow CaSO_4$$

EAC OBSERVATION NO.-3

6. Air is injected into the sump of the vessel to complete the oxidation of the sulfites to sulfate. After the sulfite oxidation, a blow downstream is withdrawn from the vessel and sent to client waste water treatment system, at where the filter removes the insoluble calcium sulfate (gypsum) and captured particulates.
7. The gypsum (calcium sulfate) can be filtered to a relatively dry 85 wt.% solid, after which it can be dispose.
8. The filtrate can be recycled back to the scrubbing system as make-up water for evaporation losses.
9. The treated gas exits the scrubber with an SO_2 content as low as 300 mg/Nm^3, depending on design parameters.

Lime Slurry - based SO_2 abatement scrubber			
No. of System: 2			
Description	**UOM**	**Source - 1**	**Source - 2**
Gas Source		**Anode & Scrap Melting Furnace Combustion & Secondary Gases**	**Electric Furnace Combustion & Secondary Gases**
Preliminary - Gas Volume	Nm^3/Hr	171,823	135,000
Preliminary - IN- SO_2 Content	mg/Nm^3	1,000	1,500
Residual gas SO_2	mg/Nm^3	300	300

Conclusion:

The secondary gases from the smelter, the converter and the tail gases from the sulphuric acid plant treated in the SO_2 abatement system based on regenerative amine and the combustion gases from Anode Furnace, Slag Cleaning Furnace and Scrap melting Furnace go into the lime based scrubbing for SO_2 abatement. The treated gas exits from the both system with an SO_2 content as low as 300 mg/ Nm^3, depending on design parameters which well be within the limit as per the CPCB.

EAC OBSERVATION NO.-4

EAC OBSERVATION:

Reduce carbon foot print by heat recovery system generating from the plant.

REPLY:

- The heat is captured from the smelter, converter and SAP plant with the help of waste heat recovery boiler
- The high-pressure steam generated by the waste heat recovery boiler is sent to the steam turbine for the power generation, i.e. 40 MW
- By adopting a waste heat recovery system in the plant, we reduce the carbon footprint by 0.25 million tonnes per year

Reduction in carbon footprint by using waste heat recovery system:

Carbon Foot Print Calculation	UOM	Value
Per day power generated from the waste heat recovery	MW	40
Number of operating days	-	330
Number of hours per day	-	24
Availability	%	95
CO_2 factor for western grid	t/MWh	0.81
Total CO_2 saved per year	t/a	243,778

Total CO_2 saved = 40 x 330 x 24 x 0.95 x 0.81
= 243,778 t/a equivalent to 244 kg/t-Cu

Total CO_2 emitted from proposed plant due to use of hydrocarbon and Limestone excluding external power consumption is around 290 kg/t- Cu.

By implementing waste heat recovery system in smelter and sulfuric acid plant of the proposed copper refinery plant, there will be approximately 25% energy savings.

EAC OBSERVATION NO.-5

EAC OBSERVATION:

Access roads to be provided for all the solid waste storages such as copper slag, gypsum storage & secured land fill and adequate green belt to be developed around all the solid waste storages.

REPLY:

The covered conveyor system will be provided for transporting copper slag and phospho-gypsum from point of generation to respective storage facility, designed as per CPCB guidelines. Arsenic bearing sludge generated from ETP will be transported by covered truck to SLF, designed as per CPCB guidelines.

Approach road around the boundary of all solid waste storages such as copper slag, gypsum storage and secure land fill (SLF) will be provided as per CPCB guidelines. The 10 m wide approach road will be provided. The approach road will be used for transportation of the solid waste/ by product. We will be providing a **15 meter wide green belt around solid waste storages** to control dust emissions from the storage. A greenbelt along with safety zone (towards river bank with gabion and gully plugs) to avoid erosion of plant if any to avoid 100 m wide will be developed along the side of **Dhaneshwari Nadi** wherever storage of solid waste is proposed**.**

Adequate arrangements such as **water sprays** will be provided to arrest the fugitive dust emission as required.

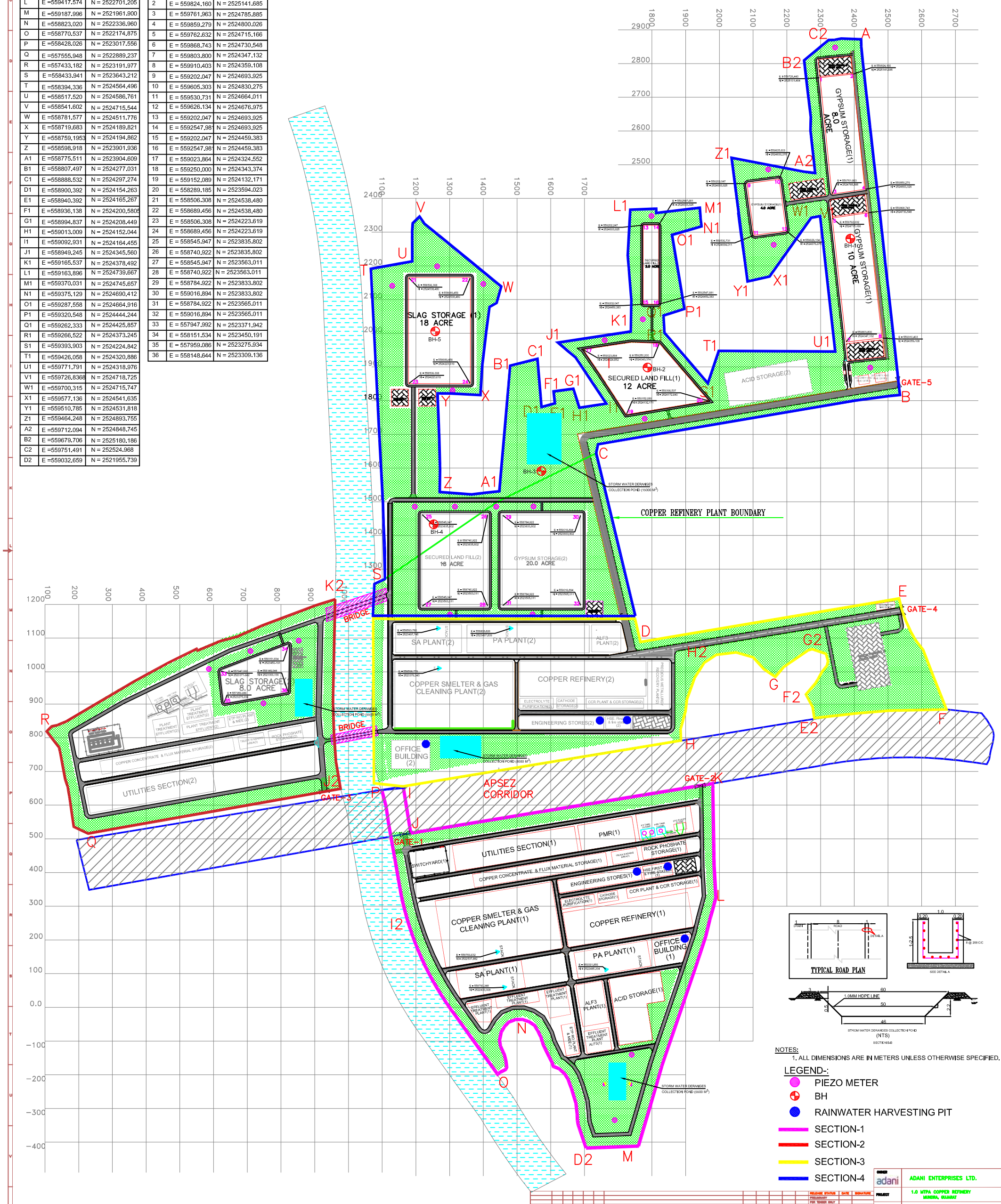
The layout map of proposed project is enclosed as **Annexure-5**.

ANNEXURE-5

SR.	EASTING	NORTHING
A	E =559848.328	N = 2525243.163
B	E =559963.374	N = 2524190.380
C	E =559071.249	N = 2524044.332
D	E =559194.182	N = 2523457.258
E	E =559960.721	N = 2523586.315
F	E =556010.2428	N = 2523257.270
G	E = 559594.1246	N = 2523353.9571
H	E =558823.020	N = 2522336.960
I	E =558492.116	N = 2523029.111
J	E =558513.043	N = 2522890.177
K	E =559407.330	N = 2523037.264
L	E =559417.574	N = 2522701.205
M	E =559187.996	N = 2521961.900
N	E =558823.020	N = 2522336.960
O	E =558770.537	N = 2522174.875
P	E =558428.026	N = 2523017.556
Q	E =557555.948	N = 2522889.237
R	E =557433.182	N = 2523191.977
S	E =558433.941	N = 2523643.212
T	E =558394.336	N = 2524564.496
U	E =558517.520	N = 2524586.761
V	E =558541.602	N = 2524715.544
W	E =558781.577	N = 2524511.776
X	E =558719.683	N = 2524189.821
Y	E =558759.1953	N = 2524194.862
Z	E =558598.918	N = 2523901.936
A1	E =558775.511	N = 2523904.609
B1	E =558807.497	N = 2524277.031
C1	E =558888.532	N = 2524297.274
D1	E =558900.392	N = 2524154.263
E1	E =558940.392	N = 2524165.267
F1	E =558936.138	N = 2524200.5805
G1	E =558994.837	N = 2524208.449
H1	E =559013.009	N = 2524152.044
I1	E =559092.931	N = 2524164.455
J1	E =558949.245	N = 2524345.560
K1	E =559165.537	N = 2524378.492
L1	E =559163.896	N = 2524739.667
M1	E =559370.031	N = 2524745.657
N1	E =559375.129	N = 2524690.412
O1	E =559287.558	N = 2524664.916
P1	E =559320.548	N = 2524444.244
Q1	E =559262.333	N = 2524425.857
R1	E =559266.522	N = 2524373.245
S1	E =559393.903	N = 2524224.842
T1	E =559426.058	N = 2524320.886
U1	E =559771.791	N = 2524318.976
V1	E =559726.8368	N = 2524718.725
W1	E =559700.315	N = 2524715.747
X1	E =559577.136	N = 2524541.635
Y1	E =559510.785	N = 2524531.818
Z1	E =559464.248	N = 2524893.755
A2	E =559712.094	N = 2524848.745
B2	E =559679.706	N = 2525180.186
C2	E =559751.491	N = 252524.968
D2	E =559032.659	N = 2521955.739

SR.	EASTING	NORTHING
E2	E =559705.888	N = 2523228.702
F2	E=559684.6685	N=2523301.4207
G2	E=559743.9055	N=2523422.4579
H2	E=559418.3173	N=2523419.2137
I2	E = 558513.781	N = 2522601.441
J2	E = 558304.785	N = 2523022.272
K2	E = 558289.185	N = 2523594.023

SR.	EASTING	NORTHING
1	E = 559726.440	N = 2525131.464
2	E = 559824.160	N = 2525141.685
3	E = 559761.963	N = 2524785.885
4	E = 559859.279	N = 2524800.026
5	E = 559762.632	N = 2524715.166
6	E = 559868.743	N = 2524730.548
7	E = 559803.800	N = 2524347.132
8	E = 559910.403	N = 2524359.108
9	E = 559202.047	N = 2524693.925
10	E = 559605.303	N = 2524830.275
11	E = 559530.731	N = 2524664.011
12	E = 559626.134	N = 2524676.975
13	E = 559202.047	N = 2524693.925
14	E = 5592547.981	N = 2524693.925
15	E = 559202.047	N = 2524459.383
16	E = 5592547.981	N = 2524459.383
17	E = 559023.864	N = 2524324.552
18	E = 559250.000	N = 2524343.374
19	E = 559152.089	N = 2524132.171
20	E = 558289.185	N = 2523594.023
21	E = 558506.308	N = 2524538.480
22	E = 558689.456	N = 2524538.480
23	E = 558506.308	N = 2524223.619
24	E = 558689.456	N = 2524223.619
25	E = 558545.947	N = 2523835.802
26	E = 558740.922	N = 2523835.802
27	E = 558545.947	N = 2523563.011
28	E = 558740.922	N = 2523563.011
29	E = 558784.922	N = 2523833.802
30	E = 559016.894	N = 2523833.802
31	E = 558784.922	N = 2523565.011
32	E = 559016.894	N = 2523565.011
33	E = 557947.992	N = 2523371.942
34	E = 558151.534	N = 2523450.191
35	E = 557959.086	N = 2523275.934
36	E = 558148.644	N = 2523309.136



EAC OBSERVATION NO.-6

EAC OBSERVATION:

Provide utilization plan for copper slag and Phospho-gypsum, with details of storage yard.

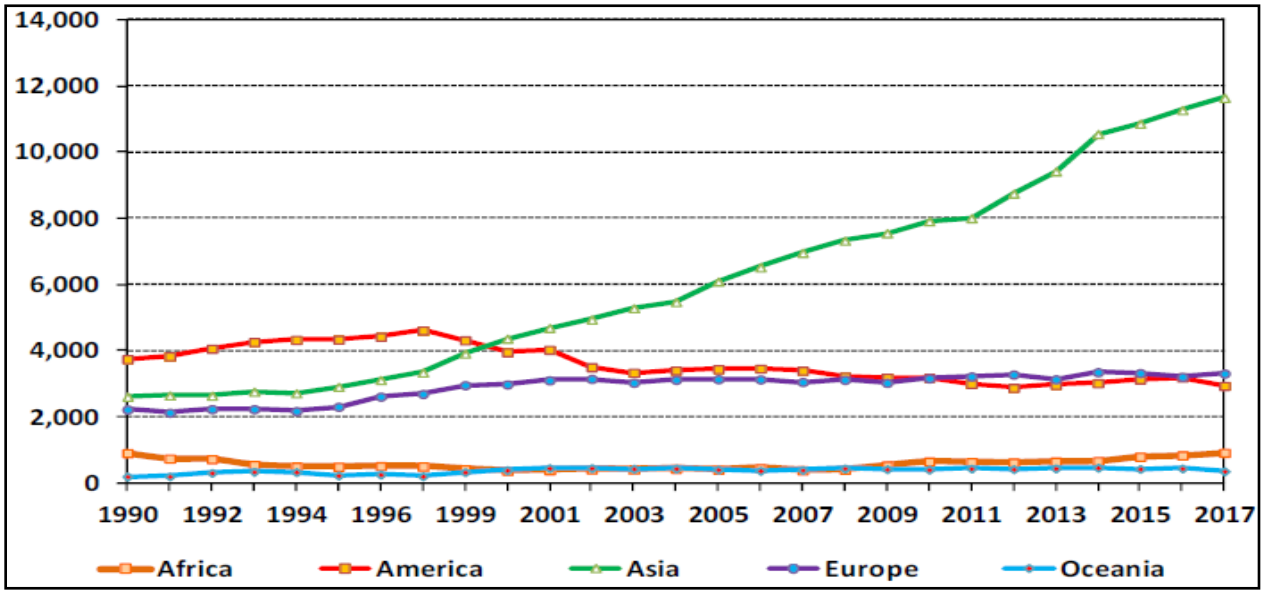
REPLY:

A) COPPER SLAG:

Copper slag, which is produced during the pyrometallurgical production of copper from copper concentrates, contains valuable metals such as copper, zinc, lead, cobalt, and nickel. For every tonne of metal produced, about 2.2 – 3.0 tonnes of slags, mainly copper smelter and converter slags, are generated. The conventional methods for treating slags are disposal in slag dumps or stockpiles. The increasing dumping of slags not only occupies large areas of land, but also wastes resources. It is therefore desirable to use slags by the current options of recycling, metal recovery, and production of high value- added materials.

Because of the favorable physico-mechanical characteristics of Copper slag can be considered a promising source of secondary raw material. It can be used to produce different products such as cement, concrete, fine aggregate, fill material, road base construction, abrasive material, roofing granules, cutting tools, railway ballast material, tiles and glass *(Reference: Gorai, Bipra, and R. K. Jana. "Characteristics and utilisation of copper slag—a review." Resources, Conservation and Recycling 39.4 (2003): 299-313).*

The global annual production of copper from concentrate smelting is around 19.5 million tons.

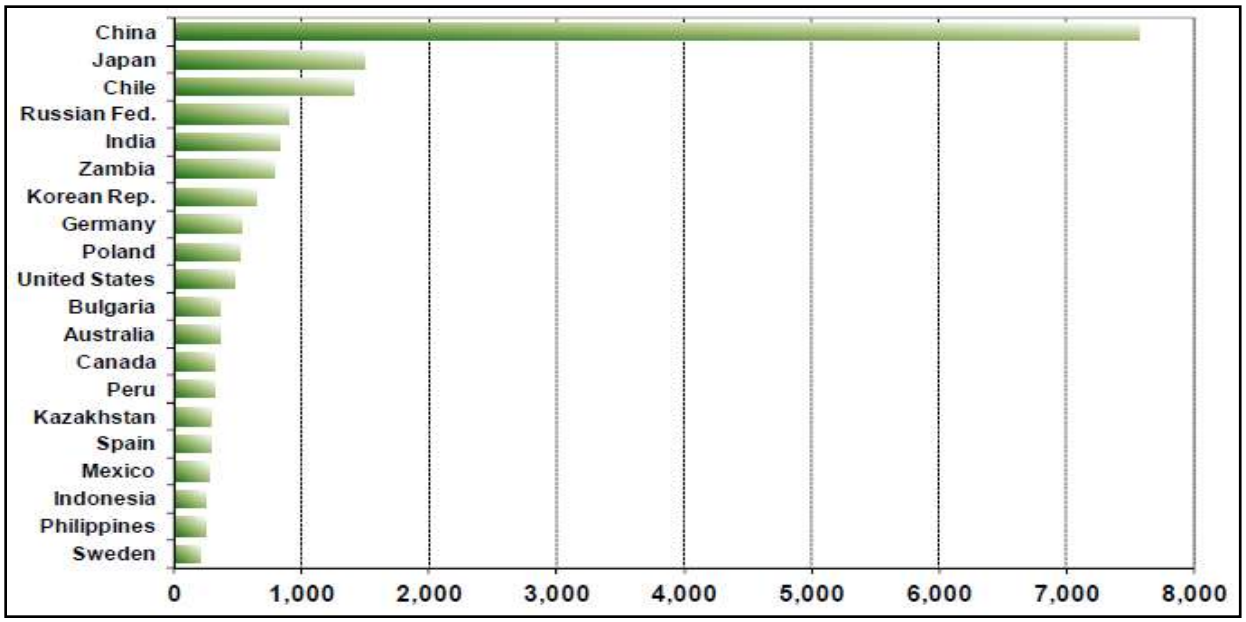


Source: ICSG Copper fact book 2018

COPPER SMELTER PRODUCTION BY REGION 1990-2017
(THOUSAND METRIC TONNES)

Asia's share of world copper smelter output is 61% and Europe & America together account for 33% of the world copper smelter output.

EAC OBSERVATION NO.-6



Source: ICSG Copper fact book 2018

COPPER SMELTER PRODUCTION BY TOP 20 COUNTRIES (THOUSAND METRIC TONNES)

China produces ~ 40% of world copper smelter production, followed by Japan 8%, Chile 7%, etc.

The global annual production of copper slag is about 43 million tons. The copper slag generation for different continents are depicted in the **Table-1** below:

TABLE-1
COPPER SLAG GENERATION IN VARIOUS REGIONS (2017)

Regions	Copper Production (million tons/year	Copper Slag Generation (million tons/year)
Asia	11.30	24.86
America	3.00	6.60
Europe	3.40	7.48
Africa	0.90	1.98
Oceania	0.45	0.99
Total	**19.05**	**41.91**

Source – ICSG Copper Factbook 2018 (Slag quantity is calculated based on copper production with factor of 2.2)

Due to the huge amount of slag generated, the potential applications of copper slag have been investigated in the past few decades. Current options of management of copper slag are recycling, recovering of metal, production of value added products and disposal in dumps or stockpiles *(Reference: Shi, C., Meyer, C., & Behnood, A. (2008). Utilization of copper slag in cement and concrete. Resources, Conservation and recycling, 52(10), 1115-1120).*

Copper Slag is produced during copper smelting process, by oxidation of iron from copper concentrate and combining with silica, to form Iron Silicate, called as copper Slag.

Process consists following process steps:

- Smelting : Slag Generation ~ 70%: Slag Cleaning
- Converting : Slag Generation ~ 30%: Slag Cleaning

EAC OBSERVATION NO.-6

- Slag cleaning : Slag from Smelting and Converting is treated to recover Copper metal
- Granulation: Post recovery of metal, slag is granulated.
  1. Use of water for quenching operation to increase surface area for cooling
  2. As per customer specification for reuse.
  3. Stacking for reuse and supplying

The flow sheet show the pyro metallurgical method of copper slag manufacturing.

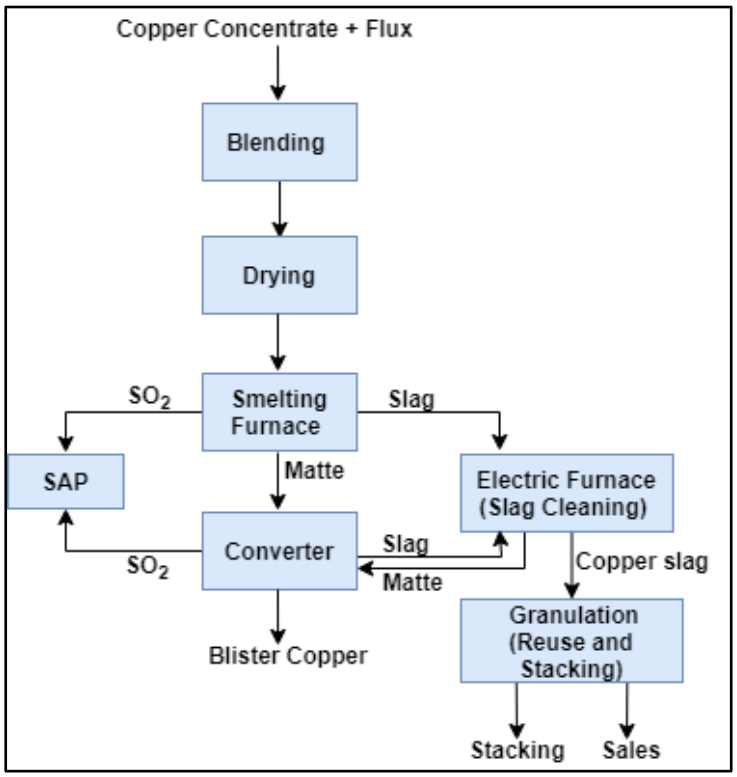


TABLE-2
CHEMICAL COMPOSITION OF THE PYROMETALLURGICAL COPPER SLAG

Element	Weight %
Fe_2O_3	42 – 60
Fe_3O_4	6 – 25%
SiO_2	27 – 33
Al_2O_3	1 – 4
CaO	< 3
Cu	< 1
S	0.3 – 1
Free Moisture	< 2

TABLE-3
PHYSICAL AND CHEMICAL CHARACTERISTICS OF COPPER SLAG

Characteristics	Description
Appearance	Black glassy granules
Color	Gray/black
Granule shape	Angular, sharp
Density, g/cm3	3.16 – 3.87
Specific gravity	2.8 – 3.8
Bulk density, T/m3	1.8 - 2.31

EAC OBSERVATION NO.-6

Copper slag does not feature in the hazardous waste category in schedule-1 of the hazardous waste management rules issued by MOEF&CC, India in 2016.

Copper slag has been excluded from the listed hazardous waste category of United States Environmental Pollution Agency (USEPA).

Copper Slag will be stacked in a designated place for reuse and supplying.

The TCLP, multiple extraction procedure test (MEP) and sulfuric acid leaching results indicate that the heavy metals present in the slag are very stable and have **poor leachability, the copper slag also has a long-term stability and weather is unlikely to activate the slag.**

The **MEP** indicates that the heavy metals present in the **slag are highly stable** and are not likely to dissolve significantly even through repetitive leaching under acid rain in a natural environment.

Copper Slag Uses:

Sector	Usage	Purpose
Cement Industry	▪ As an Additive	▪ To increase Iron
Construction	▪ Concrete, ▪ Road making as sub layer ▪ Surface coating	▪ Replacement of Sand & Aggregates ▪ Substitute for stone flour in asphalt & as an additive in bed structure stabilization. ▪ Anti-Skid purpose
Blasting	▪ Marine/ Shipping industry, ▪ Construction and Mechanical Industry	▪ Shot Blasting ▪ In place of Sand blasting
Infrastructure	▪ Port Construction & Low lying area ▪ In Paver block As an additive ▪ Blocks of concrete with slag.	▪ Back Filling Application ▪ To improve sintering and abrasion resistance ▪ To protect coastal shore lining

In Indian market various applications have been envisaged, and consumption of the Copper Slag is picking up.

a. Concrete Applications

As per the Indian Standard (IS) 383, the copper slag can be used as partial replacement to natural fine aggregates to an extent of 35% in reinforced concrete, up to 40% in plain concrete and 50% in lean concrete.

It is observed that there is 70% improvement in compressive strength with 50% replacement of copper slag. There is almost 5% increase in density comparing with the concrete of control mixture. The flexural strength and tensile strength were similar to control mixture (100% sand) spending up to 50% copper slag replacement of sand *(Reference: Use of copper slag as sustainable aggregate by Alinda Dey, Deepjyoti Dev, and Purnachandra Saha, KIIT University, Bhubaneswar, Odisha).*

Lower permeability, resistance to chloride ion penetration, resistance to sulphate attack, lower hydraulic conductivity, higher compressive and flexural strength are the added advantages of copper slag over the conventional mixture of concrete.

b. Grit blasting

Copper slag is used as blast cleaning abrasive for all application fields in conventional corrosion protection on almost all surfaces. Its sharp hard cutting edges allow for fast cleaning action and hence is excellent for surface profile preparation (for that free crystalline silica content should be <1% in copper slag).

It absorb no water, during the manufacturing of the abrasive no crushing or grinding is required, it retains its extreme hardness and tenacity and dust content is also reduced *(Reference: NAstra® Iron silicate by Sibelco - Germany).*

c. Road Application

Copper slag-pond mixes with 50 to 75% copper slag content could be used in embankment construction, while the mix with 75% copper slag content could be used in sub base layer of road pavement.

Copper slag-soil mixes with 25 to 75% copper slag content could be used in embankment construction while the mix with 50 to 75% copper slag content could be used in sub base layer of road pavement. *(Reference: Experimental study on use of Copper Slag in embankment and pavement construction – Geotechnical Engineering Division, CRRI, New Delhi).*

d. Sand / Landfilling

100% replacement & best alternative option for gravel/ red soil/ river sand. Heavy metals in the slag are stable and difficult for leaching. The slag obtained after the copper removal in the electric furnace can be safely applied in various economic sectors including cement and concrete production. The slag after the copper removal process became more environmental friendly and can be stored on dumping grounds of neutral wastes or utilized at roads and bridges building, as a concrete matrix. *(Reference: Assessment of the harmfulness of the slags from copper smelting process in an aspect of their management by M. Holtzer, A. Bydałek, W. Wołczyński, A. Kmita from Poland).*

Copper slag can be used as sand replacement material for plastering of floorings and horizontal up to 50% by mass of the fine aggregate and for vertical surfaces such as brick wall it can be used up to 25% (generally fine aggregate passing 2.36 mm sieve is suitable for plastering). Upper limit for sand replacement by copper slag is 50% for conventional grades of concrete and 75% for high grade concrete *(Reference: Study on use of copper slag as replacement material for river sand in building constructions by C. K. Madheswaran, P. S. Ambily, J. K. Dattatreya, N. P. Rajamane).*

e. Paver Blocks and Bricks manufacturing process

It is observed that paver block with copper slag gains 10% strength more than to that of paver block with conventional. The optimum content of copper slag that can be used as a replacement material for fine aggregate for the manufacture of paver blocks is 30%. Compared to the conventional specimen the copper slag based paver block shows an increase in density up to 10%. *(Reference: An experimental investigation on partial replacement of copper slag as fine aggregate in paver block by S.Kalaiselvi, S.Prabhakaran, Jagadeesan.K).*

Limitations of Copper Slag valorization – need of storage

However, it has been estimated that copper slag is **utilized only about 15-20% of the copper slag generated** in value added applications, the rest of material is dumped as waste

EAC OBSERVATION NO.-6

(Reference: Anbarasan, Replacing river sand with granulated copper slag in cement, International Journal of Scientific & Engineering Research, Volume 7, Issue 5, May-2016).

The preliminary utilisation plan for copper slag is presented as **Annexure-6(a).**

Based on the above, a **10 Hectare storage area** has been proposed in the Copper Refinery Project.

To make the Indian industry competitive and create an equal level playing field, we shall be allowed to stack for the 5 year generation quantity for reuse. We will use this period to stabilize the plant, slag quality, develop the market and meet the quality for reuse based on demand.

We request MOEF&CC to make a policy decision for utilisation of Copper Slag by circular economy concept similar to China and Japan.

However, we will make serious efforts in the various areas of use to reduce storage. In addition to this, we will also conduct research projects to increase sales of Copper Slag.

Copper Slag Storage Yard Note:

- Copper slag does not feature in the hazardous waste category in schedule-1 of the hazardous waste management rules issued by MOEF & CC, India in 2016.
- The Toxicity characteristic leaching procedure (TCLP), Multiple Extraction Procedure (MEP) test and sulfuric acid leaching results indicate that the heavy metals present in the slag are very stable and have poor leachability, the copper slag also has a long-term stability and weather is unlikely to activate the slag.
- Therefore, the ground base for open storage of copper slag will be prepared to harden to withstand the load of stored material.
- Copper slag will be stored inside the Bund wall around and a garland drain will be provided around the boundary of the Bund wall.

B) PHOSPHOGYPSUM:

Justification for the Phosphogypsum Storage:

In the manufacture of phosphoric acid (P_2O_5), the Phosphogypsum (PG) generated as a by-product, in which phosphate rock is digested with Sulphuric acid. The basic chemistry of the wet process is exceedingly simple:

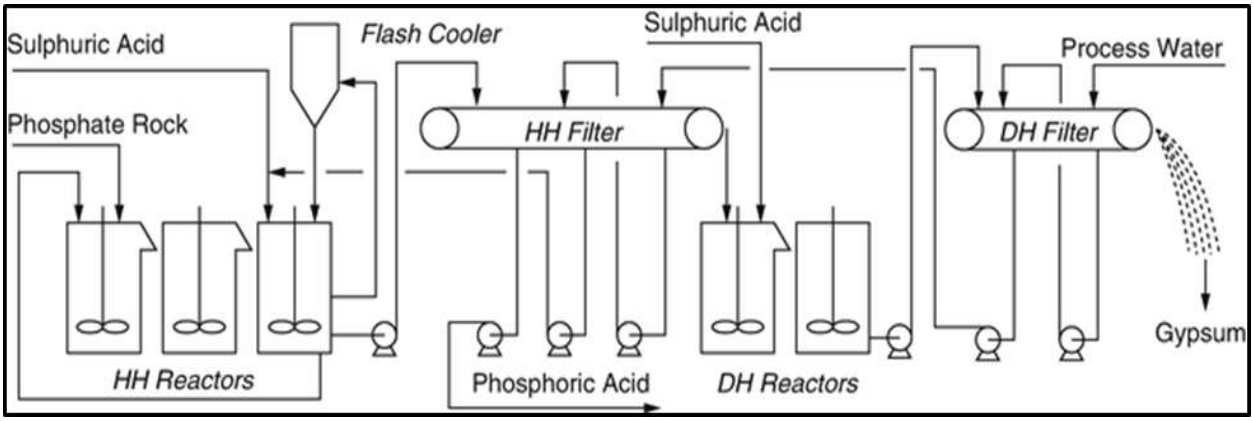
The phosphate rock is converted by reaction with concentrated Sulphuric acid into phosphoric acid and the insoluble salt calcium sulphate.

$$Ca_{10}F_2(PO_4)_6 + 10\,H_2SO_4 + 10\,n\,H_2O \rightarrow 6H_3PO_4 + 10\,(CaSO_4.nH_2O) + 2HF$$

Where n = 0, ½ or 2 depending on the hydrate form in which the calcium sulphate is crystallized.

We will be using Hemi-Di-hydrate technology for production of Phosphoric Acid and Phospho-gypsum. A typical process flow diagram is shown below:

EAC OBSERVATION NO.-6



1 ton of phosphoric acid (as P_2O_5) recovered = 4.5 – 5.0 tons of Phosphogypsum (dry basis) generated.

In India, The **total production of phosphoric acid is about 2.3 Million Ton**, and the **Phosphogypsum generation is about 11.5 Million Tons per annum** during the year 2018-19.

Presently, most of the phosphoric acid plants are disposing the Phosphogypsum within the plant premises in stack (s). Depending on the demand, the phosphoric acid units sell the Phosphogypsum for different applications as mentioned in the below Table.

Sector	Usage	Purpose
Cement	▪ As a retardant	▪ To control the setting time of cement
Agriculture	▪ As a Fertilizer	▪ To correct the Alkaline Soil condition & as a Nutrient
Construction	▪ Road Sub Layer ▪ Gypsum Blocks/ Bricks ▪ Gypsum Fiber Boards	▪ Replacement of Soil ▪ Replacement of Aggregate and sand
Others	▪ Plaster, Plaster Boards	▪ Alternative material

We understand that the cement industries in the state of Madhya Pradesh and Maharashtra, uses chemical gypsum to the tune of 50% and 70% respectively of its annual total requirement. However, cement industries in the state of in Rajasthan and Gujarat, uses chemical gypsum to the tune of 9% and 25% respectively of its annual total requirement.

Therefore, we request MOEF&CC to make a policy decision for utilisation of Phospho-Gypsum by circular economy concept similar to China and Japan.

To make the Indian industry competitive and create an equal level playing field, we shall be allowed to stack for the 5 year generation quantity for reuse. We will use this period to stabilize the plant, Phospho-gypsum quality, develop the market and meet the quality for reuse. We should be allowed to dry stacking of unsold quantities of the Phospho-gypsum till circular economy process has been put in place across the industries.

However, we will make serious efforts in the various areas of use to reduce storage. In addition to this, we will also conduct research projects to increase sales of Phosphogypsum as a part of circular economy initiative.

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Based on the market potential and future market development, we propose preliminary utilisation plan is as below subject to change based on future demand supply. The preliminary utilisation plan for phospogypsum is presented as **Annexure-6(a).**

Handling & Management of Phospho-Gypsum in EUROPE

Location	Company	Process type	Gypsum disposal	Capacity ktonnes P_2O_5
Belgium	Nilefos	DH	Stacking, fraction sold	130
	Prayon SA	DHH	Stacking 20%, sold 80%	180
Czech Rep.	Fosfa	Thermal		50
Finland	Kemira GrowHow	DH	Stacking	300
France	Grand Quevilly **(closed)**	DH	Stacking	200
Greece	PFI Ltd., Kavala	DH	Stacking	70
	PFI Ltd., Thessaloniki	DH	Stacking	110
Lithuania	AB Lifosa	HH	Stacking	350
Netherlands	Hygro Agri Rotterdam **(closed)**	HDH-2	Sea	160
	Kemira Agro Pernis **(closed)**	HDH-1	Sea	225
	Thermphos	Thermal		155
Poland	Police S.A., Police	DH	Stacking	400
	Fosfory N.F., Gdansk	DH	Stacking	110
	Alwernia S.A.	Thermal		40
	Wizow S.A.	HH	Stacking	50
Spain	Fertiberia S.A.	DH	Stacking	420
	FMC Foret S.A.	DH	Stacking	130

Source: EU IPPC - Reference Document on Best Available Techniques in Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilizers Industries. August 2007

Considering the proposed phosphor-gypsum utilization plan, a **17 Hectare storage area** has been planned for storage of Phospho-gypsum designed & developed as per **CPCB guidelines for Management, Handling, Utilisation and disposal of Phospho-gypsum generated from Phosphoric Acid Plants: 2014-2015**; in the proposed Copper Refinery Project.

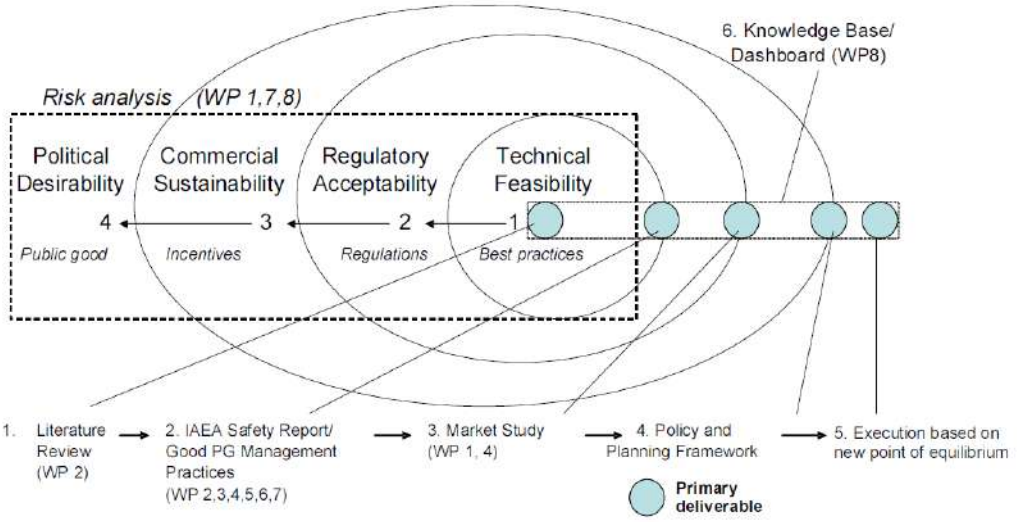
Challenges faced by countries in Phosphogypsum consumption: A Case Study*
**Reference: Towards a Management and Regulatory Strategy for Phosphoric Acid and Phosphogypsum as Co-Products, Work performed partly within the remit of the project Stack free by '53? Beneficial Uses of Phosphogypsum, supported inter alia by the Florida Institute for Phosphate Research and the Aleff Group.*

The **project Stack Free by '53?** Beneficial Uses of Phosphogypsum, supported Inter alliance by the Florida Institute for Phosphate Research and the Aleff Group. A world by 2053 in which stacks, or piles, of Phosphogypsum (PG) no longer exist, other than as holding piles for future use – whether in road building, construction, agriculture or the potentially hundreds of other applications that continue to be proposed for PG use. It then "reverse engineers" a pathway to achieve that goal, taking into account, in sequence, the four main critical success factors for arriving at the end point. These are:

1. Technical feasibility
2. Regulatory acceptability
3. Commercial sustainability
4. Political will.

But in India, we are stuck between the progressive paths of technical feasibility to regulatory acceptability so far.

EAC OBSERVATION NO.-6



STACK FREE BY 53? THE ONION RING METHODOLOGY

Example of the Onion Ring Methodology:

China has Forced Circular Economy of the PG*:

1) Zero Waste Policy
2) Government has put in place rules for phosphate fertilizer companies mandating graduating percentages of PG use
3) Non-compliance will result in steep fines
4) This is not a desirable regulatory approach, but it has resulted in R&D and successful use of PG in a variety of applications.

Reference: AAPFCO -2018, Dr. Brian Birkly

Constructive Regulation:

A five year study of Phosphogypsum use in Huelva - Spain, presents a model of a coherent, evidence-based approach, grounded in sound policy, good science and best practices. The "constructive regulation" approach builds directly on evidence and lessons learned from a long, continuous tradition of PG use in Spain, Brazil and the United States. It supported defining a new sustainable point of equilibrium in which Phosphogypsum production and consumption are in balance.

This will require new modes of collaboration between industry, regulators and independent centers of scientific research. It will set such collaboration in the context of adherence to four core values:

1. Sustainability
2. Coherence
3. Consistency
4. Evidence.

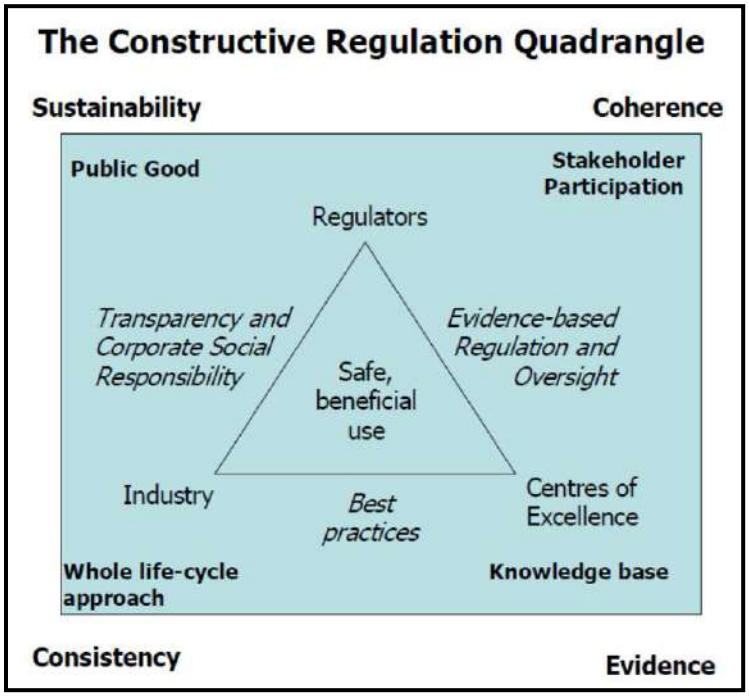
The operational context will be determined by meeting four objectives:

1. Knowledge-based planning and operations
2. A whole life-cycle management approach, from design to end point decommissioning
3. Stakeholder and public participation in consultation and risk communications
4. Pursuit of public good.

EAC OBSERVATION NO.-6

Constructive Regulation:

The desired outcomes flow from applying such principles and objectives and result in:
1. Best practices
2. Transparency and Corporate Social Responsibility
3. Evidence-based Regulation and Oversight.



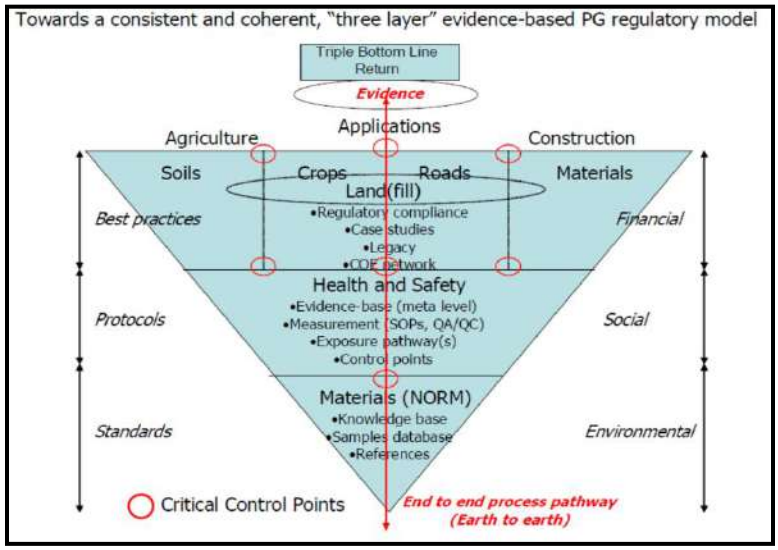
Source: *Hilton, Julian, Birky, Brian, & Johnston, A.E. (2010). The 'constructive regulation' of phosphates and Phosphogypsum A new, evidence-based approach to regulating a NORM industry vital to the global community. International Atomic Energy Agency (IAEA): IAEA*

Triple Bottom Line:

TBL seeks to differentiate, but also to aggregate, returns on major capital investments according to three interlinked criteria:

1. Financial (or Economic)
2. Social
3. Environmental

EAC OBSERVATION NO.-6



Source: *Hilton, Julian, Birky, Brian, & Johnston, A.E. (2010). The 'constructive regulation' of phosphates and Phosphogypsum A new, evidence-based approach to regulating a NORM industry vital to the global community. International Atomic Energy Agency (IAEA): IAEA*

Limitations of Phosphogypsum valorization – need of storage.

Till 2013, the production of Phosphogypsum counts 3 Billion of tones around the world as per International Atomic Energy Agency (IAEA). **Only 15% of the worldwide produced quantity is put into valorization in civil engineering, chemical industry and agriculture fields, the other 85% are either rejected into the sea or stored into embankments in the vicinities of phosphoric acid production plant.**

However, Phosphogypsum valorization is still limited to 15% of the worldwide produced quantity because of the high cost of its purification which makes it less competitive to natural gypsum. Till putting PG valorization in action, its storage into embankments is a temporary alternative to manage it. *(**Reference:** Hajer Maazoun and Mounir Bouassida. "Phosphogypsum Management Perspectives. Massive Valorization or Massive Storage?" Acta Scientific Agriculture 3.8 (2019): 184-189).*

Phospo-gypsum Lining Details:

Phosphogypsum storage yard will be developed strictly as per CPCB Guidelines for Management and handling of phosphor-gypsum.

M/s. Garware Technical Fibres Limited (Geosynthetics Division), Pune; has been engaged for preliminary design for construction of gypsum storage yard. Technical report is attached as **Annexure-6(b).**

The thickness of the liner shall be 1.5 mm thick (min) with minimum width of 7.5 m and length of 150 m to reduce the number of joints. Understanding the seriousness of the project Naue –Germany/Equivalent -GSE-Germany make shall be used. HDPE liner make will be laid at the prepared base areas as well as on the dike slopes. A detailed technical specifications has been provided as a part of the technical proposal attached.

Leachate collection system shall be installed and leachate will be recycled back into Phosphoric Acid Plant. Capacity of the leachate collection (Gypsum Return Water Pond) will be ~3000 m^3 per Gypsum storage.

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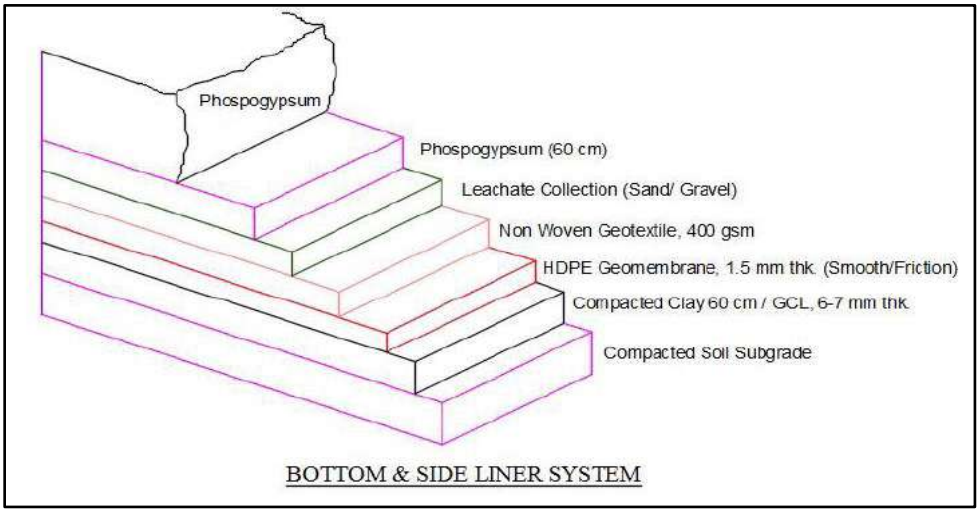
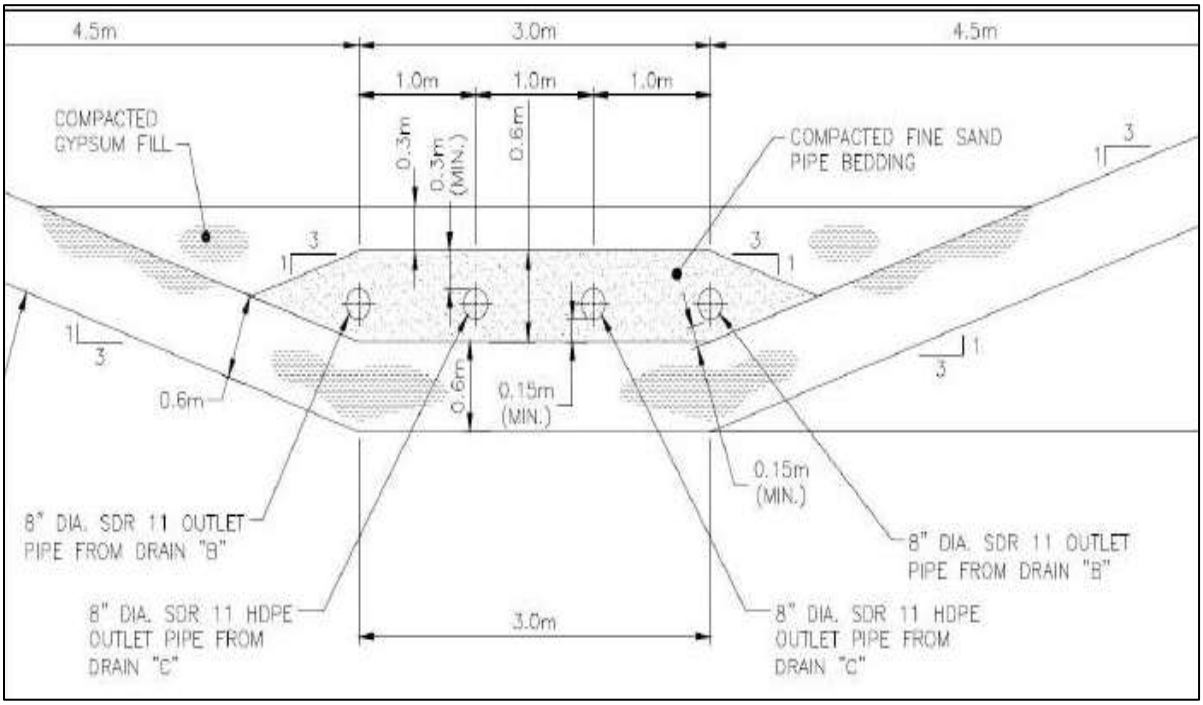
Considering hydrogeology study conducted for this project and solid waste storage locations in the plot layout, piezo well locations have been identified and marked on the plot plan as per **Annexure-6(c).** Additionally, there will be 2 nos. of rainwater collection pond having capacity of 4,000 m^3 from gypsum storage runoff.

Phospho-gypsum will be stacked in the Gypsum storage yard with a dry stacking method. Phospho-gypsum from the plant will be transported to gypsum storage area by a conveyor system and tippers will be used to spread the phospho-gypsum within the storage area. Leachate collected from the gypsum storage area will be pumped to phosphoric acid plant through a piping system for consumption within the process.



PHOSPHO-GYPSUM STORAGE AREA LINER SYSTEM



PHOSPHO-GYPSUM STORAGE LEACHATE DRAIN SYSTEM

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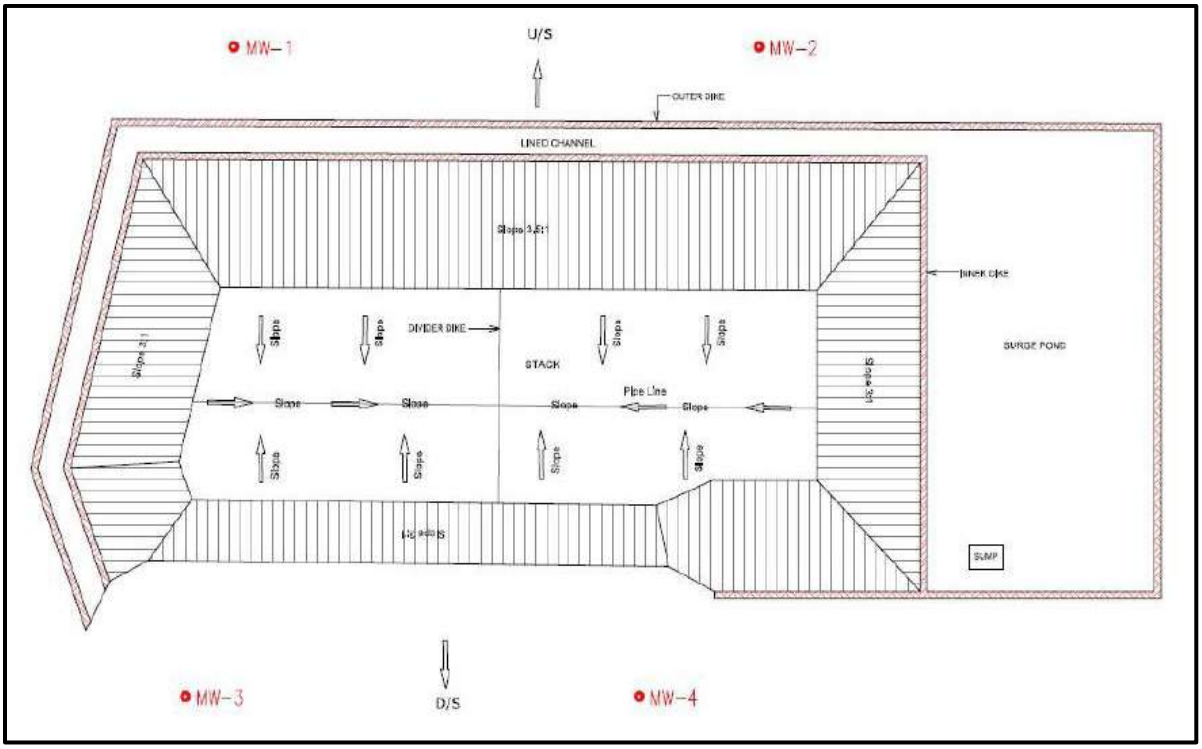

LEACHATE COLLECTION AND RECYCLING SYSTEM

To collect and convey the leachate to the collection sump and leachate collection system will have the following:

1) Drainage layer.
2) A perforated pipe collector system.
3) Sump collection area.
4) Removal of the leachate.

The leachate drainage is usually achieved using graded under-liner and drains which lead to a collection system/surge pond leading to a sump. From the sump, it is pumped back to phosphoric acid plant for consumption.

A typical layout of the stack area, leachate Channel and surge pond is shown below:

PHOSPHOGYPSUM STORAGE AREA LINER SPECIFICATION

Liner Make: Naue, Germany
Thickness: 1.5 mm-Smooth, Length:150 m, Width:7.5 m

Property	Test Method	Unit	Value
Thickness Nominal	EN-1849-(2)/ASTM D 5199	mm	1.50
Lowest individual value	EN-1849-(2)/ASTM D 5199	mm	1.42
Density	EN ISO 1183/ASTM D 1505	Gm/cc	0.942
Melt Flow Index	EN ISO 1133/ASTM D 1238-190/2.16	Gm/10 min	<1.0

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Property	Test Method	Unit	Value
Tensile Strength at Yield	EN ISO 527-3/ASTM D 6693	N/mm	22
Tensile Strength at break	EN ISO 527-3/ASTM D 6693	N/mm	42
Elongation at Yield	EN ISO 527-3/ASTM D 6693	%	12%
Elongation at Break	EN ISO 527-3/ASTM D 6693	%	700
Tear Resistance	ISO 34-1/ASTM D 1004	N	215
Puncture Resistance	ASTM D 4833/EN ISO 12236	N	500
Carbon Black Content	ASTM D 1603	%	>2
Carbon Black Dispersion	ASTM D 5596	Cat	1-2
Dimensional Stability	EN 1107-2/ASTM D 5397	%	+/- 2

Tolerance: 10% on values except thickness, Carbon Black for which a range is given

ANNEXURE-6(a)

Proposed Utilisation plan for Copper Slag																
Description	**UOM**	**Year**														
		Plant stabilisation period														
		1th	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**	**11th**	**12th**	**13th**	**14th**	**15th**
Slag generation estimated	KT	1,600	1,800	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Slag utilization action plan	KT	80	180	300	400	500	700	1,100	1,700	2,100	2,100	2,100	2,100	2,100	2,100	2,100
Slag stockpile estimated	KT	1,520	3,140	4,840	6,440	7,940	9,240	10,140	10,440	10,340	10,240	10,140	10,040	9,940	9,840	9,740
Stacking period estimated	Years	0.8	1.6	2.4	3.2	4.0	4.6	5.1	5.2	5.2	5.1	5.1	5.0	5.0	4.9	4.9
		Legacy stock									**Legacy trend**					

Proposed Utilisation plan for Phospho Gypsum																
Description	**UOM**	**Year**														
		Plant stabilisation period														
		1th	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**	**11th**	**12th**	**13th**	**14th**	**15th**
Phospo Gypsum generation estimated	KT	2,000	2,250	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Phospo Gypsum utilization action plan	KT	100	225	375	500	1,000	875	1,500	2,125	2,625	2,625	2,625	2,625	2,625	2,625	2,625
Phospo Gypsum stockpile estimated	KT	1,900	3,925	6,050	8,050	9,550	11,175	12,175	12,550	12,425	12,300	12,175	12,050	11,925	11,800	11,675
Stacking period estimated	Years	0.8	1.6	2.4	3.2	3.8	4.5	4.9	5.0	5.0	4.9	4.9	4.8	4.8	4.7	4.7
		Legacy stock									**Legacy trend**					

Brief Note

on

Technical Elements of

Phosphogypsum Stack Project

at

Adani Copper Refinery

Mundra, Gujarat, India

Submitted by

GARWARE TECHNICAL FIBRES

GARWARE TECHNICAL FIBRES LIMITED

(Geosynthetics Division)

Corporate office: Plot: 11, Block: D-1, MIDC Chinchwad, PUNE: 411019

Date of submission: April- 2019

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List of figures

1 Cover Note

With reference to the subject cited above, it give us pleasure to receive the enquiry and would like to place on record our desire to associate in the subject project for the construction of the Geosynthetic Lined Gypsum Stack construction. Sir, we at Garware Technical Fibres Ltd (GTFL)-Geosynthetics Divn have been striving tirelessly to Design, supply, install and commission the best Environmental protection Structures for the Waste/Process residue management for the industries as well as municipal corporations. We are also working in many diverse areas of Ground/Geotechnical/Geo-environmental engineering with prime focus on environmental protection, resource Conservation. In specific to the complexity of the project which Adani Enterprises Ltd is planning to undertake, we would like to put forth the following points

GTFL has been associated with similar Phosphogymsum Stack projects in the past for Coramnadal Fertilizers, Paradeep Phosphate and IFFCO (2006-2010).We are also executing Phosphogymsum Stack expansion for Paradeep Phosphate Ltd and IFFCO as per CPCB Guidelines-2014. GTFL has also been involved in design, engineering and execution of large number of Secure Landfill Projects for its customers including Indian Oil, Sterlite Industries, Cairn Energy, HZL, Vedanta Aluminium Ltd, Pimpri Chinchwad Municipal Corporation, KMML-Kerala to name a few.

We have also knowledge of the legal and statutory requirements of the project of such nature and have been associated with various Pollution Control Boards on behalf of the industry and thereby handling and holding hand in explaining the technicalities and compliance related issues.

Above all, our experience of past **20 years in Geosynthetic Lining and related construction with cutting edge technology** has always given industry the confidence to associate with us.

We would be pleased to associate with you to deliver the best available design, products and services for your project

We are also sure that your company will be equally interested to give us an opportunity to demonstrate our Supply/Service capability for the subject project.

2 Brief about Phosphogypsum Stack

The following pages gives only brief outline of key elements of the Phosphogypsum Stack for explanation purpose which Adani Copper Refinery is proposing. Adani Copper Refinery is proposing to construct at its upcoming Copper Refinery located at Mundra, Gujarat. At a later stage, detailed engineering, planning including drawing, material specifications shall be made and the same shall be submitted for approval before starting of the construction of the facility.

2.1 Phosphogymsum Stack Layout

The construction of Phospo Gypsum Stack facility at Adani Copper Refinery site is proposed to be executed with detailed planning and engineering, design of the facility. Broadly it shall consist of Access Road, Perimeter Road, Electrical Lighting, outer/perimeter embankment, inner embankment for disposal of the gypsum, installation of various Geosynthetics materials. drainage trench, outlet and lined channels around the gypsum stack, installation of the Geosynthetic materials, air vent system on the prepared base areas, installation of a 1.5 mm thick smooth & friction high density polyethylene (HDPE) liner-Naue Germany make and as per European standards on the inboard perimeter dike slopes and prepared base areas and construction of the under drains and outlets.

2.2 Site Investigation Criteria

2.2.1 Preliminary Boreholes and Geophysical Investigation:

At each site, as a part of preliminary data collection, one to two boreholes will be drilled and samples collected at every 1.5m interval to a depth of 20m below the ground surface. The following information will be obtained:

(a) soil type and stratification;

(b) permeability of each strata;

(c) strength and compressibility parameters (optional);

(d) ground water level & quality and depth to bedrock.

In addition to preliminary boreholes, geophysical investigations (electrical resistivity/seismic refraction/others) will be undertaken to assess the quality of bedrock at different sites.

A detailed site investigation program will comprise of

(a) subsoil investigation,

(b) ground water/hydrogeological investigation.

(c) hydrological investigation,

(d) topographical investigation and

(e) geological investigation.

The output expected from each investigation is listed below:

a) **Subsoil Investigation:** A detailed investigation plan may be drawn up in consultation with a geotechnical engineer The output from such an investigation should yield the following:

(i) Stratification of subsoil -type of soil and depth

(ii) Depth to ground water table and bedrock (if located within 15m of base of landfill)

(iii) Permeability of various strata beneath the landfill.

(iv) Strength and compressibility properties of subsoil

(v) Extent of availability of liner material, drainage material, top soil and protective soil in adjacent borrow areas.

(vi) Subsoil properties along approach road.

A minimum of 3 boreholes per hectare of landfill area upto 15m beneath the base of the landfill shall be drilled and in-situ tests as well as laboratory tests shall be performed for permeability, strength, compressibility and classification of soils.

In addition, test pits and boreholes shall be drilled at borrow area for liner and cover materials as well as along approach road.

b) **Ground Water/ Hydrogeological Investigation:** A detailed investigation plan may be drawn up in consultation with a ground water specialist or a hydrogeologist. The output from such an investigation should yield the following:

(i) Depth to groundwater table and its seasonal variations.

(ii) Ground water flow direction

(iii) Baseline ground water quality parameters -all drinking water quality parameters.

c) **Topographical Investigation:** Construction of a landfill involves a large quantity of earthwork. It is essential to have an accurate topographical map of the landfill site to compute earthwork quantities precisely. A map of 0.3m contour interval is considered desirable.

d) **Hydrological Investigation:** The objective of a hydrological investigation is to estimate the quantity of surface runoff that may be generated within the landfill to enable appropriate design of drainage facilities. If additional run off from areas external to the landfill is likely to enter the landfill, this quantity should also be estimated to design interception ditches and diversion channels. Such an investigation shall yield estimates of peak flows if seasonal rivers or streams run close to the site hydrological investigation should indicate the possibility of flooding of the site under one in 100 year flood flows. Surface water samples for water quality analysis may be collected from dUring hydrological studies.

e) **Geological Investigation and Seismic Investigation:** Geological investigations shall delineate the bedrock profile beneath the landfill base, if not confirmed by subsoil investigations. Geophysical surveys may be designed in consultation with a geologist. In hilly areas or in quarried rocks. Geological investigations should indicate the quality of surficial rock, depth to sound rock and the possibility of interconnected aquifers beneath the landfill base In the rock mass. Detailed seismic data may be obtained as a part of geological investigations.

2.2.2 Base Stability, Slope Stability and Seismic Aspects:

For landfills construction on the soil, the base will be checked for stability against bearing failure or excessive settlements.

The stability of side slopes of a landfill shall be checked for the following cases (Fig. 9).

(a) stability of excavated slopes

(b) stability of liner system along excavated slopes

(c) stability of temporary waste slopes constructed to their full height (usually at the end of a phase)

(d) stability of slopes of above-ground portion of completed landfills

(e) stability of cover systems in above ground landfills.

The stability analysis shall be conducted using the following soil mechanics methods depending upon the shape of the failure surface

(a) failure surface parallel to slope;

(b) wedge method of analysis;

(c) method of slices for circular failure surface and

(d) special methods for stability of anchored geomembranes along slopes.

In preliminary design of a landfill section, the following slopes will be adopted.

(a) Excavated soil slopes (2.5 horizontal : 1 vertical)

(b) Temporary waste slopes (3.0 horizontal : 1 vertical)

(c) Final cover slopes (4.0 horizontal : 1 vertical)

Slopes can be made steeper, if found stable by stability analysis results. Acceptable factors of safety may be taken as 1.3 for temporary slopes and 1.5 for permanent slopes.

In earthquake prone areas, the stability of all landfill slopes shall be conducted taking into account seismic coefficients as recommended by BIS codes.

2.3 Lining System

2.3.1 Bottom Liner System

The lining system is additional to the separation or unsaturated zone comprising soil or sand between the wet season high elevation of the ground water and the stack yard. These liner consist of native clayey soil/amended soil/ad-mixture soil. The permeability of the soil / amended soil should be less than or equal to 1×10-7 cm/sec. As an alternative to clay Geosynthetic Clay Liner made from Natural Sodium Bentonite sandwitched between two layer of Geotextile known as Bentofix made by Naue-Germany meeting the regulatory requirement may be used.

A schematic cross section of the bottom Liner system is given in **Figure 1**.

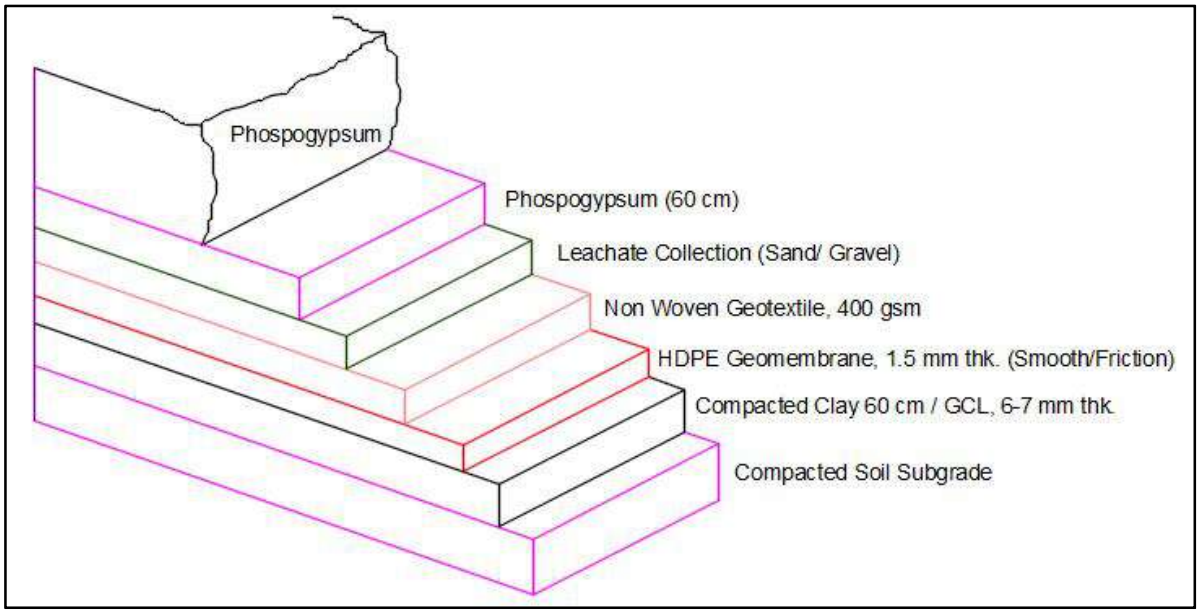


Figure 1: Bottom and Side Liner System

2.3.1.1 Geomembranes

These are flexible sheets made from various plastic materials. The recommended liner along the side as well as the bottom of the facility is HDPE Liner. HDPE lining is effected by overlapping the strips and joining them with a special welding technique.

The thickness of the liner shall be 1.5 mm thick (min) made through flat cast extrusion technology to keep the thickness variation across the rolls to less than 5% and the minimum width of the membrane shall not be less than 7.5 m and length shall not be less than 150 m to reduce the number of joints. Understanding the seriousness of the project Naue –Germany / Equivalent -GSE-Germany make has been recommended for use. Detailed Material Specifications are given in the annexure. Equivalent product's details must be shown to the Technical Engineer for review of its properties/performance.

2.3.1.2 Protection Layer (Non Woven geotextile)

To protect the geo membrane against the mechanical stress and failure thereby, non-woven needle punched Geo textile manufactured through mechanically bonding and made from continuous fibres/filaments and made of 100% UV stabilized Polypropylene is to be used on the HDPE Liner on the bed as well as the slopes. For the protection purpose, 400 gsm overlay Non-Woven Geotextile has been recommended. Equivalent product's details must be shown to the Technical Engineer for review of its properties/performance. The minimum width of the Non Woven Geotextile shall be 4 m and minimum length shall be 90.0m.

2.3.1.3 Drainage Layer

The Gypsum Stack facility essentially generates significant quantity of leachate due to inherent moisture present in the waste body and the rain water precipitation. This leachate is impregnated with harmful chemicals and pollutants. This is to be collected, removed from the facility and treated. In order to collect the leachate from the waste body a Drainage layer of 30 cm granular material of permeability>1*10-2 cm/sec is put over the protective layer of Geotextiles.

Looking at the following aspects of the Gypsum Stack the following drainage medium has been recommended:

(a) Structural profile and geometry

(b) Bottom and side slope pattern

(c) Performance of various geological and synthetic material for drainage function

Hence for the side slope geocomposite drainage net and for the bottom slopes, Sand/gravel as a drainage medium for the primary and secondary layer of desired specification has been recommended.

2.3.2 Side liner system of Gypsum Stack

The side liner system is on the inner side of soil bunds with slope 1:3 (V: H).The construction procedure of each layer of sideliner system is shown in Figure No: 02.

GCL-Bentofix-Naue Germany make of minimum 6-7mm thickness with powdered bentonite to be used instead of compacted clay as the slope is not so gentle and it is difficult to compact the clay on steep slope.

Moreover on the Non-Woven Geotextile, Geocomposite Drainage Net shall be used as a Drainage Medium instead of Sand/ Gravel. **A schematic sketch of the side liner system anchoring with gas venting system is shown in Figure 2.**

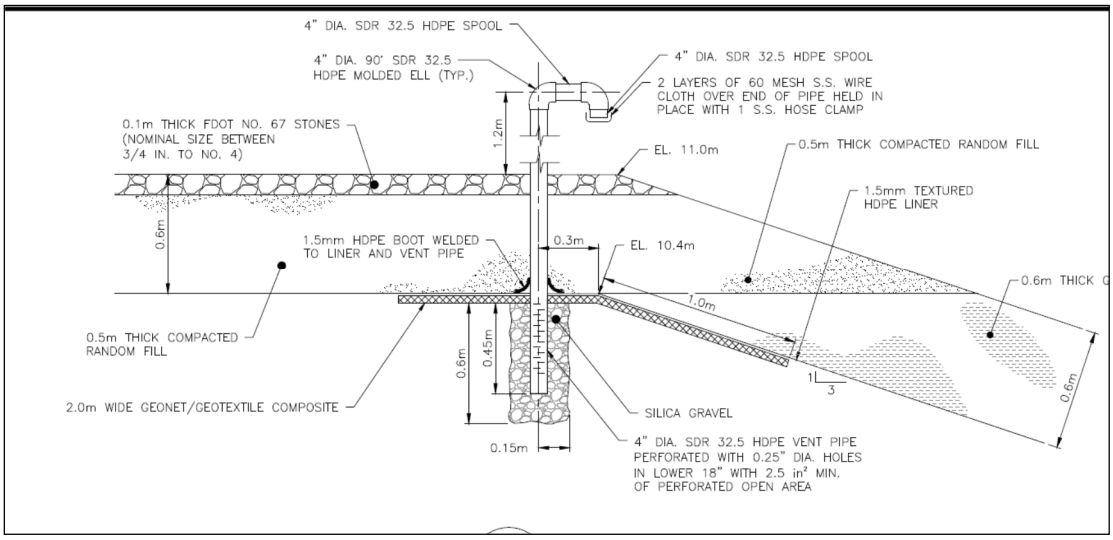


Figure 2: Side Liner System

2.4 Leachate Drainage, Collection & Removal System

In order to collect and convey the leachate generated to the collection sump, a Leachate collection System has been designed. It comprises of the following:

(a) Drainage Layer.

(b) A Perforated Pipe Collector System.

(c) Sump Collection Area.

(d) Removal of the leachate.

The leachate drainage is usually achieved using graded under-liner and drains which lead to a collection system/ Surge Pond leading to a sump. A typical layout of the stack area, leachate Channel and surge pond is shown in **Figure 3**.

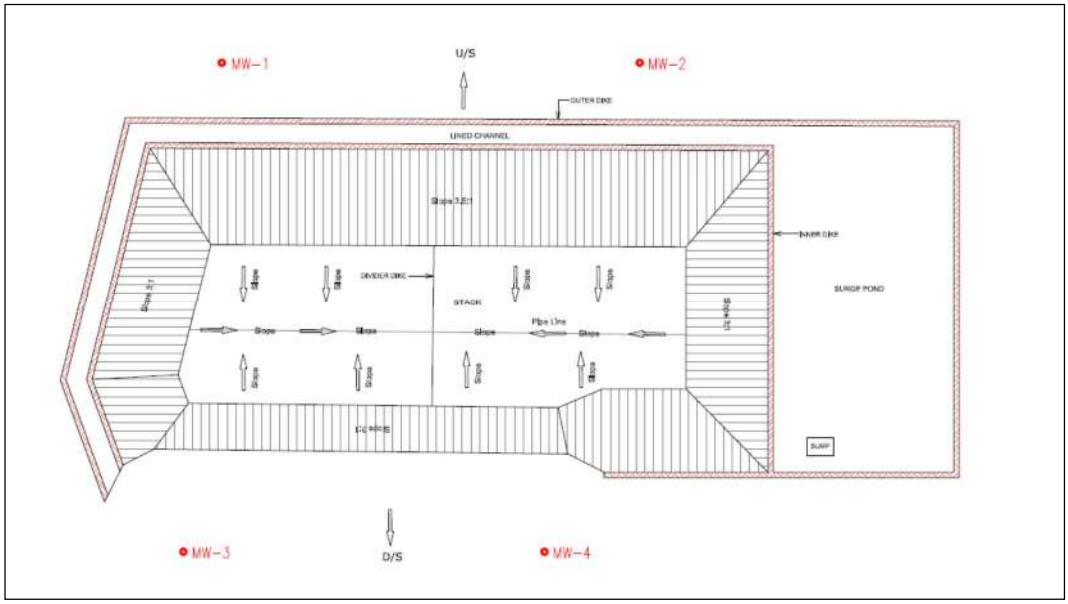


Figure 3: Typical layout of the stack area, leachate Channel and surge pond

The technical details of the leachate drainage are as under:

Thickness of the Drainage Layer should be designed in such a way so that, the leachate can be evacuated quickly. Broadly, 150 mm for arterial pipes for collecting and 200 mm main header line for transporting the leachate from the body of Gypsum stack would be able to carry the leachate to the sump. Gravel/Sand to be used for the smooth drainage of the leachate from the stack area to the piping system. A typical drain section is shown in **Figure 4**.

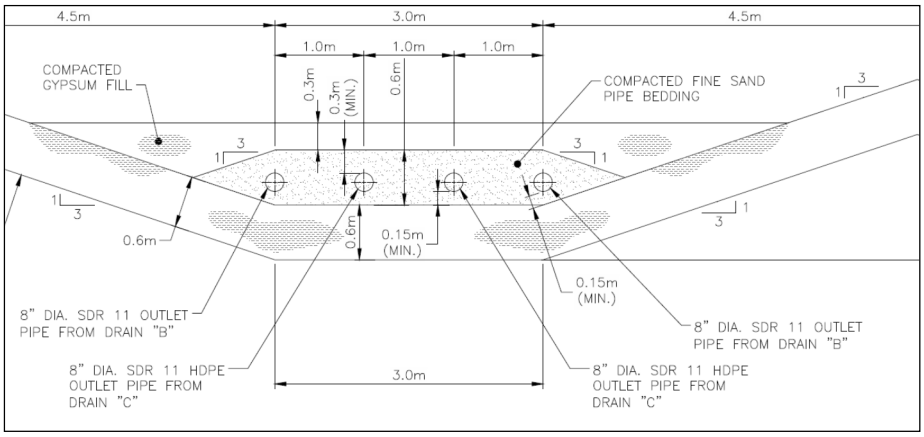


Figure 4: Typical Drain Section

2.5 Construction of Embankment

Embankment shall be designed based on sound engineering practices and also shall be checked for slope stability analysis considering seismic factors of Mundra-Gujarat region.

The embankment shall be constructed to the lines and grades shown on the drawings. Placement of fill shall be performed in an orderly way and in an efficient and workman like manner, so as to produce fills having such quantities of density, strength and permeability as will ensure the highest practicable degree of stability and performance of the embankment.

The slopes of embankment shall be maintained as per specific structures drawing.

2.5.1 Fill Materials

The materials for embankment shall be obtained from the available excavated material. Some earth material available from the excavation in the pond area if found suitable will also be used for the embankment construction. Morrum / Yellow soil or soil which satisfy the accepted civil engineering property of the bund construction shall be accepted.

2.5.2 Placing the fill material Compaction of the Embankment and Base: (IS: 2720)

The combined excavation and placing operations shall be such that the materials when compacted in the fill will be blended sufficiently to produce the specified degree of compaction and stability. The earth obtained from a particular borrow area as far as possible shall be used in forming the complete cross-section of the fill for a particular stretch.

No stones cobbles or rock fragments, having maximum dimensions of more than 5 cm shall be placed in the fill. Such stones and cobbles shall be removed either at the borrow pit or after being transported to the site but before the materials in the fill are rolled and compacted. Such stones or cobbles shall be placed in other portions of embankment if found suitable or rejected as directed. The materials shall be placed in the fill in continuous horizontal layers, stretching right across the whole section, not more than 0.4 m in compacted thickness

Vibratory rollers/static roller shall be used for compacting cohesive materials and pneumatic rollers and vibratory rollers shall be used for compacting cohesion less materials. The compaction in

horizontal layers will be done using standard compaction equipment or in inclined layers using slope compactors/appropriate method.

2.6 Inspection Test

Control tests shall be carried out in laboratory from time to time to determine whether the earth produced by methods employed satisfies the requirements of the specifications and documented for verification by the Officer- in –Charge of the regulatory authority and the work shall be inspected periodically.

Complete documentation of all quality control records and their submission to the GPPCB along with showing satisfactory achievement of acceptance criteria.

The quality control tests for compacted clay layer (or amended soils) as well as the leachate collection/drainage layer will include

(a) In-situ density tests.
(b) in-situ moisture content tests.
(c) Compaction tests.
(d) Permeability tests,
(e) Grain size distribution tests and
(f) Atterberg's limits tests
(g) Others as defined by GPCB.

The quality control tests for geomembrane liners shall be carried at as per QA/QC protocol and shall include the following:

(a) Thickness tests,
(b) Density tests,
(c) Strength tests,
(d) Field seam strength & leak tests

The Officer- in -Charge shall determine whether the desired results are being obtained.

Dressing and Trimming of the slopes

The outer slopes of the embankment shall be neatly dressed to line. Compaction shall extend over the full width of the embankment and the material in the slopes shall be compacted as for the rest of structure. To ensure proper compaction at the outer edge, the fill shall be constructed for a minimum of 0.5 m/1.0m extra width on either edges or the outer edge dressed to true width and slope after compaction. No earth slope shall be left without trimming to design slope.

2.7 Design of Storm Water Drain:

The catchment includes the top or cap of the Gypsum Stack facility as well as the outer slope of embankment and site upto fencing. Hence to divert the incoming water at the surface level as well as the slope and terraces of the Gypsum Stack facility, adequate storm water drainage channels need to be designed, constructed. The channel has to ultimately carry water to the storm water pond for storage or evaporation purpose in case not discharged outside.

2.8 Surface Water Drainage System

Surface water management shall be designed to ensure that rainwater run-off does not drain into the waste from surrounding areas and that there is no waterlogging/ponding on covers of landfills. A schematic surface water drainage system comprising of channels, drains, culverts and basins (Fig8) shall be designed to ensure the following:

(a) Rainwater running off slopes above and outside the landfill area shall be intercepted and channelled to water courses without entering the operational area of the site. This diversion channel may require a low permeability lining to prevent leakage into the landfill
(b) Rain falling on active tipping areas shall be collected separately and managed as leachate, via the leachate collection drain and leachate collection sumps to the leachate treatment and disposal system.
(c) Rainfall on areas within the landfill site, but on final covers of phases which have been completed and are not actively being used for waste disposal shall be diverted in drainage channels away from active tipping areas, and directed through a settling pond to remove suspended silt, prior to discharge.
(d) Any drainage channels or drains constructed on the restored landfill surface shall be able to accommodate settlement, resist erosion and cope with localised storm conditions.
(e) The horizontal surface of the final cover shall be provided a slope of 3 to 5% for proper surface water drainage. The slope of the cover on the sides will be higher and governed by slope stability considerations
(f) All Interceptor channels, drainage channels and settling ponds (storm water basins) shall be designed by a hydrologist using hydrometerological data.
(g) It shall be ensured that water collected by surface water drainage system and leachate collected by the leachate collection system do not get intermixed at any stage of collection or storage This shall apply to the 'active' and 'post closure' periods of the landfill

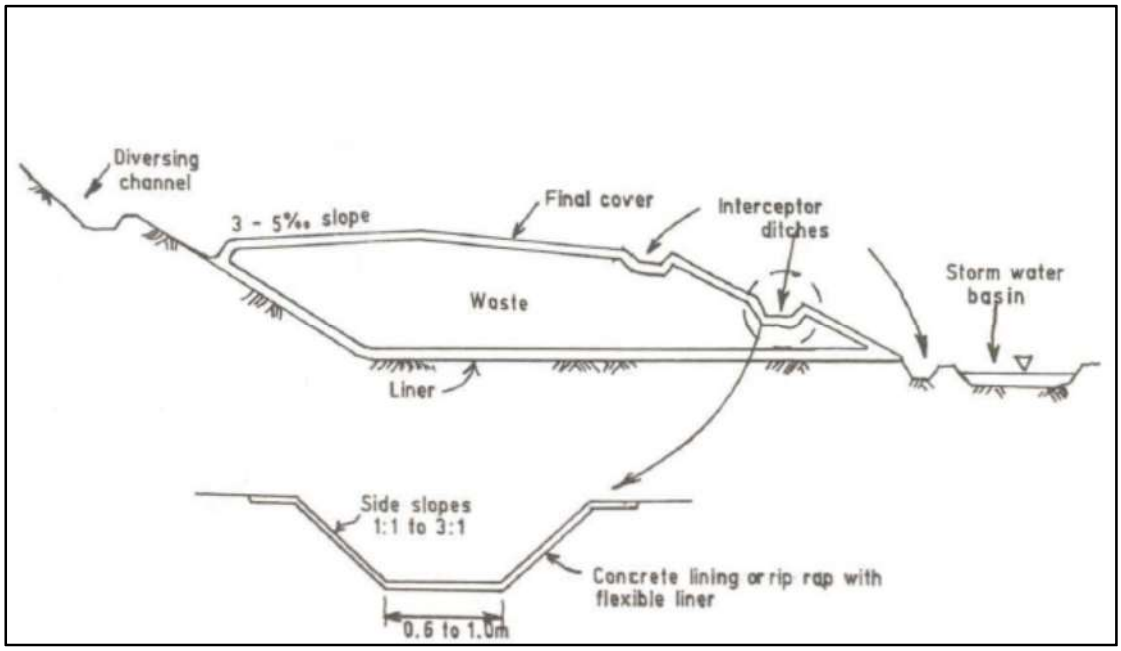


Figure 5: Surface Water Drainage System for a Completed Landfill

The design of following components will be undertaken:

(a) storm water drains, diversion channel
(b) storm water basin
(c) culverts if required

2.9 Piezometric Well

Piezometer shall be constructed to monitor the quality of groundwater. Two piezometers shall be installed on the downstream side of the SLF. Two piezometers shall be installed on the upstream side of the Gypsum Stack. At present, possible locations have been shown where the installation cane be done. But, exact location of the monitoring well shall be finalized in consultation with Gujarat State Pollution Control Board. The piezometer consist of a stand pipe made up of stainless steel/PVC which shall be screened along the entire aquifer depth i.e. the standpipe shall be- screened from a depth of 1 m to 10m or depending on ground water depth. The screened interval shall be encased in a filter zone made up of gravel and sand layer. The function of the filter zone is to allow free flow of groundwater into and out of standpipe and prevent fines from entering the standpipe. Immediately above the screened interval, a clay and bentonite seal shall be placed. The thickness of clay seal shall be 0.5 m. Above the clay and bentonite seal, a grout seal consisting of cement and bentonite shall be constructed which provides a barrier for preventing surface water and ground water from elsewhere from migrating into the screened interval. At the ground level, a steel casing embedded in concrete pad shall be employed. A cap shall be placed on the top of steel casing to prevent rainwater and surface water from entering into the standpipe. The piezometer shall be constructed at a minimum distance of 7 m from outside edge of the embankment. A schematic sketch of a Piezometer is shown in **Figure 6**. The location is shown in figure no 4.

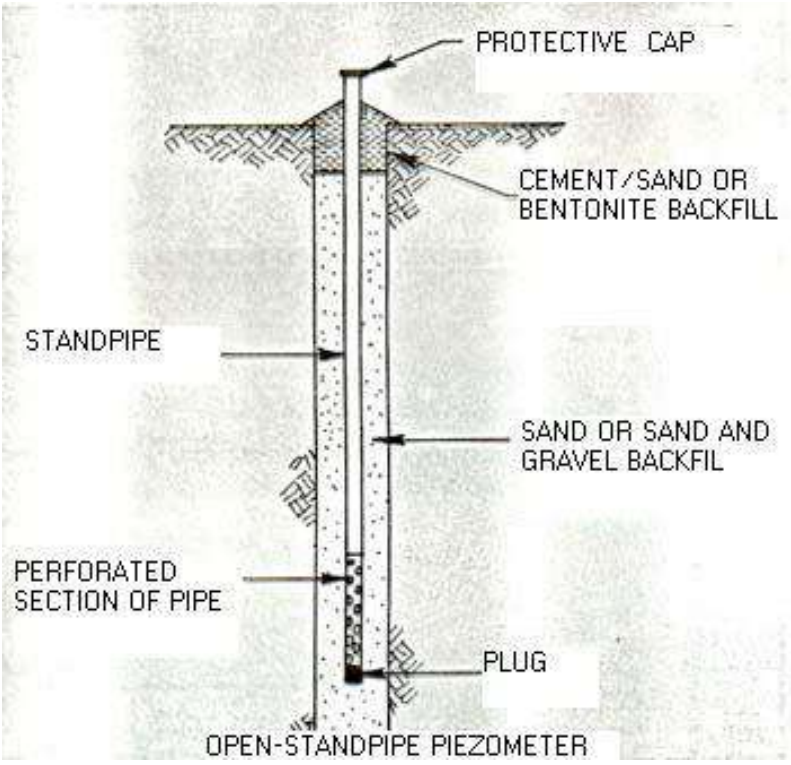


Figure 6: Piezometer

2.10 Annexure

Liner Make: Naue, Germany, Thickness: 1.5 mm-Smooth

Length:150m, Width:7,5m

Property	Test Method	Unit	Value
Thickness Nominal	EN-1849-(2)/ASTM D 5199	mm	1.50
Lowest individual value	EN-1849-(2))/ASTM D 5199	mm	1.42
Density	EN ISO 1183/ASTM D 1505	Gm/cc	0.942
Melt Flow Index	EN ISO 1133/ASTM D 1238-190/2.16	Gm/10 min	<1.0
Tensile Strength at Yield	EN ISO 527-3/ASTM D 6693	N/mm	22
Tensile Strength at break	EN ISO 527-3/ASTM D 6693	N/mm	42
Elongation at Yield	EN ISO 527-3/ASTM D 6693	%	12%
Elongation at Break	EN ISO 527-3/ASTM D 6693	%	700
Tear Resistance	ISO 34-1/ASTM D 1004	N	215
Puncture Resistance	ASTM D 4833/EN ISO 12236	N	500
Carbon Black Content	ASTM D 1603	%	>2
Carbon Black Dispersion	ASTM D 5596	Cat	1-2
Dimensional Stability	EN 1107-2/ASTM D 5397	%	+/- 2

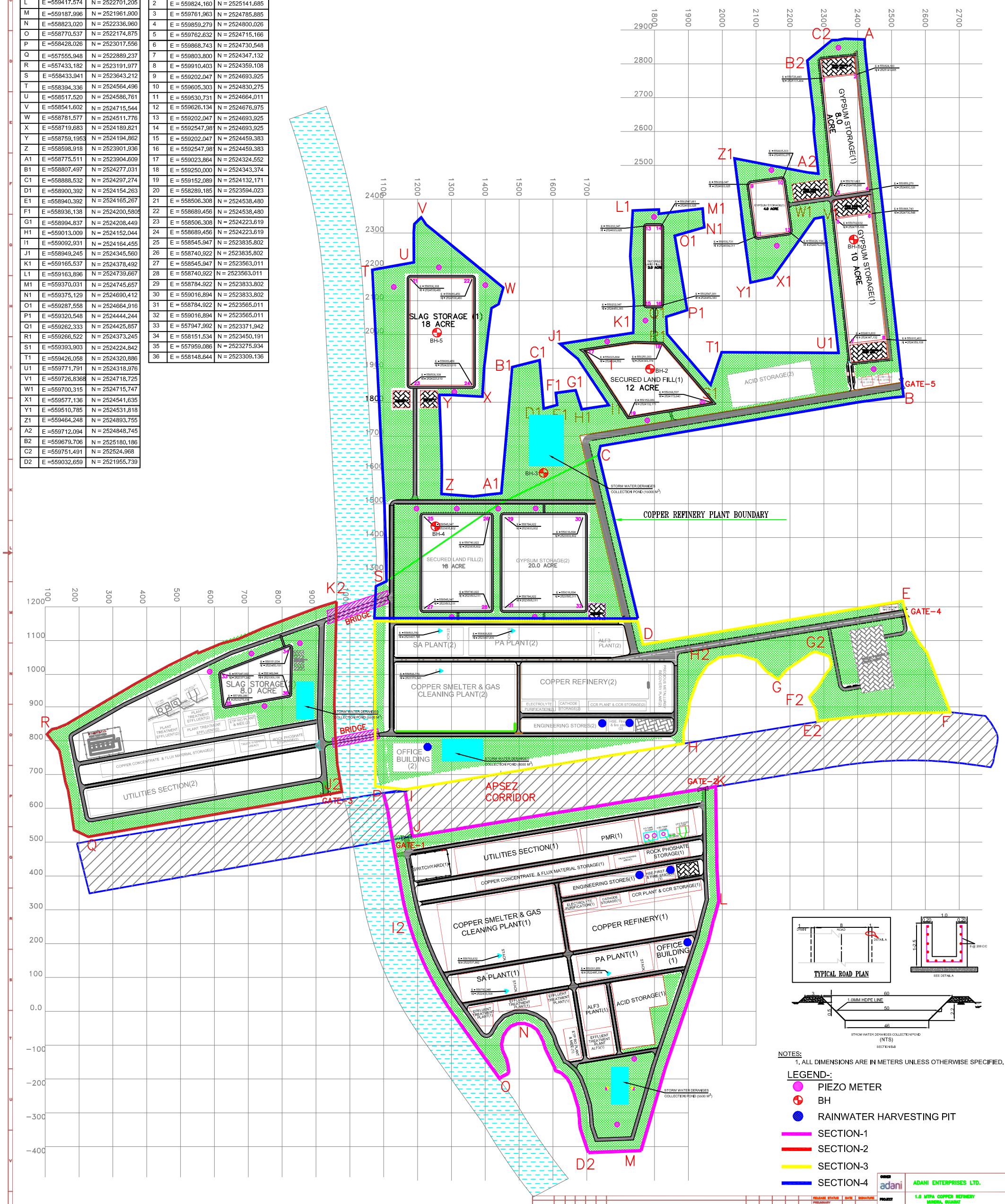
Tolerance: 10% on values except thickness, Carbon Black for which a range is given.

ANNEXURE-6(c)

SR.	EASTING	NORTHING
A	E =559848.328	N = 2525243.163
B	E =559963.374	N = 2524190.380
C	E =559071.249	N = 2524044.332
D	E =559194.182	N = 2523457.258
E	E =559960.721	N = 2523586.315
F	E =556010.2428	N = 2523257.270
G	E = 559594.1246	N = 2523353.9571
H	E =558823.020	N = 2522336.960
I	E =558492.116	N = 2523029.111
J	E =558513.043	N = 2522890.177
K	E =559407.330	N = 2523037.264
L	E =559417.574	N = 2522701.205
M	E =559187.996	N = 2521961.900
N	E =558823.020	N = 2522336.960
O	E =558770.537	N = 2522174.875
P	E =558428.026	N = 2523017.556
Q	E =557555.948	N = 2522889.237
R	E =557433.182	N = 2523191.977
S	E =558433.941	N = 2523643.212
T	E =558394.336	N = 2524564.496
U	E =558517.520	N = 2524586.761
V	E =558541.602	N = 2524715.544
W	E =558781.577	N = 2524511.776
X	E =558719.683	N = 2524189.821
Y	E =558759.1953	N = 2524194.862
Z	E =558598.918	N = 2523901.936
A1	E =558775.511	N = 2523904.609
B1	E =558807.497	N = 2524277.031
C1	E =558888.532	N = 2524297.274
D1	E =558900.392	N = 2524154.263
E1	E =558940.392	N = 2524165.267
F1	E =558936.138	N = 2524200.5805
G1	E =558994.837	N = 2524208.449
H1	E =559013.009	N = 2524152.044
I1	E =559092.931	N = 2524164.455
J1	E =558949.245	N = 2524345.560
K1	E =559165.537	N = 2524378.492
L1	E =559163.896	N = 2524739.667
M1	E =559370.031	N = 2524745.657
N1	E =559375.129	N = 2524690.412
O1	E =559287.558	N = 2524664.916
P1	E =559320.548	N = 2524444.244
Q1	E =559262.333	N = 2524425.857
R1	E =559266.522	N = 2524373.245
S1	E =559393.903	N = 2524224.842
T1	E =559426.058	N = 2524320.886
U1	E =559771.791	N = 2524318.976
V1	E =559726.8368	N = 2524718.725
W1	E =559700.315	N = 2524715.747
X1	E =559577.136	N = 2524541.635
Y1	E =559510.785	N = 2524531.818
Z1	E =559464.248	N = 2524893.755
A2	E =559712.094	N = 2524848.745
B2	E =559679.706	N = 2525180.186
C2	E =559751.491	N = 252524.968
D2	E =559032.659	N = 2521955.739

SR.	EASTING	NORTHING
E2	E =559705.888	N = 2523228.702
F2	E=559684.6685	N=2523301.4207
G2	E=559743.9055	N=2523422.4579
H2	E=559418.3173	N=2523419.2137
I2	E = 558513.781	N = 2522601.441
J2	E = 558304.785	N = 2523022.272
K2	E = 558289.185	N = 2523594.023

SR.	EASTING	NORTHING
1	E = 559726.440	N = 2525131.464
2	E = 559824.160	N = 2525141.685
3	E = 559761.963	N = 2524785.885
4	E = 559859.279	N = 2524800.026
5	E = 559762.632	N = 2524715.166
6	E = 559868.743	N = 2524730.548
7	E = 559803.800	N = 2524347.132
8	E = 559910.403	N = 2524359.108
9	E = 559202.047	N = 2524693.925
10	E = 559605.303	N = 2524830.275
11	E = 559530.731	N = 2524664.011
12	E = 559626.134	N = 2524676.975
13	E = 559202.047	N = 2524693.925
14	E = 5592547.981	N = 2524693.925
15	E = 559202.047	N = 2524459.383
16	E = 5592547.981	N = 2524459.383
17	E = 559023.864	N = 2524324.552
18	E = 559250.000	N = 2524343.374
19	E = 559152.089	N = 2524132.171
20	E = 558289.185	N = 2523594.023
21	E = 558506.308	N = 2524538.480
22	E = 558689.456	N = 2524538.480
23	E = 558506.308	N = 2524223.619
24	E = 558689.456	N = 2524223.619
25	E = 558545.947	N = 2523835.802
26	E = 558740.922	N = 2523835.802
27	E = 558545.947	N = 2523563.011
28	E = 558740.922	N = 2523563.011
29	E = 558784.922	N = 2523833.802
30	E = 559016.894	N = 2523833.802
31	E = 558784.922	N = 2523565.011
32	E = 559016.894	N = 2523565.011
33	E = 557947.992	N = 2523371.942
34	E = 558151.534	N = 2523450.191
35	E = 557959.086	N = 2523275.934
36	E = 558148.644	N = 2523309.136



EAC OBSERVATION NO.-7

EAC OBSERVATION:

Provide various stream characteristics being treated in ETP and treatment process.

REPLY:

The preliminary quantitative & qualitative characteristics of waste streams generated from the various sources from the proposed copper refinery plant are as below:

Preliminary effluent waste stream input to ETP:

PRELIMINARY EFFLUENT STREAM CHARACTERISTICS						
Parameter	**UOM**	**SOURCE**				
		Sulphuric Acid Plant - GCP	**Copper Refinery**	**Precious Metal Recovery**	**Regenerable Amine based SO_2 Scrubber**	**Lime Slurry based SO_2 Scrubber**
Flow	m^3/day	1,800-2,000	350 - 400	50 - 60	1,000 - 1,100	450 - 500
H_2SO_4	gpl	60 - 80	25 - 30	-	< 2	-
As	gpl	9.5 - 10	< 1	< 3	-	-
Cu	gpl	0.5 - 0.7	< 1	0.001 - 0.02	-	-
Pb	gpl	15 - 17	-	0.01 - 0.03	-	-
Se	gpl	6 - 7	-	0.001 - 0.1	-	-
F	gpl	5.5 - 6.5	-	-	-	-
Na	gpl	15 - 17	-	21.2 - 36.0	-	-
Ca	gpl	-	-	< 2	-	-
Cl	gpl	3 - 4	-	25.8	-	-
Na_2SO_3	gpl	-	-	-	< 3	-
Na_2SO_4	gpl	-	-	-	< 15	-
PH	-	-	-	9 - 10	4 -6	10 - 12
TSS	%	< 1	0.5	-	-	10 - 15
ETP treatment	-	ETP#1	ETP#1	ETP#2	ETP#3	ETP#3

Treated Effluent Quality:

The proposed ETP will provide following quality of the treated effluent. The same will be recycled to the plant based on its requirement and rest will be fed to the proposed reverse Osmosis Plant and MEE/MVR system as a part of Zero Liquid Discharge (ZLD).

Sr. No.	Parameter	UOM	Value (Max)
1	Suspended Solids	mg/l	200
2	pH		5.5 – 9.0
3	Oil & grease	mg/l	20
4	Total residual chlorine	mg/l	1.0
5	Ammonical Nitrogen (as N)	mg/l	50.0
6	Biochemical Oxygen Demand (3 days at 27^0C	mg/l	100
7	Chemical Oxygen Demand	mg/l	250
8	Arsenic (as As)	mg/l	0.2
9	Mercury (as Hg)	mg/l	0.01
10	Lead (as Pb)	mg/l	2.0
11	Cadmium (as Cd)	mg/l	2.0
12	Hexavalent Chromium (as Cr+6)	mg/l	1.0
13	Total Chromium (as Cr)	mg/l	2.0
14	Copper (as Cu)	mg/l	3.0
15	Zinc (as Zn)	mg/l	15.0
16	Selenium (as Se)	mg/l	0.05
17	Nickel (as Ni)	mg/l	5.0
18	Fluoride (as F)	mg/l	15.0
19	Sulphide (as S)	mg/l	5.0
20	Manganese (as Mn)	mg/l	2.0
21	Iron (as Fe)	mg/l	3.0

EAC OBSERVATION NO.-7

Wastewater Treatment process for the effluent generated from the Sulphuric acid Plant - GCP and the Copper Refinery: ETP 1

Effluents from the gas cleaning plant of Sulphuric Acid, Copper Refinery, wet scrubber water from the smelter secondary gas cleaning and bleed from slag granulation pond will be treated in a state of art Effluent Treatment Plant (ETP) facility with tertiary treatment to remove arsenic as arsenic bearing sludge which will be stored in Secured Land Fill (SLF) designed, constructed & maintained as per CPCB Guidelines and segregation of clean chemical gypsum, which will be sold to cement industries.

Processing the combined stream in a central multistage chemical water treatment plant consisting of three stages:

- Clean gypsum precipitation (treatment with milk of lime (MOL), pH 1–1.4, flocculant, precipitation of clean gypsum), clean gypsum is produced in a vacuum filter with > 96 % CaSO4.2H2O;

- Metal precipitation (treatment with lime milk, $FeSO_4.7H_2O$, H_2O_2, flocculant and increase of pH to 10–11; capture of metals by precipitation). At this stage, the pH of the solution increases to near 11 and, in order to precipitate more metals, the necessary reagents for oxidation and precipitation of arsenic and metals are also fed in, including ferric chloride. During the precipitation and decantation of the solid phase in a thickener, a sludge is produced that is sent to a filter press to produce a neutralization cake and sent to secured land fill for storage; The precipitation is accelerated with polyelectrolytes (coagulants and flocculants); and

- Arsenic removal (treatment with lime milk, $FeSO_4.7H_2O$, $FeCl_3$ and H_2O_2 to capture the remaining arsenic, pH 6–8). In this stage, the arsenic that is left in the solution is removed and the pH of the final solution of the treated waters is kept between 7 and 8. Necessary reagents, including ferric chloride, are fed into the solution for the fine cleaning to remove the remaining arsenic and metals in two tanks and a clarifier. Slimes from this precipitation step are sent to the metal precipitation.

The inlet water composition varies depending on the concentrate quality, the off-gas properties and the operation of the wet gas cleaning systems.

Environmental Benefits:

1. Production of Chemical gypsum, suitable to cement industries.
2. Reduction in Hazardous waste generation.
3. Better quality of treated water for recycling for plant process.

EAC OBSERVATION NO.-7

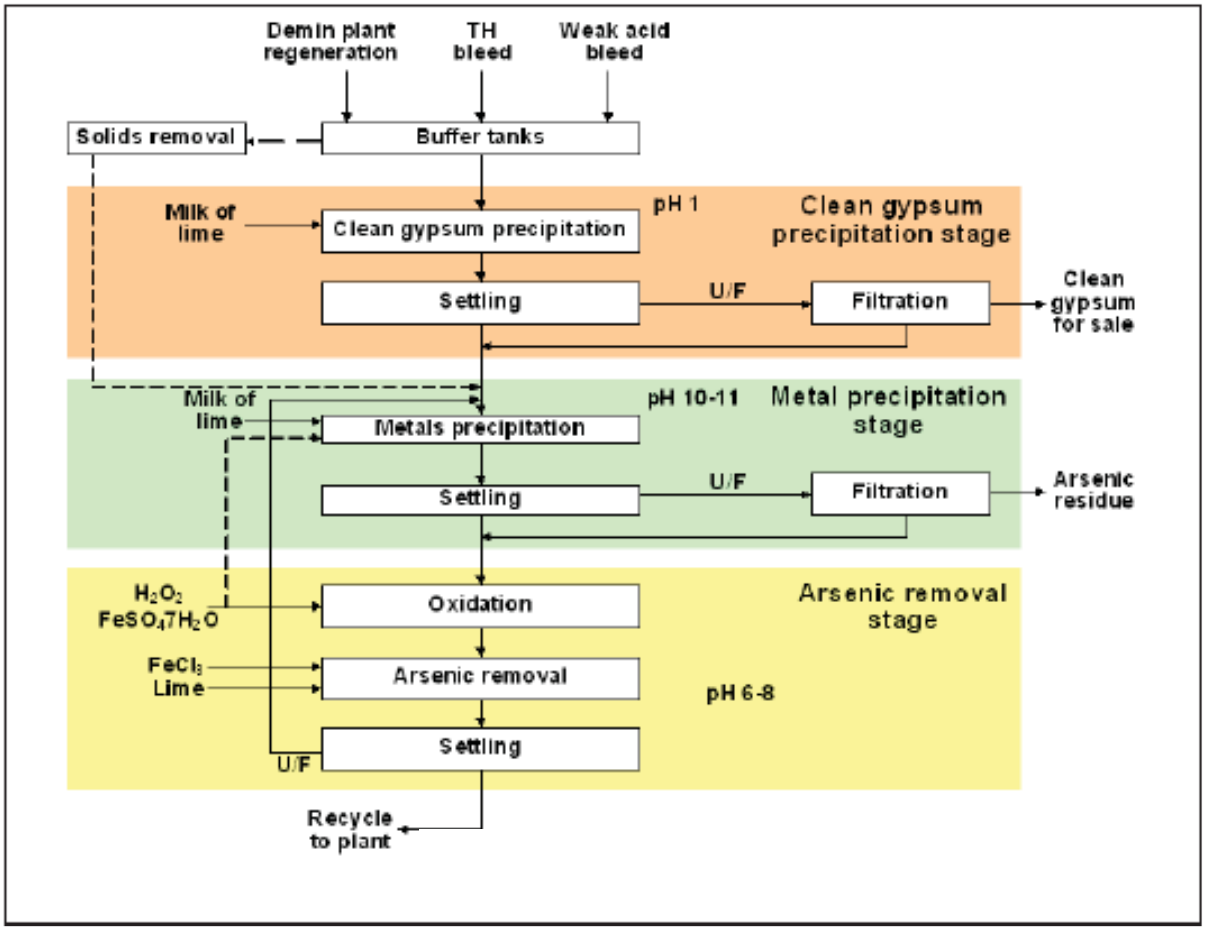


FIGURE-1:
WASTEWATER TREATMENT PROCESS FOR THE EFFLUENT GENERATED FROM THE GCP AND THE COPPER REFINERY

EAC OBSERVATION NO.-7

Wastewater Treatment process for the effluent generated from the Precious Metal Recovery Plant: ETP 2

After recovery of gold and silver from anode slime which is generated from electro-refining of copper; effluent collected from Precious Metal Recovery Plant are treated to meet the Zero Liquid Discharge plant. For that; effluent collected from Silver and Gold refinery will be treated with sodium carbonate (Na_2CO_3) and sodium hydroxide (NaOH).

Sodium hydroxide will react with dissolved metals to make a solid precipitate. Solid precipitates will be filtered from a solution and dissolved copper in effluent reacts with sodium hydroxide to make solid Copper (II) hydroxide and sodium ions.

The process chemistry for the same as mentioned below:

$$\mathbf{Cu^{+2} + 2NaOH \rightarrow Cu(OH)_2 + 2Na^{+}}$$

Once the process is complete, the solid precipitated $Cu(OH)_2$ is removed from solution by filtration. After filtration, the precipitate will be recycled to the Copper Smelter. A filtrate will be sent to the effluent treatment plant of the smelter.

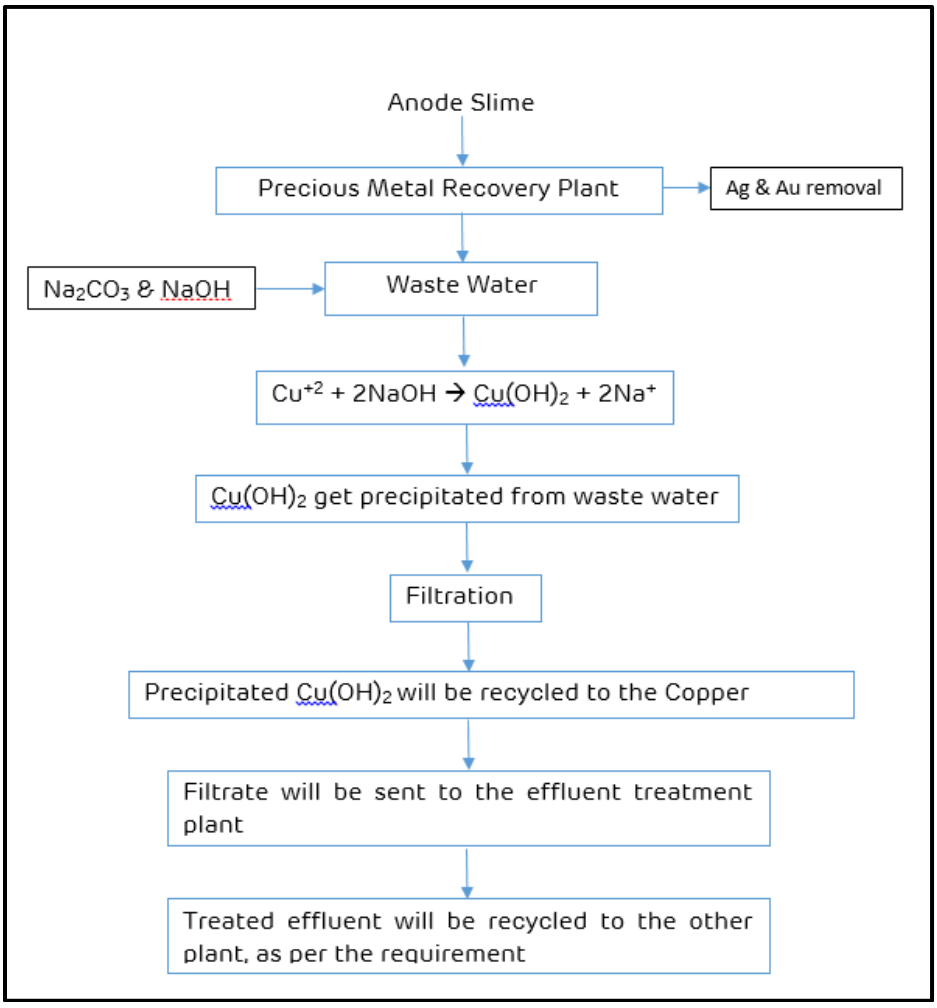


FIGURE-2:
WASTEWATER TREATMENT PROCESS FOR THE EFFLUENT GENERATED FROM THE PRECIOUS METAL RECOVERY PLANT

EAC OBSERVATION NO.-7

Wastewater Treatment process for the effluent generated from the Preliminary FGD-2 (Lime Slurry based scrubber): ETP 3

FGD bleed from limestone slurry based forced oxidation (LSFO) sent to the thickener. In the thickener, flocculants will be added in order to removal of a portion of the liquid from slurry made up of a mixture of finely divided solids and liquids. The thickener overflow liquid will be sent to the MOL preparation and the thickening slurry will go to the horizontal belt filter where the gypsum will be filtered, and the filtrate from the horizontal belt filter will be recycled to the MOL preparation. The gypsum will be sold to the cement industries.

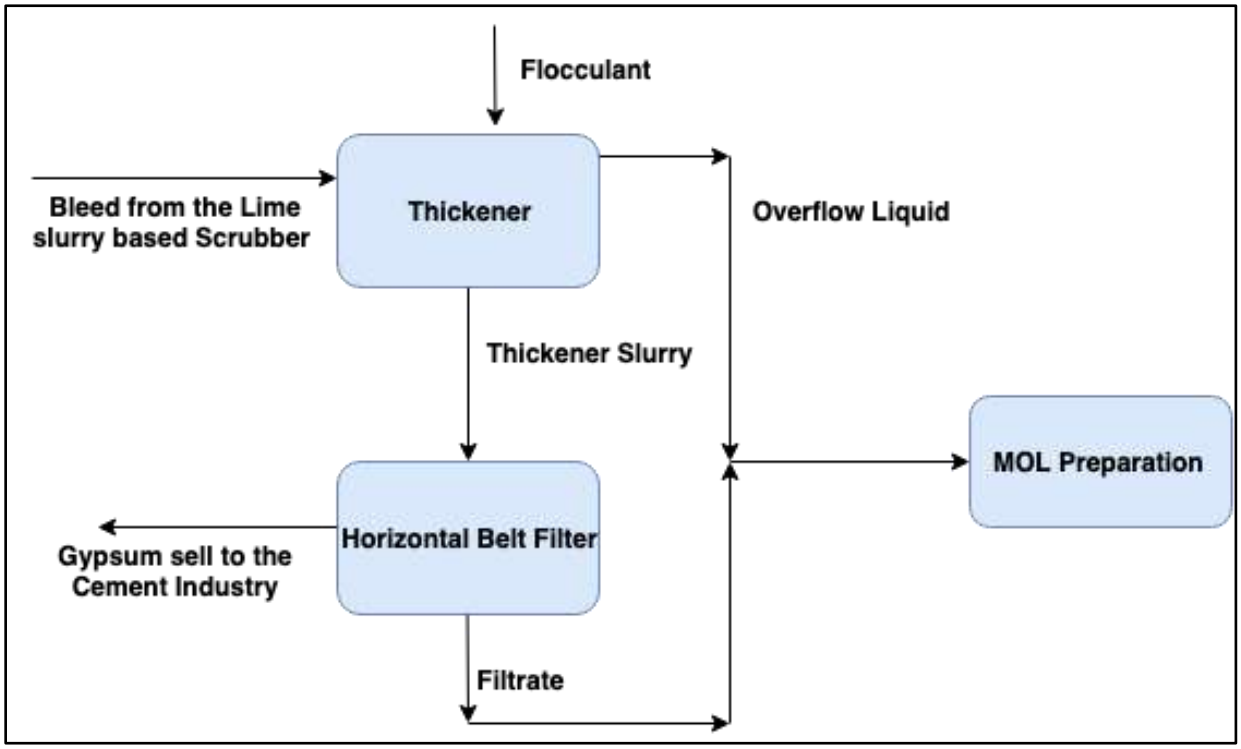


FIGURE-3:
WASTEWATER TREATMENT PROCESS FOR THE EFFLUENT GENERATED FROM THE PRELIMINARY FGD-2 (LIME SLURRY BASED SCRUBBER)

EAC OBSERVATION NO.-8

EAC OBSERVATION:

Environment Management Plan to be revised and updated with intervention for wildlife management, mangrove conservation, active mud flats and post project monitoring around solid waste storages.

REPLY:

a) CONSTRUCTION PHASE:

IFC EHS guidelines for construction will be followed:

1) Management Measures for Soil Quality:

- Top soil at construction site shall be stored separately, conserved and shall be used for greenbelt/ green cover development at later stage;
- The construction material & diesel/oil to be used for various construction activities shall be stored in designated storage yards to reduce the spills into unwarranted areas. Segregation, collection, storage and disposal of waste material generated during construction phase to minimise its impact on soil quality; and
- Use an identified area for undertaking any repair and maintenance of vehicles/equipment.

2) Management Measures for Air Quality:

- Enforce deployment of good condition vehicles with speed restrictions inside the project boundary;
- Deploy mobile water tankers to moist the vehicle movement paths to suppress dust; and
- Enforce no use of firewood for cooking and also no open air burning of any kind of wastes.

3) Management Measures for Water Quality:

- A dedicated area for repair and maintenance of construction equipment with adequate spill prevention systems;
- Proper sanitation facility for construction workers during work at site;
- Proper storm water drainage system to the construction site; and
- The existing natural drainage will not be disturbed during construction activities.

4) Management Measures for Noise Levels:

- All noise generating equipment will be provided with noise attenuation arrangements like silencers, mufflers, insulators etc., to reduce the noise levels below 85 dB(A) as far as technically feasible;
- All machineries and moving equipment will be periodically tested for their physical stability to ensure minimum noise during operation;
- Awareness will be imparted to labours employed in the project and shall be encouraged to commute through mass/public transport to reduce traffic and minimum use of horns while travel; and
- All the construction labour will be made to wear the personal protection equipment such as helmets, ear muffs etc.

b) OPERATIONAL PHASE WITHIN THE PLANT:

ISO 14001:2015 Environmental Management System (EMS) will be implemented for regular control over environmental aspects and continual improvement.

1) Management Measures for Soil Quality:

- All stack emission sources will be provided with appropriate high efficiency air pollution control equipment like bag filter, scrubber etc.;
- Dust suppression arrangement at raw material storage yard;
- Closed container collection, storage and transportation of all hazardous wastes within the plant and outside;
- Regular road sweeping for recovery of dust from the spilled areas within the plant boundary;
- The top soil will be suitably collected, stacked separately and used for greenbelt/green cover during subsequent stages; and
- Periodical soil quality monitoring.

2) Management Measures for Air Quality:

a) Secondary emissions:

- Tube and closed conveyor will be provided at raw material handling area;
- High efficiency collecting hood system for fugitive emissions from originating source such as tapping port of smelting furnaces, transfer ladles, furnace openings etc.;
- Hood system at converter to capture secondary gases while transferring;
- Ventilation system with bag filter, scrubber and stack arrangement to handle smelting furnace/SF/converter/anode furnace secondary gas emissions; and
- Minimum 15 m wide greenbelt with native species will be maintained all around the plant boundary. Total of greenbelt & green cover will be 89.84 ha (~35%) within in the Plant boundary.

b) Management Plan and Abatement Technologies:

- **Sulphur Dioxide (SO_2):** High efficiency collection and scrubbing system with lime and caustic;
- **Fluorine (F):** High efficiency collection and scrubbing system with water to produce hydro fluro silicic acid, which will be input to aluminum fluoride plant;
- **Particulate Matter:** Wet scrubbers, cyclones, electrostatic precipitators, bag filters, vacuum trucks, road vacuum sweepers, etc.; based on the application; and
- The final gaseous emissions from the copper refinery project would be well within the permissible limits as prescribed by GPCB/CPCB/MoEF&CC.

- The following monitoring and controlling mechanism will be provided to make a fool-proof system:

  - Provision of online SO_2 analyzer with interlock system & process-trip for all the process stacks;
  - Periodic online calibration of SO_2 stack analyzer will be carried out at 90 % of the analyzer range with prior intimation to state pollution control board; and
  - Online stack SO_2 analyzers will be connected with state pollution control board for real time monitoring of SO_2 emission.

EAC OBSERVATION NO.-8

3) Management Measures for Water Quality:

- No ground water will be used in this project.
- No surface water will be used in this project and only desalinated water will be used.
- No effluent will be discharged outside the plant premises and plant will operate on Zero Liquid Discharge (ZLD).
- Storm water from plant operations, storage areas, landfill and other pollution prone areas will be separated and diverted to ETP for treatment and reused for plantation and other non-potable uses.
- Storm water drainage system will be provided along the side of plant roads with required gradient. Intermediate sumps with gate valve arrangements, sump pumps and piping network will be provided to pump collected water to two collection sumps of 5500 m^3 each.
- All the solid waste storages will be constructed as per CPCB guideline with garland drains. Garland drains around respective solid waste facilities will be connected to the intermediate sumps. Water collected in these intermediate sumps will be pumped through pipeline network to two collection sumps of 8,000 m^3 and 15,000 m^3.
- Maximum recycling of treated wastewater into process;
- Utilization of treated domestic wastewater in greenbelt development and dust suppression;
- Stabilized arsenic bearing sludge, scrubber cake, spent catalyst and spent resins (from DM, RO & Refinery) will be stored in secured land fill as per guidelines of CPCB.
- SLF with double HDPE Liner of 2 mm thick and gypsum storage with single HDPE liner of 1.5 mm thickness will be constructed.
- Ground water level monitoring system and ground water quality will be established by installing 24 piezometric borewells within the plant premises based on the geological condition of the land use.
- Rainwater harvesting pits will be provided at about 6 locations near office building & canteen, HSE building & Engineering stores.

4) Management Measures for Noise Level:

- High noise generating sources shall be insulated adequately by providing suitable enclosures;
- The air compressor, process air blower, pneumatic valves shall be provided with acoustic enclosure;
- All the design/installation precautions as specified by the manufacturers with respect to noise control shall be strictly adhered to;
- Design and layout of building to minimize transmission of noise, segregation of particular items of plant and to avoid reverberant areas;
- Use of lagging with attenuation properties on plant components / installation of sound attenuation panels around the equipment;
- The noise control system shall be designed to form an integral part of the plant;
- Other than the regular maintenance of the various equipment, ear plugs/muffs shall be recommended for the personnel working close to the noise generating units;
- The oxygen plant shall be installed in double wall building and no operator shall be working within the building;
- All the openings like covers, partitions shall be designed properly;
- Inlet and outlet mufflers shall be provided which are easy to design and construct;
- Sign boards for speed limits and horns in restricted area;

- Minimum 15 m wide greenbelt with native species will be maintained all around the plant boundary. Total of greenbelt & green cover will be 89.84 ha (~35%) within in the Plant boundary;
- Mass plantation will be done using native forest plant species along the roads within 10 km radius area and community lands of panchayat offices and schools in the nearby villages; and
- Ambient and industrial noise monitoring.

5) Monitoring around Solid Waste Storages:

- All the solid waste storages will be constructed as per CPCB guideline with garland drains. Garland drains around respective solid waste facilities will be connected to the intermediate sumps. Water collected in these intermediate sumps will be pumped through pipeline network to two collection sumps of 8,000 m^3 and 15,000 m^3;

- The arsenic bearing sludge will be stored in SLF designed, operated and maintained as per CPCB guidelines for storage of hazardous waste;

- Periodical analysis of the solid waste will be carried out and records will be maintained;

- Ground water level monitoring system and ground water quality will be established by installing 24 piezometric borewells within the plant premises;

- The piezometric borewell will be located in the upstream and downstream of secured landfill, slag storage and phosphor-gypsum storage areas;

- Storm water from storage areas, landfill and other pollution prone areas will be separated and diverted to ETP for treatment and reused for plantation and other non-potable uses;

- Soil quality will be periodically monitored near the solid waste storages areas and also at secured landfills; and

- Comprehensive Waste Management Plan will be in place and available for inspection on-site.

c) <u>OPERATIONAL PHASE OUTSIDE THE PLANT:</u>

1) Management Measures for Air Quality:

- Mass plantation will be done using native forest plant species within 10 km radius area and community lands of panchayat offices and schools in the nearby villages; and
- Ambient air quality monitoring.

2) Management Measures for Water Quality:

- Installation of Piezo-metric well within nearby villages for ground water levels monitoring based on hydrogeology study.
- Surface and ground water quality monitoring

3) Management Measures for Wildlife Conservation:

- Since project deals with heavy metals, acids and hazardous materials, it is recommended that strict control on fugitive emission, dust pollution shall be

carried out using state of the art methods and technologies. Maximum area under intensive use shall be made of hard floor. Professional dust suction system from the area under intensive use shall be placed.

- Ambient noise pollution and vibrations during construction and operation phases of copper refinery plant shall be within limits of the standards mentioned.
- Plantation of thick green belt on periphery of the project site shall be created using native and hardy tree species.
- Ensure no movement of vehicles or people through Forest Areas located immediate north (Siracha) and east (Navinal) of proposed copper refinery plant area.
- Ensure zero discharge of waste water from the project site into surrounding area.
- Ensure safe passage of runoff through drainages located within and nearby the project area. It is recommended that a seasonal drainage/river (Dhaneshwari River) should be trained in such a way so that it does not carry pollutants from the project site into mangrove ecosystem located immediate south of the project boundary. Ensure no dust, fly ash, sediments, or any raw materials spill out from project areas and flow into nearby drainage, forest areas during the operation phase of the project.
- AEL shall ensure that their construction workers and other staff during construction or operational phase shall not be involved in poaching and hunting of birds, reptiles or mammals around the project site.
- Implement state of the art technologies to control pollution caused form the proposed project.
- No trespassing or vehicle or people shall be allowed through, surrounding forest area or the mangrove eco-system. This shall be instructed to the workers and staff in advance.
- No workers camps shall be established within the surrounding forest area. This shall be instructed to the workers and staff in advance.
- No resources (i.e. fuel wood, stones, sand, soil etc.) from the surrounding forest area shall be collected by staff or workers. This shall be instructed to the workers and staff in advance.
- No workers or staff members shall be involved in poaching or killing of any wild animals throughout the project life cycle. This shall be instructed to the workers and staff in advance and sign boards to this effect within project area.
- Install state of the art technologies so that pollution from the project area remains within applicable standards.
- Thick green belts shall be created using native species of plants in the periphery of project site.
- Monitoring of biodiversity including these species and take corrective measures if needed.
- Carryout biophysical monitoring of intertidal zone located south of project area at every 6 months.

- Monitoring of biodiversity including these species and take corrective measures if needed. noise is controlled within the applicable standards at the boundary of the project.
- Adjust lightings in the core area so minimum illumination spread outside core area.

- Cary out tree plantations in surrounding villages to augment habitat for Indian Peafowl and other schedule-I birds species.

- Monitor biodiversity including bird species and take corrective measures accordingly.

- Carryout habitat improvement activities through forest department in surrounding reserve forest areas, which would ensure their long term survival in the region.

- Maintain machinery so minimum vibrations and noise is generated.

4) Management Measures for Mangrove Conservation & Mudflats Conservation:

Most of the mangroves are located on high-tidal mudflats and on the banks of creeks. Major creeks present in 10 km buffer zone study area are Kotdi-I, Kotdi-II, Baradimata-I and Baradimata-II. It is observed that mangrove growth and mudflats are an integrated eco-system in the study area.

- No ground water usage will be ensured.

- The plant will be operated strictly on the ZLD system.

- It is recommended that a tall wall around the project boundary be constructed so that dusting is controlled during construction and operation phases.

- Thick green belt around the project boundary shall be created so that particulate matters are arrested.

- State of the art technology for arresting dust pollution shall be implemented for controlling different types of pollutions from various sources in the plant areas.

- State of the art water pollution control measures shall be in place including treating industrial effluents with heavy metals.

- Train Dhaneshwari river/drainage in such a way so that it does not carry spilled out pollutants from the project area to the mangrove eco-system of Kotdi creek.

- Do not release untreated sewage or effluents in to the creek areas having mangroves.

- It is recommended that Dhaneshwari River should be trained in such a way so that it does not carry pollutants with runoff from the project area.

- Ensure that strict pollution control measures are implemented in the project.

- Check health of mangrove eco-system at regular intervals.

- Prepare a comprehensive mangrove conservation plan for Kotdi and Baradimata creek system's mangroves located in the study area.

EAC OBSERVATION NO.-8

- Take up mangrove restoration and afforestation activities in consultation with Kutch East forest division.

- Project is required to be Zero Liquid Discharge (ZLD) plant.

- Project proponent shall ensure zero pollution discharge into surrounding areas particularly the intertidal areas which may include mudflats.

- Take up mudflat conservation activities in consultation with Kutch East forest division.

5) Environmental Budget at Plant:

The total project cost for the proposed project is about Rs. 10,000 Crores, which may further escalate depending upon the project execution period. Out of this, about Rs. 1044 Crores will be spent on environmental protection. The break-up of the investment is given in **Table-1.**

TABLE-1
COST PROVISION FOR ENVIRONMENTAL MEASURES

Sr. No.	Pollution control and Management Measures	Capital Cost within 5 years project development (Rs. in Crores)	Recurring Cost during Operational Phase (Rs. in Crores)
A	**Within the Project Site**		
1	Air & water pollution control measures within the project site	999.00	50.00
2	Environmental management system within the Project site including solid waste management system & monitoring	38.00	2.00
3	Post project monitoring for ground water quality within the plant for storage areas including SLF and 10 km radius study area	-	0.25
4	Greenbelt & green cover development	7.00	0.50
Sub-Total (A)		**1044.00**	**52.75**
B	**Outside the Project Site & within Study Area**		
1	Community Environment development as part of CER implementation by project proponent	2.39	The CSR cost and reporting in operational phase under CSR Rules under 2013
2	Wildlife management, Mangrove & mudflat conservation plan implementation by Forest Department	3.72	This budget of Rs. 3.72 Cr for Wildlife management plan shall cover implementation of proposed activities for 10 years
Sub-Total (B)		**6.11**	
GRAND TOTAL (A+B)		**1050.11**	

adani

Ref: AEL/Copper/Forest Department/2020/Jan -1 Date: 21/1/2020

To
Deputy Conservator of Forest,
Kutch East Forest Department,
Behind Jilla Udyog Kendra, Opp. General Hospital,
Kutch (East) Division, Bhuj-370001

Subject: Submission of Wildlife and Mangrove conservation plan for Greenfield Copper Refinery Plant (1.0 MTPA) Project of M/s Adani Enterprise Limited (AEL) located at APSEZ land, Taluka-Mundra, District-Kutch, Gujarat for approval.

Ref:

1. Letter number: - WPS/32/B/3029/2019-20 dated 5/8/2019 of PCCF to CCF (Attached)
2. Letter number:- K/JMN/T.9/502/2018-19 dated 19/10/2019 of DCF to AEL (Attached)

Dear Sir,

This is with reference to the above Letters. Kindly find our reply to your queries as below.

Point-1 of the letter (WPS/32/B/3029/2019-20 dated 5/8/2019): - Compliance of TOR Condition no 5 Dated 21st June 2016.

a) TOR has been issued by MOEF&CC vide letter reference number F.No.J-11011/113/2016-IA.II(I) dated 21st June 2016 (Annexure-1).
b) Compliance of Point no. 5 of ToR is mentioned in Wildlife Management and Mangrove Conservation Plan on Page no 1.
c) Stage-1 Forest clearance is obtained by APSEZ vide letter no. F.No. 8-04/2016-FC dated 16th November 2018. As per MoU between project Proponent and APSEZ, the required land for the proposed project would be provided by the APSEZ after seeking all the clearances. No construction would be carried out by Project Proponent before completion of Forest Diversion Process by APSEZ.

Point-2 of the letter (WPS/32/B/3029/2019-20 dated 5/8/2019):-

a) As per the information from Kutch East Forest Department there are total 71 number of Chinkara present in study area with other schedule-I species as mentioned in Conservation Plan. (Refer page no.:- 53)
b) As per the information from Kutch East forest department there are zero depredation and crime registered for the any Schedule-I species for last two years as mentioned in Conservation Plan page no 53

22/1/2020

Adani Enterprises Limited
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adani

Point-3 of the letter (WPS/32/B/3029/2019-20 dated 5/8/2019): - Authentication of the map enclosed with the application – From DCF /KEWD

The map showing distances of Sanctuaries, National Park, Biosphere Reserves and Migratory Corridors of Wild Animals from the copper refinery plant is available as Annexure-III of Conservation Plan. **Your authentication on this same map is requested as per the letter from CCF.**

Point-4 of the letter (WPS/32/B/3029/2019-20 dated 5/8/2019): - All the conditions as recommended by the chief wildlife warden shall be complied with the user agency.

Company undertakes to comply with all the conditions that will be imposed by Chief Wildlife Warden in approval of conservation plan.

Point-5 of the letter (WPS/32/B/3029/2019-20 dated 5/8/2019):-

a) As per guidelines issued by the Principle Chief Conservator of Forests and Wildlife, Dated: 13th August 2018, user agency is required to allocate up to 5% of the total cost of conservation plan as third party monitoring cost.
b) In Wildlife Management and Mangrove Conservation Plan for proposed Copper Refinery Project, total budget for conservation is Rs 323.5 Lakh which includes Rs 16.2 Lakh (5% of total budget) for third party monitoring and Rs 32.4 Lakh (10% of total budget) for Contingency to satisfy the requirement of guidance of Principle Chief Conservator of Forests and Wildlife dated 13th August 2018.

Point-6 of the letter (WPS/32/B/3029/2019-20 dated 5/8/2019):- Annual planning with site selection for 10 years shall be provided- DCF.

The year wise break up cost for implementation of various activities by forest department is attached in Wildlife Management and Mangrove Conservation plan Report on page no.:-83.

Details on above is incorporated in the Wildlife Management and Mangrove Conservation Plan.

We are resubmitting the conservation plan including map showing distance of protected areas from project site for approval by your good self and by Chief Wildlife Warden of the state.

Thanking You,
For, Adani Enterprise Limited

Authorised Signatory

Enclosures: As above Referred

CC: Chief Conservator of Forest, Kutch Forest Department, Gujarat
CC: Principle Chief Conservator of Forest and Chief Wildlife Warden, Forest Department, Gujarat

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ક્રમાંક:વપસ/૩૨/બ/૩૦૪૯ /૨૦૧૯-૨૦
અગ્ર મુખ્ય વન સંરક્ષકશ્રીની કચેરી,
અરણ્ય ભવન, બ્લોક બી/૧
સેકટર નં. ૧૦/એ, ચ-૩ સર્કલ
ફેકસ નંબર : ૦૭૯-૨૩૨૫૪૭૮૮
ગુજરાત રાજય, ગાંધીનગર
તા. ૬/૦૮/૨૦૧૯

વિષય: Submittion of Wildlife and Mangrove Conservation Plan for approval please.

સંદર્ભ: આપના પત્રાંક: અ/જમન/ટે.૧૨/૮૧૬, તા. ૦૮/૦૭/૨૦૧૯

મુખ્ય વન સંરક્ષકશ્રી કચ્છ વન વર્તુળને જણાવવાનુ કે, સંદર્ભ પત્રથી સાદર કરેલ અહેવાલ અનુસંધાને નીચે પ્રમાણેની વિગતો દિન-૦૭માં પુરી પાડવા વિનંતી છે, જેથી પ્રસ્તુત બાબતે ઘટતુ કરી શકાય.

(૧) વાઈલ્ડ લાઈફ કન્ઝરવેશન પ્લાન સાથે સામેલ થઈ આવેલ ભારત સરકારના પત્ર તા. ૨૧/૦૬/૨૦૧૬ના મુદ્દા ૫ ના તમામ પેટા મુદ્દાઓ ઉપર કરેલ/ થયેલ કાર્યવાહીની વિગતો આપવી.

(૨) વાઈલ્ડ લાઈફ કન્ઝરવેશન પ્લાન કયા મોડ્યુલના અને કયા-કયા વન્યજીવ માટે બનાવવામાં આવેલ તથા આ વન્યજીવની છેલ્લી બે વસ્તી ગણતરી પ્રમાણે નોંધાયેલ સંખ્યા તથા છેલ્લા બે વર્ષમાં નોંધાયેલ ગુનાની વિગતો આપવી. દરેક વન્યજીવ માટેના કન્ઝરવેશન પ્લાનની વિગતોનો સમાવેશ થયેલ નથી. વિગતો સાથે રજુ કરવુ.

(૩) દરખાસ્ત સાથે સામેલ નકશાને અધિકૃત કરવો.

(૪) ભારત સરકારના પત્ર તા. ૧૬/૧૧/૨૦૧૮ના મુદ્દા ૨(VIII) પ્રમાણેની નક્કી કરવાની થતી શરતોની વિગતો તથા અમલીકરણ સંબંધે વિગતો જણાવવી.

મુખ્ય વન સંરક્ષકશ્રીની કચેરી

(૫) સૂચવેલ કામગીરીમાં ડોક્યુમેન્ટેશન અને વાર્ષિક કોમ્પલાયન્સ માટે સૂચવેલ ૧૦ લાખ તથા મોનીટરીંગ માટે સૂચવેલ રકમ રૂ.૪૫ લાખની પુનઃ સમીક્ષા કરી સુધારેલ વિગતો રજુ કરવી.

(૬) સૂચવેલ ૧૦ વર્ષ કામગીરીનુ વર્ષવાર વિભાજન આપી તથા વાવેતરની કામગીરી માટેના સ્થળો નક્કી કરી દર્શાવવા.

(શ્યામલ ટીકાદર) 6/18
અગ્ર મુખ્ય વન સંરક્ષક
વન્યજીવ
ગુજરાત રાજ્ય, ગાંધીનગર

seen
PCCF (WL)

O/C
6/18

પ્રતિ,
મુખ્ય વન સંરક્ષકશ્રી,
કચ્છ વન વર્તુળ
કચ્છ

ANNEXURE-8

નાયબ વન સંરક્ષકશ્રીની કચેરી

કચ્છ પૂર્વ વન વિભાગ, ફોરેસ્ટ કોમ્પલેક્ષ,
જીલ્લા ઉદ્યોગ કેન્દ્રની પાછળ,
ભુજ-કચ્છ. ૩૭૦૦૦૧.
Email: d.eastbhuj@yahoo.co.in ફોન નં: ૦૨૮૩૨-૨૫૦૨૨૭ ફેક્ષ નં: ૦૨૮૩૨-૨૨૯૬૩૦

ક્રમાંકઃ– ક/જમન/ટે.લ/ ૫૦૨ /૨૦૧૮–૧૯ તા.૧૯/૦૫/૨૦૧૯

૧૦

પ્રતિ,
અદાણી એન્ટરપ્રાઈઝ લી.,
અદાણી હાઉસ,શાંતિગ્રામ,
એ.જી.હાઈવે,અમદાવાદ.

વિષયઃ–Submission of Wildlife and Mangrove Conservation plan approval Please.

સંદર્ભઃ– (૧)આપના તા.૨૫/૦૩/૨૦૧૯ પત્ર.
(૨) અત્રેના પત્રાંકઃ–અ/જમન/ટે.લ/૧૬૬૩,તા.૨૯/૦૩/૨૦૧૮.
(૩) મુખ્ય વન સંરક્ષકશ્રી,કચ્છ વન વર્તુળ,ભુજ–કચ્છના પત્રાંકઃ– અ/જમન/ટે.૧૨/૫૦૧,તા.૧૧/૦૪/૨૦૧૯.
(૪) અત્રેના પત્રાંકઃ–ક/જમન/ટે.લ/૯૧,તા.૦૪/૦૫/૨૦૧૯.
(૫) અગ્ર મુખ્ય વન સંરક્ષકશ્રી,વન્યજીવ,ગુ.રા.ગાંધીનગરના પત્રાંકઃ– વપસ/૩૨/બ/૩૦૨૯/૨૦૧૯–૨૦,તા.૦૬/૦૮/૨૦૧૯.

ઉપરોકત વિષયે જણાવવાનું કે,અદાણી પોર્ટ સ્પેસ્યલ ઈકોનોમીક ઝોન,તા.મુંદરા જી.કચ્છમાં APSEZની વન સંરક્ષણ ધારા–૧૯૮૦ની ૧૫૭૬.૮૧ હેક.ની દરખાસ્તને MoEF નાપત્ર.8-04/2016-FC,Dt.16/11/2018 થી ફોરેસ્ટ કલીયરન્સ આપવામાં આવેલ સ્ટેજ–૧ છે.સદરહું પત્રની શરત નં.5(V) મુજબ સદરહું વિસ્તારનો શિડયુલ–૧ના ફોન્નાનો સ્ટડી રીપોર્ટ કરાવી,"વાઈલ્ડ એન્ડ મેન્ગ્રુવ કન્ઝર્વેશન પ્લાન" તૈયાર કરી,ચીફ વાઈલ્ડ લાઈફ વોર્ડન,સ્ટેટ ગુજરાત રાજયને રજુ કરવા જણાંવેલ છે.

મોજે શીરાચા તથા નવીનાળ વિસ્તારમાં ગ્રીનફીલ્ડ ક્રોપર રીફાઈનરી પ્રોજેકટ ૧.૦ MTPA કેપેસીટીના પ્લાન સ્થાપના માટે પર્યારણીય મંજરી લેવા યુઝર એજન્સી દ્વારા NABET નામની સંસ્થા પાસે બેઝીક પ્રાથમિક માહિતી તથા સ્થળ પરના ફ્રેશ ફીલ્ડસર્વે તથા મેન્ગ્રુવનો સર્વે કરી,વાઈલ્ડ લાઈફ તથા મેન્ગ્રુવ કન્ઝરવેશન પ્લાન તૈયાર કરાવી રજુ કરવામાં આવેલ છે તેને અત્રેના સંદર્ભ(૨)વાળાથી સાદર કરવામાં આવેલ હતો પરંતુ સંદર્ભ(૫)થી અધુરાસથી પરત કરવામાં આવેલ,જેની નકલ આ સાથે સામેલ છે.પ્રસ્તુત બાબતે મુદાસર પુર્તતા કરી,ફેર ચાર(૪) નકલ મોકલી આપવા વિનંતી.

બિડાણ :– ઉપર મુજબ

(પી.એ.વિહોલ)
નાયબ વન સંરક્ષક
કચ્છ પૂર્વ વન વિભાગ,ભુજ

Wildlife Conservation Plan & Mangrove Conservation Plan for Proposed Greenfield Copper Refinery Project (1.0 MTPA) at Adani Port Special Economic Zone in Siracha and Navinal Villages of Taluka Mundra, District Kutch, Gujarat

adani

SUBMITTED BY

M/S. ADANI ENTERPRISE LIMITED

MARCH-2019/JANUARY-2020

Wildlife Conservation Plan & Mangrove Conservation Plan for Proposed Greenfield Copper Refinery Project (1.0 MTPA) at Adani Port Special Economic Zone in Siracha and Navinal Villages of Taluka Mundra, District Kutch, Gujarat

Submitted by

M/s. Adani Enterprise Limited

Study by
Dr. Bharat Jethva
NABET Accredited FAE
Cat-I, Ecology & Biodiversity
Bhagwati Enviro Care Pvt. Ltd.
March-2019

CERTIFICATE

This report "Wildlife Conservation Plan and Mangrove Conservation Plan for Proposed Greenfield Copper Refinery Project (1.0 MTPA) at Adani Port Special Economic Zone in Siracha and Navinal Villages of Taluka Mundra, District Kutch, Gujarat" has been prepared by us based on extensive field visits and data collected, review of published literature, information and maps furnished by M/s Adani Enterprise Limited, and data available in public domain. The study was restricted to project area and its 10 km periphery from the project area.

Dr. Bharat Jethva
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Ahmedabad

Study Completion Date: 10th March 2019
Ahmedabad

Study Revision Date: 5th January, 2020
Ahmedabad

ANNEXURE-8

CONTENT

List of Maps, Plates and Tables

Figures

Plate

1. `INTRODUCTION

1.1. Background

M/s. Adani Enterprises Limited (AEL) intends to set up a Greenfield copper refinery project of 1.0 MTPA (10 LTPA) capacity in 256.58 ha (634 acres) of area, which includes facilities like copper smelter, sulphuric acid plant, copper refinery, continuous cast copper wire rod plant, precious metal recovery plant, phosphoric acid plant, aluminium fluoride plant, effluent treatment plant, utilities storage of water and fuel, etc. with the state of the art environment friendly technology, which will be located at Adani Port Special Economic Zone (APSEZ) land in villages Siracha and Navinal, Taluka Mundra, district Kutch, Gujarat.

As per Environmental Impact Assessment (EIA) Notification dated14th September 2006, proposed project falls under category-'A' of project activity 3(a) and requires prior Environmental Clearance (EC) to be obtained from Ministry of Environment, Forest & Climate Change (MoEF&CC) before the commencement of ground activity. The application No: IA/GJ/IND/53004/2016 for prior EC (Form-1 and Pre Feasibility Report) for the proposed project has been submitted to MoEF&CC on 21st April 2016 and same was reviewed by the Expert Appraisal Committee (Industry-I) the meeting held on 4th May 2016 in New Delhi to prescribe Terms of Reference (TORs) for the preparation of EIA/EMP report. TOR has been issued by MoEF&CC vide letter reference F.No.J-11011/113/2016-IA.II(I) dated 21st June 2016 (Annexure-I). EIA for the project has been conducted by the NABET accredited consultant and submitted to MoEF&CC for Environmental Clearance in 2018.

As a part of approved ToR No. 5(v) 'Wildlife Conservation Plan duly authenticated by the Chief Wildlife Warden of the State Government for conservation of Schedule I fauna, if any exists in the study area is to be prepared'. Present study is carried out towards preparation of above mentioned plan based on primary data and field surveys. Besides, as on voluntary basis, the Mangrove Conservation Plan has also been

incorporated in this report. Therefore, the present study is carried out to fulfil requirement of the Term of Reference (ToR).The present study is a detailed account of flora, fauna, mangrove and wildlife habitats present in 10 km radius of the proposed project area based on literature survey and primary data collection. Additionally 10-15 km radius area was also studied to check if there is any environmental sensitivity present based on the secondary information and published literature. Compliance of point no.:- 5 of ToR is mentioned below(Table-1.1).

Table-1.1: Compliance of point no.:- 5 of ToR.

No	Condition	Compliance/Response
i	Permission and approval for the use of forest land (forestry clearance), if any and recommendations of the state forest department	• Stage-1 clearance is obtained by APSEZ FCA vide letter no.:-F.No. 8-04/2016-FC dated 16th November 2018. • The required land for the proposed project would be provided by the APSEZ after seeking all clearances including Stage-2 clearance for forest land. • No construction would be carried out by Project Proponent before completion of Forest Diversion Process.
ii	Land use map based on high resolution satellite imagery (GPS) of the proposed site delineating the forest land (in case of project involving forest land more than 40 ha.)	• Land use map is available in the Wildlife Management and Mangrove Conservation Plan (Map-no 4.2 on page no -20) submitted by Project Proponent.
iii	Status of application for obtaining Stage-I Forestry clearance with latest status shall be submitted.	• Stage-1 clearance is obtained by APSEZ vide letter no.:- F.No. 8-04/2016-FC dated 16th November 2018.
iv	The project to be located within 10 km of the National Parks, Sanctuaries, Biosphere Reserves, Migratory Corridors of Wild Animals the project proponent shall submit the map duly authenticated by Chief Wildlife Warden showing these features vis-a-vis the project location and the	• A map showing distances of Sanctuaries, National Park, Biosphere Reserves and Migratory Corridors of Wild Animals in Kutch district from project site is attached herewith in Wildlife Management and Mangrove conservation Plan as Annexure-III in the report for the authentication. • The proposed project does not fall within 10 km distance of the National Parks, Sanctuaries and Biosphere Reserves. No notified Migratory Corridors of Wild

	recommendations or comments of the Chief Wildlife Warden thereon	Animals are located within 10 km. radius of the proposed project site.
v	Wildlife Conservation Plan duly authenticated by the Chief Wildlife Warden of the State Government for the conservation of Schedule-I fauna, if any exists in the study area.	• Evidence of total 8 species classified as Schedule-I under the Wildlife Protection Act 1972 are found to be present within the 10 km radius of the proposed project site.
vi	Copy of application submitted for clearance under the Wildlife Protection Act 1972, to the standing committee of the National Board for Wildlife	• Clearance under Wildlife Protection Act is not required as project area do not involve diversion of any protected area under Wildlife Protection Act 1972. Neither the project falls within any Eco-system zone notified around any protected area.

1.2. Legal Framework

M/s. Adani Enterprises Limited (AEL) intends to set up a Greenfield copper refinery project of 1.0 MTPA (10 LTPA) capacity in 256.58 ha (634 acres) of area, which includes facilities like copper smelter, sulphuric acid plant, copper refinery, continuous cast copper wire rod plant, precious metal recovery plant, phosphoric acid plant, aluminium fluoride plant, effluent treatment plant, utilities storage of water and fuel, etc. with the state of the art environment friendly technology, which will be located at Adani Port Special Economic Zone (APSEZ) land in villages Siracha and Navinal, Taluka Mundra, district Kutch, Gujarat.

The proposed project falls under category-'A' of project activity 3(a) and requires prior Environmental Clearance (EC) to be obtained from Ministry of Environment, Forest & Climate Change (MoEF&CC) before the commencement of ground activity. The application No: IA/GJ/IND/53004/2016 for prior EC (Form-1 and Pre Feasibility Report) for the proposed project has been submitted to MoEF&CC on 21st April 2016 and same was reviewed by the Expert Appraisal Committee (Industry-I) the meeting held on 4th May 2016 in New Delhi to prescribe Terms of Reference (TORs) for the preparation of EIA/EMP report. TOR has been issued by MoEF&CC vide letter reference F.No.J-11011/113/2016-IA.II(I) dated 21st

June 2016. The present study is to fulfil the requirements of studies mentioned under ToR No. 5(v) issued to AEL.

1.3. Scope of Work

Scope of work for this study is in line with the ToR No. 5(v) issued to AEL which include preparation of Wildlife Conservation Plan and Mangrove conservation plan as part of this report. The preparation of the wildlife and mangrove consecration plan required the study of habitat types and quality, species, diversity, rarity, fragmentation, ecological linkage, age, abundance, etc. in case of schedule fauna, conservation measures should be proposed, And a detailed study to assess the wildlife habitats, their migration route, etc. and measures to mitigate impacts of the proposed activities.

The present study has carried out identification of ecologically sensitive receptors (species, habitats& eco-systems) based on field investigations and literature survey along with their mitigation with conservation action plan. The study was carried out in core area (project site) and in buffer area i.e. 10.0 km periphery from the project site. The study was carried out systematically and scientifically using primary and secondary data in order to bring out factual information on the ecological conditions of the project site and its surroundings.

The study involved assessment of general habitat type, vegetation pattern, preparation of inventory flora and fauna of terrestrial ecosystem in 10 km radius from the boundary of proposed project site. Biological assessment of the site was done to identify whether there are any Rare, Endemic or Threatened (RET) species of flora or fauna in the core area as well its buffer zone and to identify whether there are any ecologically sensitive area within buffer zone that is likely to be impacted. The study also designed to suggest suitable mitigation measures if necessary for conservation of important species and their habitats etc.

1.4. Objectives of the Study

The major aim of the present study is to avoid any impact of proposed project activity on important natural habitats or species in the study area. Therefore, the study is carried out with following objectives.

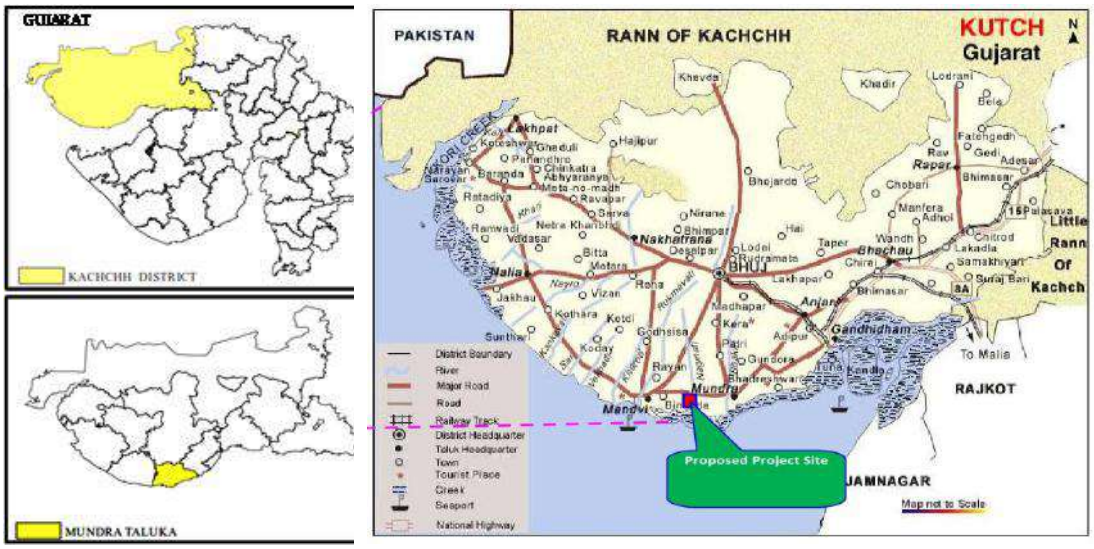
- To evaluate the ecological status of the study area with respect to important flora, fauna and ecologically sensitive habitats etc.
- Assessment of any impacts of the project activities on ecologically sensitive habitats and species.
- Recommend mitigation measures in the form of wildlife conservation plan with an in-built monitoring mechanism and schedule of implementation along with financial budget.

2. STUDY AREA

2.1. Project Location

The proposed project site is located in villages Siracha and Navinal at APSEZ Taluka Mundra, district Kutch in the state of Gujarat (Map-2.1).

Map- 2.1: Proposed project location in Siracha village of Kutch district in Gujarat.



2.2. Study Area:

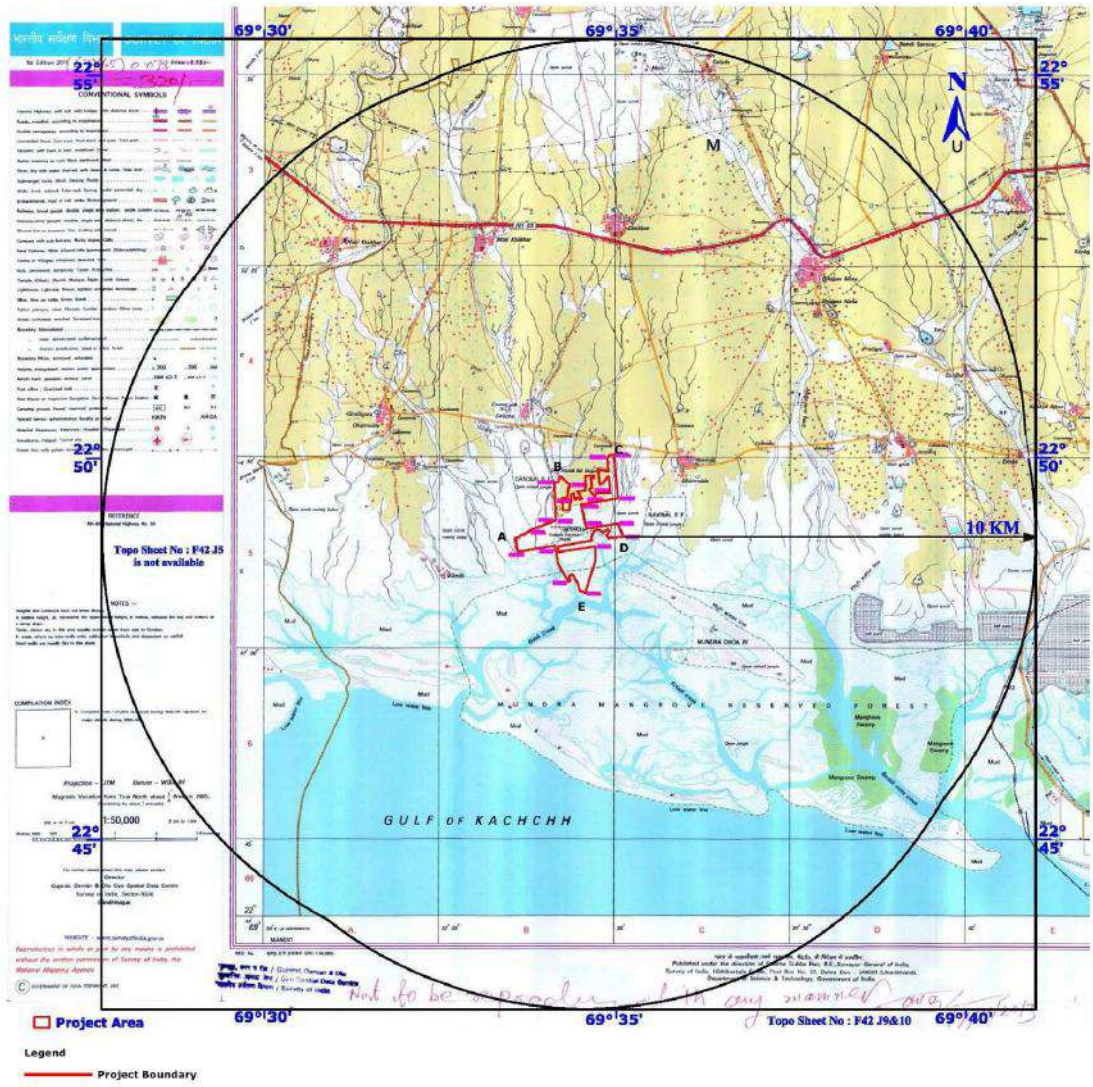
For the convenience of the study and the user agencies, the study area was divided in two major parts i.e. 1) Core area/project area and 2) Buffer area i.e. 10.0 km periphery of the project boundary (Map-2.3).

2.2.1. Core Area:

Core area is proposed project area of Greenfield Copper Refinery plant at Mundra (Map-2.2) The total area earmarked for the proposed project is 256.58 ha (634 acres), in which 154.19 ha (381 acres) of land belongs to APSEZ area and 102.39 ha (253 acres) of land belongs to forest area for promoting industrial development. The Gulf of Kutch sea coast is located at 3.9 km south from the proposed project site. The area is located 5.0 km south of National Highway NH- 8A and 0.3 km from State Highway SH-6. No

major vegetation or any human settlements present in the core area, therefore, there is no need for rehabilitation of any human settlements from the project site. Most importantly the project site does not fall in 10.0 km periphery of any National Park or Sanctuary or their eco-sensitive zones. Site is located outside the Coastal Regulatory Zone areas of Gulf of Kutch sea coast therefore, does not attract CRZ clearance.

Map-2.2: Proposed project location on Toposheet.



Corner Point	Latitude	Longitude
A	22°48'55.40"N	69°33'34.74"E
B	22°49'44.92"N	69°34'13.74"E
C	22°50'01.88"N	69°34'59.78"E
D	22°48'57.23"N	69°35'08.42"E
E	22°48'13.26"N	69°34'35.43"E

Map-2.3: Project location (core area) with 10.0 km buffer (study area) in Gujarat

2.2.2. Buffer Area

The buffer area mainly consists of revenue areas 18 villages that fall in 10.0 km periphery of the project site (Map-2.2). The list of villages is given in Table-2.1.

Table-2.1: List of villages falling in 10 km buffer area.

No	Village	No	Village	No	Village
1	Tunda	7	Mota Bhadiya	13	Khakhar Moti
2	Shiracha	8	Kandagara Mota	14	Deshalpar
3	Navinal	9	Bhujpar Nani	15	Sukhapar
4	Jarpara	10	Bhujpar Moti	16	Nani Khakhar
5	Bidada	11	Depa	17	Gelda
6	Tragadi	12	Nana Bhadiya	18	Dhrab

Majority of the land of the buffer area is occupied by the agriculture fields, forest area, industries (Saltpans, Ports, and Power plants), open scrub vegetation, mangrove, mudflats, pond/ reservoir, roads & railway network & built up areas etc. Most importantly there are no Wildlife Sanctuaries or National Parks located in the 10.0 Km periphery of the proposed project area. The proposed project land is located outside the Coastal Regulatory Zone of Gulf of Kutch coast.

3. METHODOLOGY

3.1. Basic frame work of data collection

The prediction of impacts of industries on flora and fauna depends on understanding of the proposed activities, its magnitude/extent, scale and ecological conditions in the surrounding area. Collection of comprehensive baseline information on flora and fauna is therefore a prerequisite for assessment of impacts of development activities. It would also help in advance planning and mitigate the impacts and ultimately managing the natural habitats and resources. The approach to achieve the stated objectives within defined scope of work, include field surveys, interviews, and reviews of literature. Following was the basic fame work of the data collection and analysis for the present study.

3.2. Field Surveys

Several field visits were carried out between month of February-March 2019 and September 2019 to understand and assess the impacts of proposed project activities on flora and fauna and natural habitats. We evaluated the distribution and abundance of flora and fauna and mangroves in project area and in buffer area separately.

3.3. Identification of Important Ecological Habitats

The important ecological habitats and features were identified based on our field visits and also mapping of landuse types in the study area. We identified ecologically important habitats through primary survey, literature survey and consulting local naturalists etc. These important ecological habitats and features were then identified on landuse map that is prepared for the study area. Land use map of 10 km radius of the proposed project site is prepared by Vimta Labs Limited is used for the present study. Prominent landuse features such as, roads, rivers/waterbody/drainages, agriculture, sea, sandy beach, mangrove, mudflats, industrial and built up areas, forest area, scrubland etc. were digitized using open source software such as QGIS and their areas were calculated. There may be acceptable

margin of errors in the final map however, locations and important features are identified and shown on map.

3.4. Study of Flora

In order to study the flora we laid 10X10 m^2 size 37 quadrates in buffer and 10 quadrates in core area (Map-3.1 & 3.2). Quadrates were laid separately for detailed analysis of vegetation in the core area (project site area) and buffer areas (10 km periphery). In order to study herbs and grass species, we laid a 1X1m^2 quadrate within the above mentioned quadrates. Details of Geographic Coordinates of each of the quadrates laid are given in Map-3.1 and Annexure-II. Information on geographic coordinate, occurrence of plants, their species names, numbers and floral phenotypes, life forms etc. were collected from each quadrate we laid. Direct visual enumeration of plant species was carried out to generate data on flora. The collected data was then systematically and scientifically analyzed to produce information on following biodiversity parameters of flora. The encountered vegetation of the study area was analyzed to calculate density, frequency & abundance (Curtis and Mclntosh, 1950). Total abundance, density and frequency in respect to individual species were calculated in order to understand the vegetation structure and relative importance of the sampled areas. We used Shannon Weaver Index (Shannon & Weiner, 1949) for Species diversity and Simpson dominance index (Simpson, 1949) for species dominance. Species enumeration (inventory), richness, total abundance, density, and evenness provide systematic baseline information of the vegetation community.

3.5. Study of Fauna

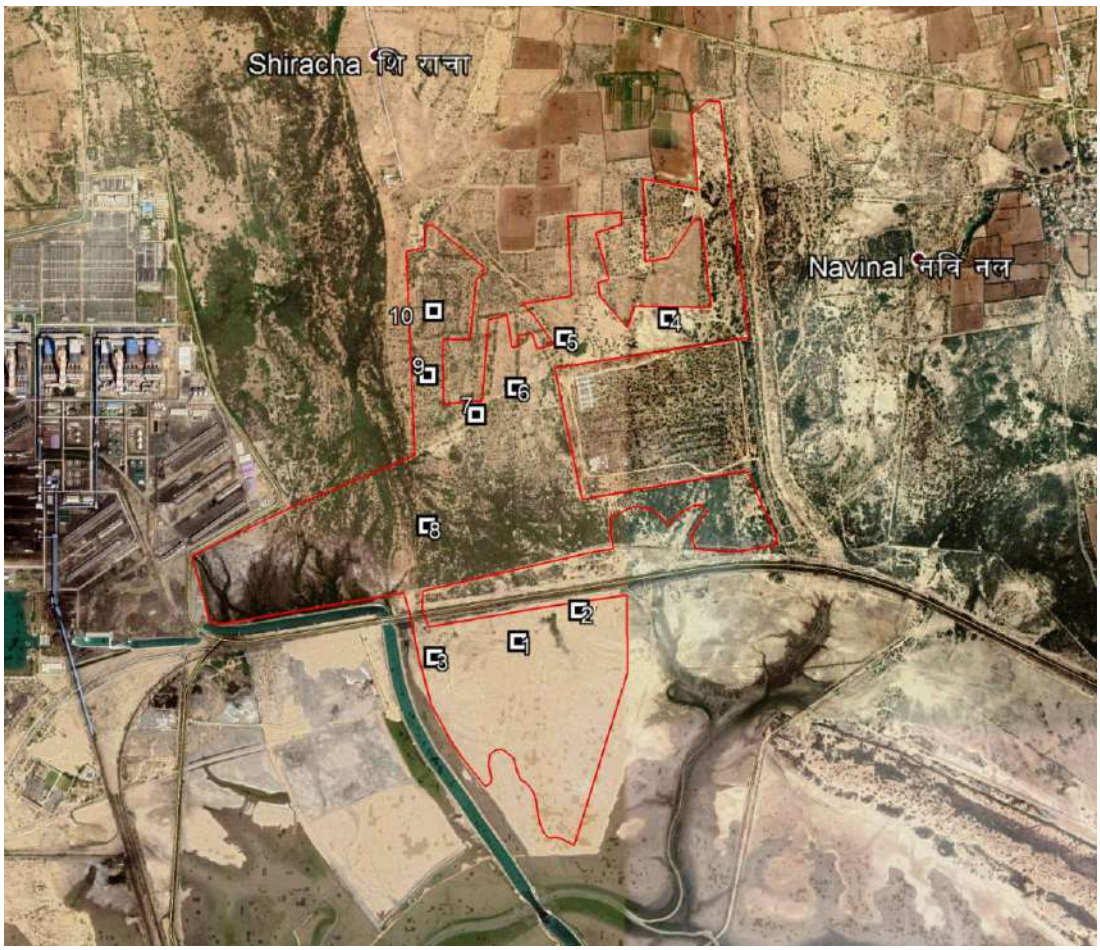
We mainly studied the fauna of higher trophic levels which acts as indicator of the type and health of the environment.

Reptiles: Majority of the reptile species are fossorial in habit therefore the assessment of reptiles and their diversity etc. holds special significance for any development projects. It is difficult to conduct quantitative study on reptiles within a short period of time. Therefore, we relied on qualitative observations only. We carried out study based on interview survey,

secondary literature as well as direct observation on road killed reptiles. We randomly looked for various reptiles and their presence i.e. lizards, snakes etc. in the study areas. Therefore, only a check list of reptiles observed during the study period was prepared.

Birds: Birds, occupying higher trophic levels in the ecosystems, respond quickly to the changes in the habitats and therefore serve as one of the best indicators for evaluating the status of the area. Therefore, we created baseline data on birds by systematically and collected data on their occurrence i.e. presence absence in the buffer and core areas in the study area.

Map-3.1: Sampling locations for flora and fauna study in the core area.



Map-3.2: Sampling locations for flora and fauna study in the buffer area.

For creating baseline data on birds we randomly walked in the study area during early morning i.e. 6:00 AM to 9AM and at evening 5:00PM to 7:00 PM. These time periods of the day are when maximum bird movements are expected. We walked randomly in the study area carried out sightings of birds ad libitum and recorded species based on their identification. Special reference books for bird species identification were used. Apart from walking randomly, we also relied on specific habitat search for different species i.e. dense bushes, wetland, ponds, big trees, agriculture areas etc. In order to accomplish the inventorization of the bird species found in the study area. All the bird species are classified based on their conservation status, their schedule under Wildlife Protection Act 1972, their migratory status, habitats and their feeding guilds. This was further used for finding out important bird

species in the study area i.e. rare, endangered or species of high conservation significance.

Mammals: Like birds, mammals are also occupying higher trophic levels in many ecosystems and respond quickly to the changes in their habitats therefore, serves as best indicators of the ecosystem health. We therefore, chose to create qualitative baseline information on presence and absence of mammals in the study area. Since the presence of mammalian species is low affecting probability of their sightings, in the study area, it was difficult to estimate their population using line transect method. More importantly, it was difficult to accommodate the sightings of nocturnal and diurnal animals in the study. Therefore, we prepared a qualitative check list of mammals based on their presences and absence using indirect evidences and signs such as footprints, dens, droppings, diggings, scrap marks, etc. in the project area.

Apart from these, search efforts were also made for various signs of important wildlife species in the study area which includes looking for wildlife signs such as dens, diggings, scrap marks, droppings etc. The sites where likelihood of animals is higher such as shady trees, waterholes, dense and undisturbed bushes etc. were surveyed intensively during the survey in the study area. This survey has helped us in identifying various species of mammals in the study area. For mammal inventory, both direct sightings and indirect evidences (like dung, scats, pellets, foot prints, nests, dens etc.) were accounted.

3.6. Important Wildlife Habitats and Protected Areas

We assessed the presence and distances of important wildlife habitats and hotspots such as protected areas, mangroves, breeding and nesting habitats, coastal habitats, important wetlands, and grassland area from core area. These important areas such as Protected areas (National Park, Wildlife Sanctuaries, Conservation Reserves etc.), Wetlands of national importance, Ramsar sites, Important Bird Areas (IBAs), classified by the Bombay Natural History Society etc.

3.7. Rare, Threatened & Endemic Wildlife Species and Their Corridors

We also assessed the presence of rare, endangered, endemic and threatened wildlife species in the project area/core area and buffer area. Special search efforts were made during the field visits to identify any such sensitive species or their corridors etc. in the project area and buffer area. Apart from field visits we relied on interview surveys of local people, consultation with local biologists and naturalists etc.

3.8. Literature Review

Considering the time limitation to undertake statistically rigorous data gathering system, study also relied on existing knowledge about the ecology and biodiversity of the region. Importantly, there are quite a few studies undertaken in the past dealing with the impacts of copper refinery plants on flora and fauna and other concerns of biodiversity conservation. Literature on copper refinery projects and associated environmental issues were downloaded and collated through internet. Various relevant literatures were surveyed during the study for collection of baseline information. Maps, reports and documents collected from the project proponent were also reviewed and used in the present study. Books on flora, fauna and wildlife were also studied in order to understand the biology of several species. Other wildlife and mangrove conservation plans submitted for the surrounding area are also referred.

3.9. Consultations

During the study, series of consultations were made with both technical and non technical stakeholders to get precise information on the project area/core area and buffer zone habitats. In order to know more about the seasonal presence of several faunal species and their movement, study team informally consulted and discussed with local naturalists and local people, from the villages, herders and farmers who inhabit close to the proposed project area.

3.10. Supplementary Information

Other than the above, for the purpose of this study, relevant information was also collected from following sources:

Research papers on flora and fauna and mangroves

Google imageries/Google Maps

Project related Maps provided by Adani Enterprise Limited

Communications with subject experts

3.11. Analysis to Evaluate the Potential Impacts

The information collected on status of flora and fauna and, their spatio-temporal distributions, hotspots, and potential impacts of proposed project development were logically analyzed and conclusions were extracted for preparation of conservation plan for the project proponent to implement.

3.12. Preparation of Wildlife Conservation Action Plan:

After identification of key impacts of the project, on flora, fauna or any key habitats of any important species or their corridors, a comprehensive wildlife conservation action plan was prepared with monitoring mechanism and financial projections.

3.13. Limitations of the Study

The study undertaken is structured around the project information as provided by the project proponent, any change in the proposed activities may result in variation of outcome. The study is based on field visits, literature survey, consultation with local people etc. Professional judgment and subjective interpretation of facts has been applied for this study. All information's and inferences presented herein are based on the specifics currently available within the limits of the scope of work, information provided by the client or its representative, existing secondary data and schedule.

4. Ecological Assessment

The observations and assessment of overall ecological scenario presented in this chapter include details of flora, fauna, natural habitats, protected areas, wildlife species and their migration corridors etc. Such baseline information provides better understanding of the situation and overall ecological importance of the area. This baseline information viewed against proposed project activities help in predicting their impacts on the wildlife and their habitats in the region. Data collected and information gathered from secondary literature on flora, fauna, protected area, natural habitats, wildlife species etc., were analyzed and results are presented as follow.

4.1. Biogeographic Zone

The region falls in Indo-Malay Realam (IM 1303) and Deserts and Xeric Shrublands Biome as defined by WWF. The North-western Thorn Scrub Forests [IM1303] ecoregion represents a large expanse of degraded dry forest surrounding the Thar Desert. Neither exceptionally species-rich nor high in endemism, the ecoregion nevertheless harbours viable populations of antelopes.

As per classification of Indian Biogeographic zones by Rodgers et al. (2000), Kutch district falls under Biogeographic Zone 3 - the Indian Desert and the Biogeographic Province Kutch Desert- 3B.

4.2. Protected Areas

As per our information and survey there is no Sanctuary, National Park, or notified wildlife corridors within the core area and buffer area (10 km) of the project site. Marine National Park is located at 33.0 km distance in south-west direction, Marine Sanctuary is located in same direction at 35.0 km distance, where as Narayan Sarovar Sanctuary is located at 103.0 km in North-West direction, Kutch Desert Wildlife Sanctuary is situated in the Great Rann of Kutch at 70.0 km North East direction. The Wild Ass Sanctuary is located in the Little Rann of Kutch at distance of 77.0 km, Kutch Bustard

Sanctuary at 92.0 km in North direction and Chari-Dhand Wetland Conservation Reserve is located at 82.0 Km north**.** Majority of the protected areas and their eco-sensitive zones are located beyond 30 km distance from the project site (Table-4.1, Map-4.1, Annexure-III).

Table-4.1: Protected area and their distances from proposed project site.

No	Protected Areas	Distance	Direction
1	Marine National Park	33 Km	South-West
2	Marine Sanctuary	35 Km	South-West
3	Narayan Sarovar Sanctuary	103 Km	North-West
4	Kutch Bustard Sanctuary	92 Km	North-West
5	Wild Ass Sanctuary	77 Km	East
6	Kutch Desert Sanctuary	70 Km	North-East
7	Chhari Dhandh Conservation Reserve	82 Km	North
8	Banni Grassland Important Bird Area	69 Km	North

4.3. Landuse Types in the Study Area

We mapped various landuse types of the study area using field surveys and various references available online. The major landuse features are agriculture, sea, open scrubland, sparse wasteland, mangroves etc (Table-4.2 & Figure-4.1, Plate-4.1).

Table-4.2: Area & percentages of various landuse types in the study area.

No	Landuse Type	Area (ha.)	% of Area
1	Built up Area	2103.27	5.08
2	Forests	837.62	2.02
3	Agriculture	15484.69	37.41
4	Wasteland	5620.36	13.58
5	Waterbody	9366.3	22.63
6	Wetlands	4469.36	10.80
7	Others	3512.17	8.48
	Total	41.393.77	100.0

Map-4.1: Project site location vs. protected areas in Kutch district.

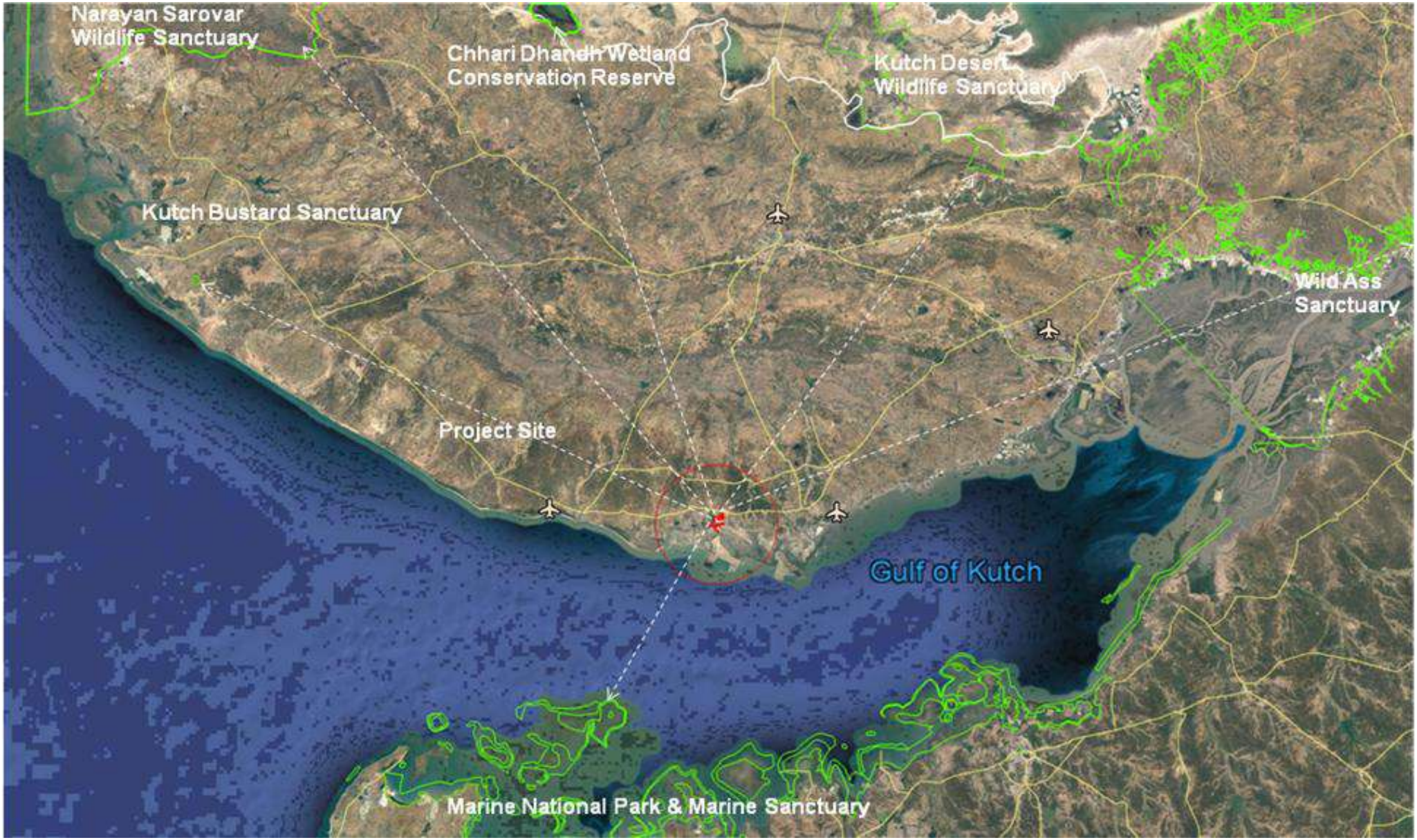
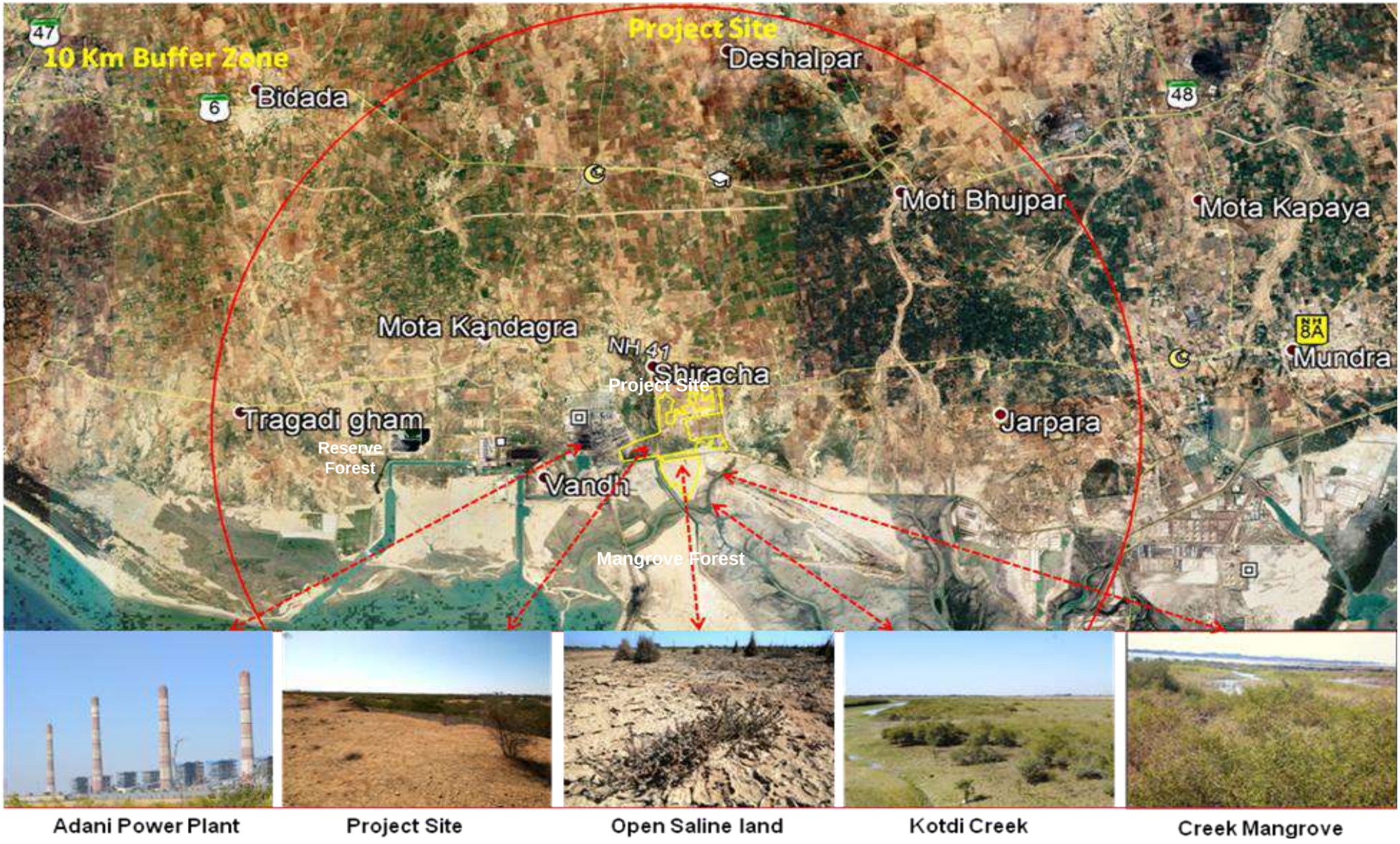


Plate-4.1: Project site location and habitat types in the 10 km buffer study area.



Map-4.2: Landuse pattern in the study area.

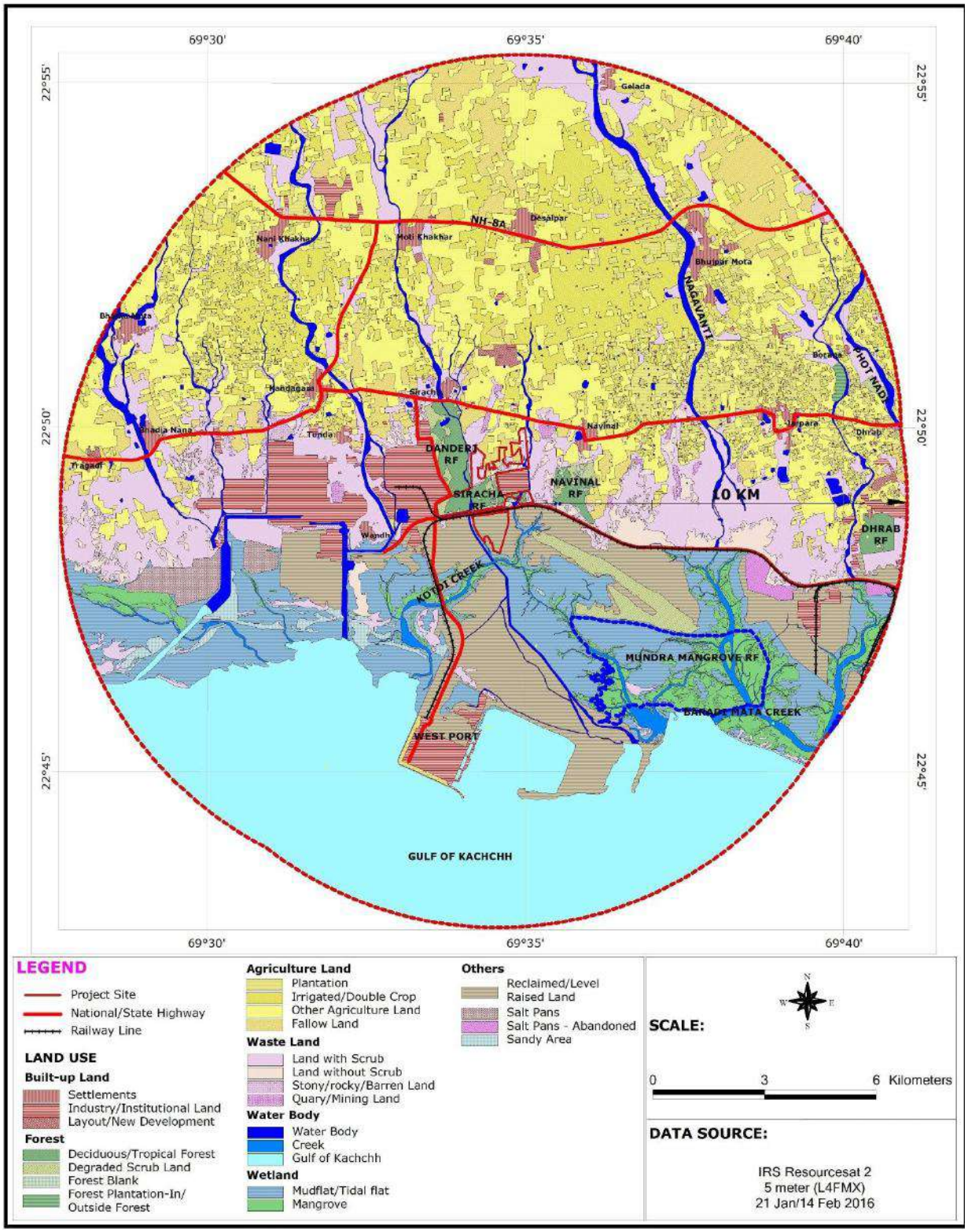
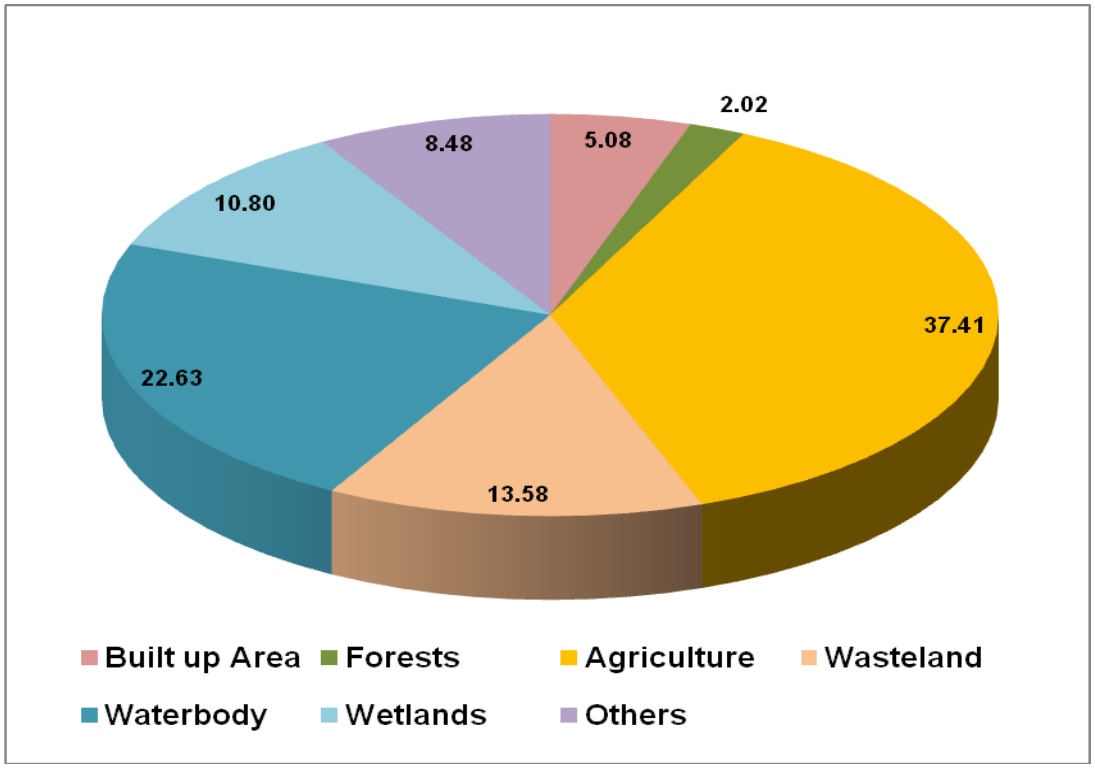


Figure-4.1: Percentage of various landuse classless in the study area.



4.4. Important Ecological Habitats

Based on our field visits and literature survey we identified two important and ecologically sensitive habitats that are located within 10km buffer zone. These habitats are listed below

i. *Forest Area*
ii. *Mangrove ecosystem*
iii. *Waterbodies*
iv. *Intertidal mudflats*
v. *Important birdwatching site*

4.4.1. Forest Area & Forest Type

As per information received from project proponent, the Land requirement for the project is 256.58 ha. (634 acres), in which 154.19 ha is APSEZ area and 102.39 ha. (253 acres) of land belongs to forest area for promoting industrial development. Therefore, core project area does include forest area. Forest Clearance for this land is under process and stage-I clearance is already received for the same. MoEF&CC (forest conservation division) has granted

Stage-I approval for diversion of 1576.81 ha. of reserved forest land in favour of Adani Ports & Special Economic Zone Limited (APSEZL) vide letter F.No.8-04/2016-FC dated 16th November 2018 (Annexure-IV). Part of the diverted forest land area (253 acres) will be utilized for the proposed copper refinery project after all approvals.

As per the forest classification of Champion and Seth (1968), forest of Kutch district classified under the "Northern Tropical Thorn Forest". The forest area in the proposed project area consists of mostly Prosopis juliflora with scattered trees of *Anogeissus pendula, Acacia leucophloea, Zizyphus mauritiana, Prosopis cineraria, Salvadora persica* and *Salvadora oliodes etc.*

Apart from forest areas involved in the core area, there are forests areas present in the buffer zone which are under the jurisdiction of Kutch West Forest Division of Gujarat Forest Department (Table-4.3). These forest areas are well marked with a boundary wall indicating its possession by the forest department. These forest areas are of two vegetation types 1) Open scrub forest and 2) Mangroves. Total 6419.25 ha. of Reserved Forests area is present in the study area (Table-4.3). Most part of the reserve forest areas (83.0%) is in the form of mangrove forest falling in the creek systems on the coast. Remaining 17.0% falls in the open thorny scrubland forests.

The inland open scrub forests are dominated with dense patches of *Prosopis juliflora* along with scattered plants of *Acacia nilotica*, *Prosopis cineraria*, *Zizyphus numularia, Salvadora persica, Salvadora oliodes, Capparis decidua, Calotropis procera, Balanites aegyptica, Butea monosperma, Acacia leucophloea, Casia auriculata etc.* The vegetation type of these forest areas are representative of desert eco-system. The details of the forest areas are given in Table-4.3.

The other kind of forest reserve are situated in costal area for example on high tidal mudflats which are harbouring inadequate patches of mangroves and coastal vegetation details of the region is given in the section on mangroves.

Table-4.3: Details of Forest area and forest types in study area.

No	Village	Survey No	Area	Type
1	Deepa	220/p	17.36	RF Section-20
2	Borana	20/p	26.62	RF Section-20
3	Dhrab	169/p	23.43	RF Section-20
4	Dhrab	169/p	81.59	RF Section-20
5	Jarpara	169/p	26.61	RF Section-20
6	Mundra Mangrove Range	2	5333.73	RF Section-20
7	Mundra Rakhal Dhuvo	2	334.34	Reserve Forest
8	Navinal	223/p	21.85	RF Section-4
9	Navinal	223/p	89.52	RF Section-20
10	Siracha	295/p	125.00	RF Section-20
11	Siracha	295/p	209.20	RF Section-20
12	Siracha	517/p	130.00	RF Section-4

4.4.2. Mangroves Ecosystem

Kutch mangroves distributed in the arid to semi-arid coastal belts are traditionally considered as the low dense mangroves which are mostly degraded. Structural attributes of Kutch mangrove are not comparable with other luxuriant mangrove formations on other coasts of India (Sawale and Thivakaran, 2013). The semi-arid coastal belt of Kutch is known for its harsh environmental conditions like hyper-salinity (36-47 ppt), wider ambient temperature fluctuations (11.2 to 48.7oC), high evopo-transpiration (R/ETP-0.03−0.20) and frequent natural disasters like cyclones and earthquakes (Sawale and Thivakaran, 2013). Added, the recent spurt in inland watershed development schemes deprive the meagre seasonal run-off to neretic waters, rendering it singly conspecific formations of *Avicennia, marina*; a hardy species capable of tolerating high physiological stresses (Sawale and Thivakaran, 2013). Though eight true mangrove species were reported earlier from the Gulf of Kutch, *A. marina* was the only species recorded on the coast of Mundra with sporadic occurrence of *Rhizophora mucronata* and *Ceriops tagal* (Sawale and Thivakaran, 2013). Majority of the mangrove areas are represented by only one species i.e. *Avicennia marina*. Few other species such as *Rhizophora mucronata* and *Ceriops tagal* are planted by forest department as part of their mangrove conservation schemes. National Centre for Sustainable Coastal Management, Chennai, carried out a status

survey ('Comprehensive and Integrated plan for preservation and conservation of mangroves and associated creeks in and around the Adani Ports and Special Economic Zone Ltd., Mundra, Gujarat') of the mangroves along the creeks and adjoining land/island as of 2016-17. The total mangrove cover of the area was estimated to be 2340 ha. There has been an increase of mangrove cover by 246 ha (~10%) compared to the mangrove area of 2011 (using aerial photo of 2011, NCSCM has estimated it to be 2094 ha). In 2016-17, out of 2340 ha, the dense mangroves were 629 ha contributing to 27% of total mangrove cover.

Most of the mangrove areas (83.0%) are located in the notified reserve Mangrove Forest areas of Navinal, Shiracha and Jarpara village coasts (Survey no-2 Mangrove Forests). The coastal area of Tunda, Navinal, Shiracha, Jarpara and Tragdi villages have patches of scattered, sparse and dense mangroves. Most of the mangroves are located on high-tidal mudflats and on the banks of creeks. Major creeks present in 10 km buffer zone study area are Kotdi-I, Kotdi-II, Baradimata-I and Baradimata-II. A sizable patch of dense mangrove is also located at 170 meters (on bank of kotdi- II creek) from Southern most boundary of the proposed project site (Map-4.1, & Map-4.2, Plate-4.1). Dense mangrove formations are common on banks of creeks from 0 to 75 meters where tidal water reaches everyday. Rest of the mangroves are in the form of sparse stunted which are grown on the tertiary branches of tidal creeks.

Kotdi and Baradimata are shallow creeks compared to Bocha, Navinal and Khari creeks. Kotdi I exhibited least depth, and significant areas of the creek are exposed during low tide. In case of Kotdi II creek, though part of mouth is exposed during low tide, considerable sections of the inner parts of the creek have water at MLWS levels. The mouth regions of both main branches of Baradimata creek were covered with water during high tide. Due to the presence of water covered areas during high tide, Kotdi I & Kotdi II and branches of Baradimata-I and Baradimata-II have conditions conducive for growth of mangroves.

4.4.3. Waterbodies

Our observation and literature review suggests that there are no major inland wetlands present within the study area i.e. 10.0 km buffer zone of the project site. Drainage pattern of the study area and project site are drained by several rivers and small tributaries, which are of dendritic pattern which remains dry in almost all the season. The Dhaneswari River (Danesri Nadi) a seasonal river (rain fed) flows in the western part of the project site. The water bodies flows through study area are Kotdi creek (0.5 km, S), Khari Nadi (1.9 km, W), Gulf of Kutch (3.9 km, S), Nagavanti Nadi (4.7 km, E) and Phot Nadi (8.7 km, ENE) from the project site. Natural drainage passing through the site will be suitably trained and maintained. These drainages have small check dams built on them which are known to accumulate overflowing runoff water for a short period. Apart from being important hydrological features in the semi-arid area, these check dams provide important habitat for many bird species and water source for wildlife in the region. One such drain is Khari River which flows from North-to South in western side of proposed project site. There is no check dam on this river in the vicinity of project site. However, all such drainages are seasonal in nature and flows only during rainy days. These drainages flows water from main land to Gulf of Kutch. Most of the stagnant water sources i.e. check-dams are located at substantial distances i.e. more than 2.5 km distance from the proposed project site. There will not be any diversion of rivers. Further, conveyer for copper concentrate and rock phosphate and acid pipeline will cross over the existing water intake channel available for power plant. Suitable culverts will be built as required.

4.4.4. Intertidal mudflats

Mudflats refer to land forms near a waterbody that is regularly flooded by tides and is usually barren (without any vegetation). Also known as tidal flats, mudflats are formed upon the deposition of mud by tides or rivers. This coastal landform usually occurs in sheltered areas of the coast like bays, coves, lagoons, estuaries, etc. Since most of the sedimented area of a

mudflat is within the intertidal zone, the mudflat experiences submersion under water and exposure twice daily. Mudflats, mangroves, and salt marshes together constitute an important ecosystem. Mudflats attract a large number of migratory shorebirds. These intertidal areas also house a number of species of crabs, fish, and mollusks which form the food base for the migratory birds. Thus, mudflats are often significant bird-watching spots.

Though, mudflats are important ecological habitats, their extent on Kutch district coast is yet to be identified officially on Coastal Zone Maps of Gujarat. Therefore, their distances and directions from the proposed project site are not yet known. For the conservation of mudflats budget of Rs. 25 lakhs has been provided which will be given to forest department by the Project Proponent.

4.4.5. Important Birdwatching Site

Majority of the waterbird species reported in the present study are found at Modhva mudflats located beyond 11.0 km south-west outside the study area. It is located adjacent to Sea water outfall of CGPL. Modhva area is a mix of sandy beach, saltpans, coastal mudflats with scattered mangroves and thorny bushes on the coast which provides a suitable mix of wetland habitat to attract large populations of migratory and resident birds. Most importantly this area provides much needed staging and stop over sites for the migratory birds flying on Central Asian Migratory bird Flyway.

The Modhva coastal area is known amongst the birdwatcher as it is one of the important and prominent birdwatching and bird photography sites of Kutch. The national and international birdwatching tour agencies bring their keen birdwatching and bird photography clients to this birdwatching site of Kutch. The site is known for shore birds such as Crab plover, Oystercatcher and waterbirds such as flamingos etc. The site is therefore one of the important eco-tourism sites of Kutch. Therefore in view of its ecological and economical value, Modhva coastal area is considered as important site for conservation. Since it lies outside the study area i.e. 10.0km, there are negligible chances of impacts on this area by the proposed project.

4.5. Floral Diversity and Vegetation Type in Core & Buffer Area

We evaluated biodiversity and abundance parameters of vegetation/plant species in the core area and in the buffer area of the project site.

4.5.1. Vegetation Type & Community in Core Area & Buffer Area:

Core area: The proposed project site falls in the arid-semi arid climatic condition. Our field survey and literature review suggest that the vegetation types and community in the project area is that of semi arid-arid regions. It is represented by sparse thorny scrub vegetation in two industrial areas i.e. thermal power plants. The major part of the project area is devoid of large trees and mainly consists of dense and sparse shrubs i.e. *Prosopis juliflora, Prosopis cineraria, Acacia nilotica, Casia auriculata* and *Zizyphus numularia, caparis deciduas etc.* the major grasses include several species of *Cyperus* and herbs *Indigofera*. Details of vegetation survey results are discussed in forth coming sections.

Buffer area: The buffer area (10.0 km periphery) comprises mainly of agriculture fields, wastelands, forest plantation patches by forest department, scattered bushes of *Prosopis juliflora, Prosopis cineraria, Acacia nilotica, Salvadora persica, Salvadora oliodes, Azadirachta indica. Prosopis juliflora* and *Zizyphus numularia* among the wild plants and cotton, coconut, dates, pomegranate, among the cultivated crops are the most dominant plants in the buffer area.

Except for highly scattered and small plants of *Commiphora wightii*, there were no rare, endangered or conservation concern species present in the close vicinity of the project area in the buffer zone. Major part of the buffer area is agriculture fields particularly on the Eastern side of the project area. Since ground water is saline up to 15 km from the coast and highly saline up to 4 km from the coast. Thus, dry land farming is practiced near the coast and irrigated farming is practiced in the farms that are 5-6 km away from the coast. Cotton, Jowar, Bajra are the main crops grown here. Some villages, especially in the central corridor are endowed with good surface water

facilities, and irrigated agriculture is possible in these villages. Being semi-arid, arid zone, this region support low plant growth and therefore, not many large trees with sizable canopies are present in the buffer zone. However, at every village local people have managed to grow trees for shade, aesthetic and religious values.

Though, we could not report presence of some of the important species plant species (probably due to lack of rain species did not occur), according to literature survey, Navinal area at Mundra has representation of native vegetation of Kutch. Some of the important threatened plant species reported from the region include *Dipcadi erythraeum, Helichrysum cutchicum, Ephedra foliata, Heliotropium rariflorum, Tribulus rajasthanensis, Pavonia ceratocarpa, Convolvulus stocksii, Commiphora wightii*. Out of this *Helichrysum cutchicum, Ephedra foliata and Tribulus rajasthanensis* are endemic species. Gujarat State Biodiversity Board earlier proposed to declare the area as biodiversity heritage site. However the proposed development of the “Biodiversity Park at Navinal village, Mundra Taluka” has been shelved by Gujarat State Biodiversity Board, though initially proposed. Hence, it is given to understand that the earlier proposed biodiversity park will not be further developed in the study area.

4.5.2. Floral Abundance, Frequency and Density

Based on our vegetation sampling data we derived various measures of abundance of plants species in the core and buffer area of the project site (Table-4.4). These parameters help understand the vegetation community structure in the project area/core area and buffer area/ surrounding area. We found total 12 species of Grass, 12 herbs, 4 shrubs and 2 tree species in the project core area. Where as we reported total 22 species of grasses, 26 species of herbs, 8 species of shrubs and 7 species of trees during our sampling efforts in the buffer areas. There could be more species of plants in the study area. However, our sampling and analysis of the vegetation data suggests that the abundance and density of plant species are lower in the core and buffer area (Table-4.4). This suggests that the area falls in Arid-

Table-4.4: Floral Diversity and their relative frequency, abundance density, important value index for core and buffer area.

No	Type/ Class	Species	Abundance		Relative Frequency		Relative Dominance		Relative Density		IVI	
			Buffer	Core	Buffer	Core	Buffer	Core	Buffer	Core	Buffer	Core
1	Grass	*Aeluropus lagopoides*	1.86	1.6	7.45	16.7	7.40	8.3	10.24	22.2	25.09	47.2
2	Grass	*Apluda mutica*	1.60	1	5.32	3.3	3.70	8.3	6.30	2.8	15.32	14.4
3	Grass	*Aristida adscensionis*	1.33		3.19		3.70		3.15		10.04	
4	Grass	*Aristida funiculata*	1.50	1.3	6.38	13.3	3.70	8.3	7.09	13.9	17.17	35.6
5	Grass	*Aristida histricula*	1.00		5.32		3.70		3.94		12.96	
6	Grass	*Cenchrus ciliaris*	1.00	1	4.26	6.7	3.70	8.3	3.15	5.6	11.11	20.6
7	Grass	*Chloris barbata*	1.20		5.32		3.70		4.73		13.75	
8	Grass	*Chloris quinquesetica*	1.00		4.26		3.70		3.15		11.11	
9	Grass	*Chrysopogon fulvus*	1.50		4.26		3.70		4.73		12.68	
10	Grass	*Cymbopogon martinii*	2.00	1.3	6.38	13.3	3.70	8.3	9.45	13.9	19.54	35.6
11	Grass	*Cynodon dactylon*	1.00		4.26		3.70		3.15		11.11	
12	Grass	*Cyperus difformis*	1.00	1	4.26	3.3	3.70	8.3	3.15	2.8	11.11	14.4
13	Grass	*Cyperus flavidus*	1.00	1	6.38	6.7	3.70	8.3	4.73	5.6	14.81	20.6
14	Grass	*Dactyloctenium aegypticum*	1.00		4.26		3.70		3.15		11.11	
15	Grass	*Dactyloctenium sindicum*	1.50		2.13		3.70		2.36		8.19	
16	Grass	*Desmostachya bipinnata*	1.00	1	1.06	10	3.70	8.3	0.79	8.3	5.55	26.7
17	Grass	*Dichanthium annulatum*	1.40	1	5.32	3.3	3.70	8.3	5.51	2.8	14.53	14.4
18	Grass	*Eragrostis cilianensis*	1.50	1	2.13	10	3.70	8.3	2.36	8.3	8.19	26.7
19	Grass	*Heteropogon contortus*	1.25	1	4.26	3.3	3.70	8.3	3.94	2.8	11.90	14.4
20	Grass	*Ischaemum indicum*	1.50		2.13		3.70		2.36		8.19	
21	Grass	*Sporolobus maderaspatenus*	1.20		5.32		3.70		4.73		13.75	
22	Grass	*Urochondra setulosa*	1.67	1.3	6.38	10	18.51	8.3	7.88	11.1	32.77	29.4
23	Herb	*Achyranthus aspera*	1.17	1	3.59	2.4	4.69	0.1	2.64	1.3	10.92	3.8
24	Herb	*Aerva javanica*	1.13	1	4.79	4.8	7.04	0.1	3.40	2.6	15.22	7.5
25	Herb	*Ageratum conezoides*	1.00		1.20		4.69		0.75		6.64	

26	Herb	*Aloe barbandensis*	1.00		0.60		4.69		0.38		5.67	
27	Herb	*Argemone mexicana*	1.00		2.40		0.05		1.51		3.95	
28	Herb	*Casia auriculata*	1.00	1	2.99	9.5	0.05	0.1	1.89	5.3	4.93	14.9
29	Herb	*Censia coromandelica*	1.33		1.80		0.05		1.51		3.35	
30	Herb	*Citrulus colocynthis*	1.00		0.60		0.05		0.38		1.02	
31	Herb	*Coculus hirsutus*	1.00		1.80		0.05		1.13		2.98	
32	Herb	*Cressa cretica*	6.00	1	1.20	4.8	8.44	0.1	4.53	2.6	14.17	7.5
33	Herb	*Crotolaria lutescens*	1.00		1.20		4.69		0.75		6.64	
34	Herb	*Fagonia indica*	1.00	1	0.60	4.8	7.04	0.1	0.38	2.6	8.01	7.5
35	Herb	*Indigofera cordifolia*	1.00	1	1.20	2.4	5.86	0.1	0.75	1.3	7.82	3.8
36	Herb	*Indoneesiella echioides*	1.00		4.79		5.02		3.02		12.83	
37	Herb	*Justicia procumbens*	1.00		2.40		0.05		1.51		3.95	
38	Herb	*Lepidagathis trimerus*	1.00		1.80		0.05		1.13		2.98	
39	Herb	*Leptochloa fusca*	1.00		1.80		0.05		1.13		2.98	
40	Herb	*Metanus emarginatus*	1.00	1	2.99	4.8	0.05	0.1	1.89	2.6	4.93	7.5
41	Herb	*peristrophe bicalyculata*	1.00	1	1.20	2.4	0.09	0.1	0.75	1.3	2.05	3.8
42	Herb	*Plantago ovata*	2.25		2.40		0.05		3.40		5.84	
43	Herb	*Salicarnia brachiata*	1.50	1	1.20	4.8	0.05	0.1	1.13	2.6	2.38	7.5
44	Herb	*Scirpus tuberosus*	2.00	1	1.80	4.8	0.05	0.1	2.26	2.6	4.11	7.5
45	Herb	*Solanum xanthocarpum*	1.00	1	2.99	4.8	0.05	0.1	1.89	2.6	4.93	7.5
46	Herb	*Suaeda meritima*	1.00	2	1.20	7.1	0.05	0.1	0.75	7.9	2.00	15.1
47	Herb	*Tephrosia purpurea*	1.00		1.20		0.05		0.75		2.00	
48	Herb	*Tribulus terrestris*	1.00		1.20		0.05		0.75		2.00	
49	Shrub	*Balanites aegyptica*	1.00		1.80		0.05		1.13		2.98	
50	Shrub	*Calotropis procera*	1.25	1	2.40	2.4	0.05	9.4	1.89	1.3	4.33	13.1
51	Shrub	*Capparis decidua*	1.00	1	1.20	4.8	0.05	9.4	0.75	2.6	2.00	16.8
52	Shrub	*Commiphora wightii,*	1.00		1.20		0.05		0.75		2.00	
53	Shrub	*Prosopis juliflora*	1.00	5.3	2.99	16.7	4.69	37.7	1.89	48.7	9.57	103
54	Shrub	*Salvadora oliodes*	3.70		13.77		13.60		32.08		59.45	

55	Shrub	*Salvadora persica*	1.67		3.59		0.09		3.77		7.46	
56	Shrub	*Zizyphus numularia*	1.00	1	2.40	7.1	11.73	4.7	1.51	3.9	15.63	15.8
57	Tree	*Acacia leucophloea*	1.00	1	2.40	4.8	11.73	18.8	1.51	2.6	15.63	26.2
58	Tree	*Acacia nilotica*	1.00	1.3	1.20	7.1	0.05	18.8	0.75	5.3	2.00	31.2
59	Tree	*Acacia senegal*	1.00		2.99		0.05		1.89		4.93	
60	Tree	*Acacia tortilis*	2.00		2.99		0.09		3.77		6.86	
61	Tree	*Avicennia marina*	1.00		1.80		0.05		1.13		2.98	
62	Tree	*Butea monosperma*	1.00		1.20		0.05		0.75		2.00	
63	Tree	*Prosopis cineraria*	1.33		7.19		4.69		6.04		17.91	

semi arid condition. As per classification of biome, biogeographic zone, biogeographic province, this area falls in Indian Desert/Kutch Desert/Northern Thorny Scrub Forest. These classifications of the study area suggest lower abundance, density and diversity of plants in the region is reflected in our floral study of the project area.

4.5.3. Dominant Plant Species

Important Value Index is a parameter for calculating the dominance and diversity indices for vegetation as it is combination of frequency, density and dominance. Based on our survey results we found that *Prosopis juliflora* & *Zizyphus numularia, Salvadora,* in shrubs and *Cymbopogon martini, Aristida, Dichanthium annulatum,* in grasses and *Casia auriculata etc. in herbs* are the most dominant species in the region (Table4-4). This is derived through, the Important Value Index (IVI) that we calculated for various plant species through quadrate sampling (Table-4.4). IVI for *Prosopis juliflora* was 58.7 in buffer and 103.0 in core area. Whereas, *Aeluropus lagopoides (9.5/47.2), Cymbopogon martinii* (*116.7/*35.6*)* were in the buffer and core areas respectively.

4.5.4. Invasive or Exotic Species

Prosopis juliflora is an evergreen tree native to South America, Central America and the Caribbean. In the United States, it is well known as mesquite. It is fast growing, nitrogen-fixing and tolerant to arid conditions and saline soils. *Prosopis julifl*ora is an exotic and invasive widespread, multi-branched shrub/tree species in the India. It has been invading grasslands, native scrubland and forests of Gujarat and India.

Our study showed that the *Prosopis juliflora* is one of the most dominant and wide spread in the core and buffer areas of the project site. Our biodiversity, abundance, density measures suggests *Prosopis juliflora* is fast growing in the area.

4.5.5. Floral Biodiversity in the Study Area

In order to understand the status of vegetation communities in terms of stability, diversity indices such as species dominance, species diversity, similarity index and abundance are derived.

Table-4.5: Biodiversity indices (Averages) for core and buffer areas.

Indices	Buffer Area		Core Area	
	Grass	Other vegetation	Grass	Other vegetation
Species Richness	22	41	12	18
Dominance_D	0.05	0.12	0.12	0.26
Simpson_1-D	0.94	0.88	0.88	0.74
Shannon_H	2.96	2.97	2.26	2.08
Evenness_e^H/S	0.88	0.47	0.80	0.44

Shannon-Wiener Diversity Index: The biodiversity values for core and buffer areas were derived from the quadrate samples laid in the field. The value of the Shannon-Wiener Index (H') usually lies between 1.5 and 3.5 for ecological data and rarely exceeds 4.0. Lower value of Shannon-Wiener Index (H') suggests degraded or arid conditions with low biodiversity values. Our results suggest the H' value to be normal for the dry arid conditions (Table-4.5). There was difference between the core and buffer area in terms of diversity indices. This was because core area mostly consists of Prosopis juliflora dominated bushes and saline land with open wasteland where as in buffer area there is variety of habitats and agriculture lands.

Species Richness (S): It is a count of the number of species found when the observers sample the community. It is represented by "S". Our data analysis for the core and buffer zone suggests that average species richness per sample is lower in core area compared to that of buffer area (Table-4.5). This is because of the difference in the land use types in core and buffer areas.

Simpson's Diversity Index (D): The Simpson index is one of the most meaningful and robust diversity measures available. In essence it captures the variance of the species abundance distribution. It is a diversity index

proposed by Simpson (1949), to describe the probability that a second individual drawn from a population should be of the same species as the first. The value of D varies between 0 and 1. Our data analysis suggests that relatively core area is less diverse than the buffer area as the D value is higher in core area than in the buffer area (Table-4.5).

Evenness: It is a measure of species diversity, which quantifies how equal the community is numerically. The less variation in communities between the species show higher evenness. The value varies between 0 and 1. Our data analysis for core and buffer zone showed higher values of this index suggesting that the communities of vegetation does not vary much within the core and outside in the buffer areas (Table 4-5).

4.5.6. Endangered/Threatened/Protected Species

Our field survey in the project area suggest that there are no endangered, endemic, rare plant species present within the project boundary i.e. core area. However, we found an important species i.e. *Commiphora wightii*, in the buffer area with low abundance and frequency of occurrence (Table-4.4). This plant has high medicinal value and is facing the threats of extinction by overexploitation for commercial purpose (GUIDE, 2009, Joshi et al. 2005) from Kutch.

4.6. Faunal Diversity and Species Inventory

The present study has made assessment of 3 major higher vertebrate classes such as Reptiles, Birds and Mammals. The assessment of fauna representing higher trophic levels in the ecosystem was carried out since their diversity acts as indicators of the health of the ecosystem in which they live. The details of the results/observations are given as following.

4.6.1. Reptiles Species Recorded During the Survey

Majority of the reptile species are fossorial in habit, therefore the assessment of reptiles and their diversity etc. holds special significance for any

development project. In the present study we identified a total of 6 species of reptiles within the core area and 12 species in the buffer area (Table-4.6).

Table-4.6: Checklist of reptiles reported form the core and buffer area.

S. No.	Name of Species		Conservation Status as per IWPA-1972 (Schedule I to VI)	Conserv-ation Status as per IUCN	Observed/ Reported	
	Common Name	Scientific Name			Core Area	Buffer Area
1	Cheakered Keelback	*Natrix piscator*	Schedule-IV	LC		1
2	Common Skink	*Mubuya carinata*	Schedule-IV	LC	1	1
3	Fan Throated Lizard	*Sitana ponticeriana*	Schedule-IV	LC	1	1
4	Flap shell Turtle	*Lissemus punctatea*	Schedule-I	LC		1
5	Garden Lizard	*Calotes versicolor*	Schedule-IV	LC	1	1
6	Indian Fringe Toed Lizard	*Acanthodactylus cantoris*	Schedule-IV	LC	1	1
7	Indian monitor lizard	*Varanus bengalensis*	Schedule-I	LC		1
8	John Sand Boa	*Eryx johni*	Schedule-IV	LC	1	1
9	Rat Snake	*Ptyas mucosus*	Schedule-IV	NT		1
10	Saw scaled Viper	*Echis carinatus*	Schedule-IV	NT		1
11	Short tailed Agama	*Agama minor*	Schedule-IV	LC	1	1
12	Spiny-tailed Lizard	*Uromastix hardwickii*	Schedule-II	LC		1
VU=Vulnerable, EN=Endangered, NT=Near Threatened, LC=Least Concerned						

Of the reported reptiles species in the buffer area, 2 species (Flap shelled turtle and Indian Monitor Lizard) belong to Schedule-I of the Wildlife Protection Act 1972. No threatened species of reptiles as classified by the IUCN are reported from core or buffer area during our survey. The Indian Flap shell turtle was reported from waterbodies in buffer area which is common throughout country is also listed as least concerned by IUCN. However, one species belong to Schedule-II (Spiny tailed Lizard) where as reset of the species belong to Schedule-IV. Majority of the reptile species (except Rat snake and Saw scaled viper) reported from the buffer area fall in 'Least Concerned' category of IUCN. No endangered, rare, threatened or endemic species of reptiles was reported from the project core area.

4.6.2. Birds Species Recorded During the Survey

During the study we observed a total of 95 bird species in the study area. Majority of the species (74) are resident specie, where as only 21 species were found to be migratory (Table-4.7). Of these 95 recorded bird species, 89 belong to 'Least Concerned' category rated by IUCN where as total 6 species are i.e. Painted Stork, Oriental White Ibis, Eurasian Curlew, Lesser Flamingo, Oriental Darter and Black tailed Godwit belong to Near Threatened Species (Table-4.7).

Majority of the birds reported from the core and buffer area belong to the Schedule-IV of Wildlife Protection Act 1972 (Table-4.7). Whereas, total 5 species (Black shoulder kite, Eurasian Spoonbill, Indian Peafowl, Marsh Harrier, Shikra) belong to Schedule-I of IWPA 1972. Whereas House crow belong to Schedule-V.

The birds were recorded mainly from non-forested, degraded areas and in the surrounding agriculture landscape interspersed with scattered trees and drainages. The bird species groups observed in the study area were represented by species of open scrubland such as Passerines, Shrikes, Francolin, etc. and waterbodies birds such as Waders/shorebirds, Waterbirds, Egrets, Herons sandpipers, plovers etc. Majority of the birds observed in the study area represent birds of wetlands, coastal mudflats, wetland and semi arid non-forested landscapes etc. Moreover, many of the bird species reported in the present study are common even in human dominated landscapes such as urban cities, lakes and ponds etc. Majority of the waterbird species reported here are found from adjoining reserve forest areas, mangrove creeks, and mudflats located south-west side in the study area. Intertidal mudflats, saltpan and the coastal creeks provide suitable mix of wetland habitat which attracts large populations of migratory and resident birds. Most importantly this area provides much needed staging and stop over sites for the migratory birds flying on Central Asian Migratory bird Flyway. The Modhva coastal area is well known amongst the birdwatcher as it is one of the most important and prominent birdwatching and bird photography sites of Kutch. However, this site is located beyond 11.0 km

Table-4.7: Inventory of birds reported from the study area with their conservation status.

S. No.	Name of Species		IWPA-1972 Status	IUCN Status	Observation		Migratory
	Common Name	Scientific Name			Core	Buffer	
1	Asian Koel	*Eudynamys scolopacea*	Schedule-IV	LC		1	R
2	Baya Weaver	*Ploceus philippinus*	Schedule-IV	LC		1	R
3	Black drongo	*Dicrurus macrocercus*	Schedule-IV	LC	1	1	R
4	Black Francolin	*Francolinus francolinus*	Schedule-IV	LC	1	1	R
5	Black headed Gull	*Larus ridibundas*	Schedule-IV	LC		1	M
6	**Black shoulder kite**	***Elanus caeruleus***	**Schedule-I**	**LC**		**1**	**R**
7	Black winged stilt	*Himantopus himantopus*	Schedule-IV	LC		1	R
8	Black-tailed Godwit	*Limosa limosa*	Schedule-IV	**NT**		1	M
9	Blue rock pigeon	*Columba livia*	Schedule-IV	LC	1	1	R
10	Brown headed Gull	*Larus brunnicephalus*	Schedule-IV	LC		1	M
11	Cattle egret	*Bulbulcus ibis*	Schedule-IV	LC	1	1	R
12	Chestnut-bellied Sandgrouse	*Pterocles exustus*	Schedule-IV	LC		1	R
13	Comb Duck	*Sarkidiornis melanotos*	Schedule-IV	LC		1	R
14	Common babbler	*Turdoides caudatus*	Schedule-IV	LC	1	1	R
15	Common Coot	*Fulica atra*	Schedule-IV	LC		1	R
16	Common Crane	*Grus grus*	Schedule-IV	LC		1	R
17	Common Crested Lark	*Galerida cristata*	Schedule-IV	LC	1	1	R
18	Common Greenshank	*Tringa nebularia*	Schedule-IV	LC		1	R
19	Common Hoopoe	*Upupa epops*	Schedule-IV	LC	1	1	R
20	Common Iora	*Aegithina tiphia*	Schedule-IV	LC		1	R
21	Common Kingfisher	*Alcedo atthis*	Schedule-IV	LC		1	R
22	Common myna	*Acridotheres tristis*	Schedule-IV	LC	1	1	R
23	Common Redshank	*Tringa totanus*	Schedule-IV	LC	1	1	R
24	Common Sandpiper	*Actitis hypoleucos*	Schedule-IV	LC	1	1	R
25	Common tailor bird	*Orthotomus sutorius*	Schedule-IV	LC		1	R
26	Common Woodshrike	*Tephrodornis pondicerianus*	Schedule-IV	LC	1	1	R
27	Coppersmith Barbet	*Megalaima haemacephala*	Schedule-IV	LC		1	R
28	Crab Plover	*Dromas ardeola*	Schedule-IV	LC		1	M
29	Desert Wheatear	*Oenanthe deserti)*	Schedule-IV	LC	1	1	M
30	Dunlin	*Calidris alpine*	Schedule-IV	LC		1	M

31	Eurasian collared dove	*Streptopelia decaocto*	Schedule-IV	LC	1	1	R
32	Eurasian Curlew	*Numenius arquata*	Schedule-IV	**NT**		1	M
33	Eurasian Oystercatcher	*Haematopus ostralegus*	Schedule-IV	LC		1	M
34	**Eurasian Spoonbill**	***Platalea leucorodia***	**Schedule-I**	**LC**		1	R
35	European Roller	*Coracias garrulus*	Schedule-IV	LC		1	M
36	Franklin's Prinia	*Prinia hodgsonii*	Schedule-IV	LC	1	1	R
37	Graceful Prinia	*Prinia gracillis*	Schedule-IV	LC		1	R
38	Great Cormorant	*Phalacrocorax carbo*	Schedule-IV	LC		1	R
39	Great White Pelican	*Pelecanus onocrotalus*	Schedule-IV	LC		1	M
40	Greater couckal	*Centropus sinensis*	Schedule-IV	LC	1	1	R
41	Greater Flamingo	*Phoenicopterus roseus*	Schedule-IV	LC		1	R
42	Greater Painted-Snipe	*Rostratula benghalensis*	Schedule-IV	LC		1	R
43	Green bee eater	*Merops orientalis*	Schedule-IV	LC	1	1	R
44	Green Sandpiper	*Tringa ochropus*	Schedule-IV	LC		1	R
45	Grey francolin	*Francolinus pondicerianus*	Schedule-IV	LC	1	1	M
46	Grey heron	*Ardea cinerea*	Schedule-IV	LC		1	M
47	House crow	*Corvus splendens*	Schedule-V	LC		1	R
48	House sparrow	*Passer domesticus*	Schedule-IV	LC		1	R
49	**Indian Peafowl**	***Pavo cristatus***	**Schedule-I**	**LC**		1	R
50	Indian pond heron	*Ardeola grayii*	Schedule-IV	LC		1	R
51	Indian robin	*Saxicoloides fulicata*	Schedule-IV	LC	1	1	R
52	Indian Roller	*Coracias benghalensis*	Schedule-IV	LC	1	1	R
53	Indian silverbill	*Lonchura malabarica*	Schedule-IV	LC	1	1	R
54	Jungle babbler	*Turdoides striatus*	Schedule-IV	LC	1	1	R
55	Jungle Crow	*Corvus macrorhynchos*	Schedule-IV	LC	1	1	R
56	Kentish Plover	*Charadrius alexandrinus*	Schedule-IV	LC		1	M
57	Large Egret	*Casmerodius albus*	Schedule-IV	LC		1	R
58	Laughing dove	*Streptopelia senegalensis*	Schedule-IV	LC	1	1	R
59	Lesser Flamingo	*Phoenicopterus minor*	Schedule-IV	NT		1	R
60	Little cormorant	*Phalacrocorax niger*	Schedule-IV	LC		1	R
61	Little egret	*Egretta garzetta*	Schedule-IV	LC		1	R
62	Little grebe	*Tachybaptus ruficollis*	Schedule-IV	LC		1	R
63	Little Ringed Plover	*Charadrius dubius*	Schedule-IV	LC		1	M

64	Long tailed shrike	*Lanius schach*	Schedule-IV	LC	1	1	R
65	**Marsh Harrier**	***Circus aeruginosus***	**Schedule-I**	**LC**		1	M
66	Marsh Sandpiper	*Tringa stagnatilis*	Schedule-IV	LC		1	M
67	Median Egret	*Mesophoyx intermedia*	Schedule-IV	LC		1	R
68	**Oriental Darter**	***Anhinga melanogaster***	**Schedule-IV**	**NT**		1	R
69	Oriental magpie robin	*Copsychus saularis*	Schedule-IV	LC	1	1	R
70	Oriental White Ibis	*Threskiornis melanocephalus*	Schedule-IV	**NT**		1	R
71	Oriental White-eye	*Zoosterops palpebrosus*	Schedule-IV	LC		1	R
72	Painted Stork	*Mycteria leucocephala*	Schedule-IV	**NT**		1	R
73	Pied Avocet	*Recurvirostra avosetta*	Schedule-IV	LC		1	M
74	Pied Kingfisher	*Ceryle rudis*	Schedule-IV	LC		1	R
75	Purple Moorhen	*Porphyrio porphyrio*	Schedule-IV	LC		1	R
76	Purple sunbird	*Nectarinia asiatica*	Schedule-IV	LC	1	1	R
77	Red vented bulbul	*Pycnonotus cafer*	Schedule-IV	LC	1	1	R
78	Red wattled lapwing	*Vanellus indicus*	Schedule-IV	LC	1	1	R
79	River Tern	*Sterna aurantia*	Schedule-IV	LC		1	R
80	Rose ringed parakeet	*Psittacula krameri*	Schedule-IV	LC	1	1	R
81	Ruff	*Philomachus pugnax*	Schedule-IV	LC		1	M
82	Rufus tailed lark	*Ammomanes phoenicurus*	Schedule-IV	LC	1	1	R
83	**Shikra**	***Accipiter badius***	**Schedule-I**	**LC**		1	R
84	Singing Bush-Lark	*Mirafra cantillans*	Schedule-IV	LC	1	1	R
85	Southern Grey Shrike	*Lanius meridionalis*	Schedule-IV	LC	1	1	R
86	Stone-Curlew	*Burhinus oedicenemus*	Schedule-IV	LC	1	1	R
87	Sykes's Crested Lark	*Galerida deva*	Schedule-IV	LC	1	1	R
88	Variable Wheatear	*Oenanthe picata*	Schedule-IV	LC	1	1	M
89	Western Reef Egret	*Egretta gularis*	Schedule-IV	LC		1	R
90	White throated kingfisher	*Halcyon smyrnensis*	Schedule-IV	LC		1	M
91	White Wagtail	*Motacilla alba*	Schedule-IV	LC	1	1	R
92	White-eared Bulbul	*Pycnonotus leucotis*	Schedule-IV	LC	1	1	R
93	Wire-tailed Swallow	*Hirundo smithii*	Schedule-IV	LC		1	R
94	Wood Sandpiper	*Tringa glareola*	Schedule-IV	LC	1	1	M
95	Yellow wattled lapwing	*Vanellus malarbaricus*	Schedule-IV	LC		1	R

NT=Near Threatened, LC=Least Concerned; R=Resident, M=Migratory

therefore, lies outside the study area. Majority of the resident species reported in the study area are known to breed in this region as well as in entire Gujarat. No rare, endangered, endemic bird species were found to breed in the core project area.

4.6.3. Mammal Species Recorded During the Survey

We observed a total of 13 mammal species in the buffer area and 6 in the core area of the project site (Table- 4.8). The common mammalian species that were directly observed in the core area include Indian Jackal, Wild Pig, Common Mongoose, Indian Hare, Indian desert gerbil and Five Striped Squirrel etc.

No Threatened or Schedule-I species reported from the core area of the project site (Table-4.8). Indian Jackal, Jungle cat, Indian Fox, Common Mongoose belong to Schedule-II of IWPA 1972. Whereas Nilgai, Wildpig belong to Schedule-III. Rest of the species belong to Schedule-IV of WPA. Majority of the common mammalian species recorded during the survey in the core and buffer area are present throughout semiarid, non-forested and non-protected landscapes especially in Kutch region.

4.6.4. Dominant Faunal Species in the Core & Buffer Area

Based on our observations, interview survey of local people, forest officials and NGOs working in nature conservation activities in Kutch region, we found that Nilgai, Wild Pig are most common and dominant mammal species present in the landscape. Whereas there were several birds species belong to Passerine were most common and dominant group of birds present in the core and buffer area of the project site. Among reptiles, Spiny tailed Lizard, common garden lizard, Indian Monitor Lizard etc. were most common species present in the buffer areas of the project site.

Table-4.8: Inventory and conservation status of mammals reported from study area.

S. No.	Name of Species		Conservation Status as per IWPA-1972	Conservation Status as per IUCN	Observation	
	Common Name	Scientific Name			Core	Buffer
1	Indian Jackal	*Canis aureus*	Schedule-II	LC	1	1
2	Jungle cat	*Felis chaus*	Schedule-II	LC		1
3	Indian Fox	*Vulpes bengalensis*	Schedule-II	LC		1
4	Nilgai	*Boselaphus tragocamelus*	Schedule-III	LC		1
5	**Chinkara**	***Gazella bennettii***	**Schedule-I**	**LC**		**1**
6	Indian Hare	*Lepus nigricollis*	Schedule-IV	LC	1	1
7	Wild Pig	*Sus scrofa*	Schedule-III	LC	**1**	1
8	Common mongoose	*Herpestes edwardsi*	Schedule-II	LC	1	1
9	Indian porcupine	*Hystrix indica*	Schedule-IV	LC		1
10	Palm squirrel	*Funambulus pennanti*	Schedule-IV	LC	1	1
11	Fruit Bat	*Cyanopterus sphynx*	Schedule-V	LC		1
12	Long-eared hedgehog	*Hemiechinus auritus*	Schedule-IV	LC	1	1
13	Indian desert gerbil	*Meriones hurrianae*	Schedule-IV	LC		1

4.6.5. Wildlife Corridors

Our observations suggested that there is no rare, endangered, conservation concern species of fauna present within the proposed project core area. The proposed project area for Copper Refinery Plant is not a part of any special habitat (breeding) for any of the Threatened or Schedule-I important fauna and does not provide any contiguity of habitats between two important habitats or any other protected areas. Moreover, the proposed project area is located in close to already industrialized zone therefore; it does not make part of any wildlife habitats. Apart from this, there are no protected areas located within 30.0 km radius of the proposed project site therefore; the proposed area does not seem to make part of any wildlife corridors.

4.6.6. Identification of Species of High Conservation Significance

Based on our extensive field visits, literature survey, and consultation with experts & local people, we found following 8 species that are of high conservation significance (Table-4.9).

Table-4.9: Species of high conservation significance (Threatened or Schedule-I) present in the study area.

S. No.	Name of Species		IWPA-Status	IUCN Status
	Scientific Name	Common Name		
Reptiles	Flap shell Turtle	*Lissemus punctatea*	Schedule-I	LC
	Indian monitor lizard	*Varanus bengalensis*	Schedule-I	LC
Bird	Black shoulder kite	*Elanus caeruleus*	Schedule-I	LC
	Eurasian Spoonbill	*Platalea leucorodia*	Schedule-I	LC
	Indian Peafowl	*Pavo cristatus*	Schedule-I	LC
	Marsh Harrier	*Circus aeruginosus*	Schedule-I	LC
	Shikra	*Accipiter badius*	Schedule-I	LC
Mammal	Chinkara	*Gazella bennettii*	Schedule-I	LC

We found total 8 faunal species belong to Schedule-I of Wildlife Protection Act 1972. These species include 2 species of reptiles, 5 species of birds and one mammal. These species are present in the buffer zone of 10 km radius i.e. study area.

5. Potential Impacts & Mitigations

Impacts of proposed Copper Refinery Plant on flora and fauna of surrounding area were identified mainly by using baseline ecological information presented in previous Chapter-4. The baseline information was collected through direct field visits and substantiated through secondary information including EIA, consultation with local people etc. We also utilized assessment provided in the EIA particularly Air modelling information. Finally, the baseline ecological information was juxtaposed with the project activities and impacts arising due to its construction and operation phases. The specific impacts were visualized in terms of issues related with the ecology of important species issues related with their habitats.

Following the above mentioned approach, impacts on various components of biodiversity were assessed. The component wise identification of potential impacts is deliberated below.

5.1. Anticipated Ecological Impacts of Proposed Project Activity

M/s. Adani Enterprises Limited (AEL) intends to set up a Greenfield copper refinery project of 1.0 MTPA (10 LTPA) capacity in 256.58 ha. of area, which includes facilities like copper smelter, sulphuric acid plant, copper refinery, continuous cast copper wire rod plant, precious metal recovery plant, phosphoric acid plant, aluminium fluoride plant, effluent treatment plant, utilities storage of water and fuel, etc. with the state of the art environment friendly technology, which will be located at Adani Port Special Economic Zone (APSEZ) land in villages Siracha and Navinal, Taluka Mundra, district Kutch, Gujarat.

The above mentioned project in absence of mitigation measures could have numerous ecological impacts during the construction and operation phases. The impacts during construction phase could be short term, temporary in nature and will be confined to the close boundary of the project site. Following are the general ecological impacts anticipated from the construction and operation phases of the copper refinery plant.

- Irreversible change in landuse/habitat worth the project area. Vegetation would be removed from the project site. Total 154.19 ha of APSEZ land and 102.39 ha. forest land would be converted to industrial use.

- Copper is a metal that occurs naturally in the environment, and also in plants and animals. Low levels of copper are essential for maintaining good health. Elevated levels of copper are toxic in aquatic environments and may adversely affect mangroves, mudflats, fish, invertebrates, plants, and amphibians.

- Chronic fugitive emissions and the material flow through water and air could potentially degrade aquatic (mangrove, mudflats, wetlands) and terrestrial eco-systems (reserve forests, vegetation). Copper refinery is likely to release toxic fumes, pollutants such as compounds of sulphur, fumes of metals like Cd, Zn etc., & impurities like Ni, Fe, As, Sb in surrounding environment and cause irreversible damage to ecology if strict environment control measures are not implemented.

- The major impact on terrestrial ecology could be due to emission of dust which will settle on surrounding area soil and vegetation and it would gradually decrease biomass productivity of the eco-systems.

- During the construction work, the excavation of the soil take place and construction wastes such as oil, grease and debris may pollute the soil and decrease its productivity of surrounding Reserve Forests in absence of proper pollution control measures.

- The impact on the terrestrial ecology could be due to the emission of pollutants such as SO_2 and Particulate Matters (PMs) due to dusting. When sulfur dioxide combines with water and air, it forms sulfuric acid, which is the main component of acid rain. Acid rain can cause deforestation and could potentially acidify waterways to the detriment of aquatic life.

- Project site runoff drains into Kotdi creek system of Gulf of Kutch through minor drainages. Chronic spillage and flow of pollutants and dust sediments from the project site through runoff could have severe impacts on flora and fauna of Kotdi creek system which include mangroves, mudflats, birds, fishes, crabs etc.

5.2. Impacts on Terrestrial Flora

Baseline status of terrestrial vegetation clearly suggests that the project sites falls in semi-arid and coastal biogeographic zone with low floral density and diversity.

Removal of vegetation: The proposed copper refinery plant construction activities may involve removal of vegetation from the project site. Out of total 256.58 ha. 33% i.e. 85.79 ha. area would be used for green belt/green cover. Whereas 170.79 ha. area would be cleared off vegetation. Therefore, standing vegetation from total 170.79 ha. area would be removed permanently. The vegetation in the proposed project site consists of mostly *Prosopis juliflora* which is an invasive species. Therefore, the unavoidable removal of vegetation during construction activity from the core area could not be considered significant. However, it is recommended that minimum vegetation shall be removed from the project site and the important plant and tree species on the periphery of the project site be left as part of green belt development. Apart from this, project proponent would be providing compensatory land to forest department which would compensate the loss of forest land.

Pollution affecting soil, water & plants growth: Suspended particulate matter produced during construction and operational phase of the copper refinery plant would be deposited in the surrounding forest areas and water bodies including river will change habitat quality of aquatic and terrestrial ecosystem. Their direct deposition on vegetation causes loss of chlorophyll content in leaves, arrest of photosynthesis process, leaf injuries resulting in restricted growth and regeneration of plants. There are patches of reserve

forest plantations and mangroves located in the buffer area of the proposed project site.

According to air modelling carried out by EIA agency, it is predicted that the pollutants would travel up to 2.2 km North-East direction. The project area is partly located in the forest area. Also there are reserve forest areas located adjacent to the proposed project site, hence chances of pollutants and dust causing degradation of the forests and vegetation in surrounding area is higher if strict pollution control measures are not implemented. Development of thick green belt would also restrict pollutants spreading outside the premises. It is also recommended that a tall compound wall shall be built on the periphery of the project area premises this would restrict spread of pollutants.

Degradation of vegetation due to acid rain: It is also well known through number of studies that SO_2 emission from copper refinery plant has been a major cause of acid precipitation, commonly known as “acid rain,” which can damage vegetation. These pollutants originate from copper plants and nearby thermal power plants would interact with reactants present in the atmosphere and result into acid deposition. Due to the interaction of these acids with other constituents of the atmosphere, protons are released causing increase in the soil acidity, lowering of soil pH mobilizes and leaches away nutrient cations and increases availability of toxic heavy metals. Such changes in the soil chemical characteristics reduce the soil fertility, which ultimately causes the negative impact on growth and productivity of forest trees and crop plants. Strict pollution control using state of the art technology measures would restrict emission of gaseous emissions.

Impacts on Reserve Forests and Important flora: Though, we did not report presence of some of the important plant species (probably due to lack of rain species did not occur), according to literature survey, Navinal area at Mundra has representation of native vegetation of Kutch. Some of the important threatened plant species reported from the region include *Dipcadi*

erythraeum, Helichrysum cutchicum, Ephedra foliata, Heliotropium rariflorum, Tribulus rajasthanensis, Pavonia ceratocarpa, Convolvulus stocksii, Commiphora wightii. Out of this *Helichrysum cutchicum, Ephedra foliata and Tribulus rajasthanensis* are endemic species. Our present survey also reported presence of a 'Critically Endangered' species listed by IUCN i.e. *Commiphora wightii* in the surrounding forests and wasteland areas. If no strict pollution control measures are taken, these species and their habitats could be affected. *Commiphora wightii* is medicinally and economically important plant which has very slow growth rate in semi-arid zones. However, their population is quite small and isolated in the buffer area. Also they are found in quite stunted stage. It is recommended that project proponent shall financially support forest department's activities to conserve these endemic and important species found in this region by way of carrying out plantation activities specifically to conserve these species in reserve forest areas of Navinal, Dhrub and Borana.

Impacts on Mangroves: The baseline information suggests that the coastal area of Tunda, Navinal, Shiracha, Jarpara and Tragdi villages have patches of scattered, sparse and dense mangroves. Most of the mangrove areas are located in the notified reserve Mangrove Forest areas of Navinal, Shiracha and Jarpara village coasts. Closest mangrove distribution is located at 170 meters South form the project areas on the bank of Kotdi creek (Map-4.2). However, a sizable patch of dense mangrove is also located on the coast of Tragdi village.

The closest mangrove distribution is located at 170 meters (on bank of Kotdi –II creek) from South of the proposed project site (Map-4.1, & Map-4.2). Therefore, the chances of damage to mangroves by fugitive emission are high which are located immediate south of the project site. Though the predominant wind direction is from south-west in the region, there are still chances of mangrove being impacted due to its close distance from the project site. It is therefore, recommended that strict pollution control measures shall be implemented so that the mangrove south of the project area are least affected.

Apart from the above mentioned impact, a drainage known as Dhaneshri Nadi flows through the western part of the project site and it drains into Kotdi Creek system. Kotdi creek system has sparse and dense mangrove growth on both sides. Therefore, if the Dhaneshri river/drainage is not trained suitably, it may carry spilled out pollutant load from the project area to the mangrove eco-system of Kotdi creek. This may increase heavy metal toxicity to mangrove and its habitats. Therefore, it is recommended that Dhaneshri River should be trained in such a way so that it does not carry runoff from the project area.

Since mangroves are important plants and constitutes important eco-system in the study area, it is recommended that project proponent shall chalk out a detailed mangrove conservation plan. Aim & Objective of mangrove conservation plan shall be to strictly avoid any damage by the project activities, preserve and add more mangrove areas. The mangrove conservation plan shall include following aspects.

- Identification potential mangrove plantation area in the study area for taking up mangrove plantations.
- Systematic monitoring of mangrove stock at every 5 years for 20 years. Monitoring shall include monitoring of species diversity, tree density, tree height, tree girth (GBH), regeneration classes, recruitment classes etc. in the study area.
- Creating awareness about mangrove and their conservation among local villagers in the study area.
- Review of the actions taken at every 5 years and extend the plan accordingly if necessary.

5.3. Impacts on Mudflats

Mudflats refer to land forms near a waterbody that is regularly flooded by tides and is usually barren (without any vegetation). Also known as tidal flats, mudflats are formed upon the deposition of mud by tides or rivers. According to CRZ notification 2019, Biologically Active Mudflats are classified as CRZ--IA areas. Such areas are ecologically most sensitive and generally no activities shall be permitted to be carried out in the CRZ-I A area, with few

exceptions. Since the CZMP maps for Kutch district are not finalized, the extent and locations of mudflats are not yet known. After finalization of CZMP maps for Kutch district coast, they would be shown on map.

Generally, mudflats and mangrove are associated or sometime even integrated eco-systems. Therefore, conservation and preservation measures for mangroves also take care of mudflats. Pre-empting the presence of mudflats in the study area after finalization of CZMPS for Kutch district and possible impacts due to this project, pollution control and conservation measures are envisaged and interventions are proposed for implementation by the project proponent within project boundary and by the forest department outside project boundary. Chronic spillage and flow of pollutants, dust sediments, untreated effluents, construction debris, oil, grease etc from the project site through runoff into Kotdi creek system to be controlled by the project proponent. Project is required to be Zero Liquid Discharge (ZLD) plant. Project proponent shall ensure zero pollution discharge into surrounding areas particularly the intertidal areas which may include mudflats.

To ensure mudflat conservation, it is proposed that outside the project boundary, Forest Department shall implement monitoring by department officials and also through the third party agency for which budget has been proposed in conservation plan. Project proponent shall support forest department’s efforts by submitting the proposed cost of conservation for protection and conservation of mangroves, mudflats on the coast of Kutch district particularly on Mundra cost in the study area.

5.4. Impacts on Fauna

Though, the impacts of proposed plant and related construction activities may be on several faunal taxa, but for the present study we focused mainly on vertebrate classes i.e. reptiles, birds and mammals for identification of impacts and future monitoring purpose. Therefore, in the present study we

identified impacts on the reptiles, birds and mammals particularly important, threatened, endemic and flagship species of the landscape.

5.4.1. Impacts on Reptiles

The baseline study has reported total 12 species of reptiles reported from the study area and 6 species from core area. No rare, endangered or Schedule-I species are reported from the core area i.e project site. However, Flap shell Turtle, and Indian Monitor Lizard are reported from the buffer area which belongs to Schedule-I of Wildlife Protection Act 1972. These species are listed as Least concerned as per IUCN Red list categories. However, a species i.e. *Uromastix hardwickii* belong to Schedule-II which is reported from buffer area. This is a resident and most vulnerable species as it is localized and sedentary unlike other reptiles such as snakes and lizards. This species is often hunted or poached for their oil and meat. Therefore, it is recommended that during construction phase no construction workers shall be involved in poaching of such species. Since no rare or high conservation significance species of reptiles is present in the core and immediate buffer area of the proposed project site, the impact on the reptiles could be low. Moreover, it shall be ensured that no vehicle passes through the reserve forest areas located.

5.4.2. Impacts on Birds

We observed total 95 species of birds in the study area. We identified total 5 species of high conservation significance which are protected as Schedule-I species under Wildlife Protection Act 1972. Most important bird habitat is identified near Modhva coast, is located beyond 11.0 km distance i.e. outside the study area. Intertidal mudflat, sandy beach, mangrove, coastal thorn forest etc. provide favourable and suitable habitats to large number of resident and migratory birds. Since this area is located beyound 10.0 km south west from the project site, the impact of project activities is expected to be negligible due to opposite wind direction most time of the year. However, project proponent shall take utmost care in controlling dust, fugitive emissions and pollutants flowing to this area thorugh water or air. Chronic

spillage and flow of pollutants such as, hazardous chemicals, dust sediments, untreated effluents, construction debris, oil, grease etc. from the project site through runoff into Kotdi creek system could potentially affect mangrove eco-system and mudflats if present in the study area, this inturn affect the birds present in the intertidal zone. Therefore, it is recommended that the pollutoin control measures shall be strictly implemented by project proponent during construction and operation phase.

It is often noticed, that construction workers engage in poaching of wild animals particularly birds which are easy to trap using various methods. It is therefore, recommended that construction workers shall be strictly instructed so that they don't engage in such acts. It is also recommended that project proponent shall monitor the status of this ecologically and economically important birdwatching habitat as part of their periodic comprehensive biodiversity monitoring programme.

5.4.3. Impacts on Mammals

We observed a total of 13 mammal species in the buffer area and 6 in the core area of the project site. No Threatened or Schedule-I species reported from the core area of the project site. Majority of the common mammalian species recorded during the survey in the core and buffer area are present throughout semiarid, non-forested and non-protected landscapes especially in Kutch region.

There are only few most common mammals species present in the core area reported during the study. These species would be displaced during construction phase and operation phase. There is only one schedule-I species, present in the buffer area. Overall habitat degradation due to change in landuse pattern, pollution (dusting, air, and noise), increase human presence, increased illumination, increased traffic etc. in and around proposed project area would displace majority of the mammal species from the project core and surrounding buffer areas. Therefore, project proponent shall control emission and dust pollution which would not affect the forest areas and vegetation in the surrounding area which provides resting and feeding habitats to mammalian species in the study area.

6. Wildlife Conservation Plan

Based on our field observations and literature survey we found several species important plant and animal species as well as Schedule-I wildlife species in the study area (Table-6.1). We reported a plant species and 12 animal species. The faunal wildlife species include 2 species of Reptiles, 9 species of birds and one species of mammal.

Table-6.1: Species of higher conservation significance present in the study area for which mitigation plan is recommended.

Sr. No.	Name of Species		IWPA-1972 Status	IUCN Status
	Common Name	Scientific Name		
Plants	Gugal	*Commiphora wightii*		CR
	Mangroves	*Avicennia marina*	Important	LC
Reptiles	Flap shell Turtle	*Lissemus punctatea*	Schedule-I	LC
	Indian monitor lizard	*Varanus bengalensis*	Schedule-I	LC
Bird	Black shoulder kite	*Elanus caeruleus*	Schedule-I	LC
	Eurasian Spoonbill	*Platalea leucorodia*	Schedule-I	LC
	Indian Peafowl	*Pavo cristatus*	Schedule-I	LC
	Marsh Harrier	*Circus aeruginosus*	Schedule-I	LC
	Shikra	*Accipiter badius*	Schedule-I	LC
Mammal	Chinkara	*Gazella bennettii*	Schedule-I	LC

As per the information from Kutch East forest department there are total 71 number of Chinkara and other Schedule-I species present in study area. As per the Information from Kutch East forest department there are zero depredation and crime registered for any Schedule-I species for last two years.

Species wise status, impacts and the mitigation measures are suggested in as follow.

6.1. CRITICALLY ENDANGERED PLANT SPECIES:

Gugal: (*Commiphora wightii*)

Status: Our field survey in the proposed project area revealed that there is a critically endangered plant species present in the buffer areas. However, this plant was found with low density in the buffer area. This plant has high medicinal values and is facing the threats of extinction by over exploitation for commercial purpose (Silori et al., 2004; Joshi, 2002; GUIDE 2009) from Kutch. However, recently Gujarat Forest Department has accomplished a large scale project on plantation of *Commiphora wightii* in Gujarat. Through this project thousands of plants were raised and planted in entire Kutch region. This project has improved the number and density of the species in the region.

Impacts: The construction of copper refinery plant and allied industrial development operations would involve large scale removal or vegetation, excavation, material handling, could result in habitat degradation due to air borne dusting from copper plant, effluent discharge, pollution load, movement of vehicle etc. can potentially affect the density and distribution of this species in the buffer area.

Recommendations: AEL shall put in place all kinds of pollution control measures so that the surrounding vegetation is not degraded and this species along other plants survive normally in the study area. AEL shall carryout comprehensive biodiversity monitoring at regular intervals in order to check impact of their project activities on surrounding area and special emphasis shall be given to this species. It is also recommended that company should take up plantation of *Commiphora wightii* by involving local

forest department, which has vast experience of carrying out plantation of this specialized plant species. Since removal of vegetation would be done in the first year of commencement of the project, it is advised that the plantation shall be carried out in the first year itself. Since the plant is slow growing, it is recommended that a total of 10.0 ha. of *Commiphora wightii* plantation shall be done in the first year itself. Rest of the time Kutch East Forest Division would carry out maintenance of the plants. This plantation shall be carried out in the reserved forests, unclassed forests or roadside areas as found suitable by the Kutch East Forest Division.

6.2. SCHEDULE-I FAUNA

Among the fauna, we reported total 8 animal species. As mentioned above, the faunal wildlife species include 2 species of Reptiles, 5 species of birds and 1 species of mammal.

6.2.1. REPTILE/ INDIAN FLAP SHELL TURTLE/ MONITOR LIZARD

Status: During our study this species of reptile was recorded from the small village ponds in the study area. The species is resident and breeding in the buffer areas. The Indian Flap shell Turtle (*Lissemys punctata*) is a freshwater species of turtles are widespread and common in the South Asian provinces. They are listed as Schedule-I species under Wildlife Protection Act 1972 and as Least Concerned as per IUCN threat categories. Monitor Lizard is also one of the reptile's species which is found in the study area.

Impacts: Since this species is an aquatic and cold blooded, it may be subjected to impacts related to water pollution and hydrological impacts arising due to project activities. These may include degradation of water sources, soil characteristics, choking of drainages etc. This species is otherwise not hunted or eaten by the people. Therefore, changes of

degradation of overall aquatic habitat qualities in the buffer area are likely to affect these species and their distribution.

Recommendations: AEL shall put all kind of pollution control measures in place so that surrounding area ecological conditions are not degraded. During construction it shall be seen that no drainage, ponds etc. are damaged or altered. AEL shall carryout comprehensive biodiversity monitoring at regular intervals in order to check impact of their project activities on surrounding area and special emphasis shall be given to monitoring of surface (drainage, check dams, ponds) water and wetlands in the buffer area.

6.2.2. BIRDS/ INDIAN PEAFOWL

Status: The Indian Peafowl *(Pavo cristatus*) is a resident breeder in the Indian subcontinent. The bird was justifiably declared as the national bird of India in year 1963 due to its 'flagship' value founded on its glorious position in mythology and its widespread distribution in the country.

The species is found in dry semi-desert grasslands, scrub and deciduous forests. It forages and nests on the ground but roosts on top of trees. It eats seeds, insects, fruits, small mammals and reptiles. The Indian Peafowl is a ground nesting bird and it lays a clutch of 4-8 eggs which take 28 days to hatch. The eggs are light brown and are laid every other day usually in the afternoon. The male does not assist with the rearing, and is illegal. Poaching of peacocks for their feathers and poisoning by feeding on pesticide treated seeds are known threats to wild birds.The collection of tail feathers is only allowed if shed by the bird. The Indian peafowl is under various threats that include the demand for feathers and wild meat, conflict with farmers during cropping season, increased use of chemical fertilizers and pesticides and habitat degradation.

Impacts: Our field study reported presence of Indian Peafowl in the buffer areas of project site. The species was observed in the buffer area of 10 km radius particularly near human habitations, villages and agriculture fields. Since our study reported presence of Indian Peafowl in the buffer area, its possibility of nesting in buffer area could not be ruled out. Since Indian Peafowl is a ground nester, several project activitie can have adverse impacts on their nesting grounds such as pollution, degredation of soil and vegetation from surrounding ara and in the forest areas. Direct disturbance by presence of people, vehicle, their noise, vibrations, lights etc. can potentially disturb most of the bird species.

Recommendations: following actions for the conservation and protection are suggested in wildlife conservation action plan to reduce impacts of project related activities on the species. Based on our field observation on the distribution, behavioral ecology, conservation need, and envisaged impacts of proposed copper refinery project, we identified several species specific actions that would help reduce the impacts of project on Indian Peafowl as under.

i. A rapid survey for the breeding population of Indian Peafowl during their nesting season shall be carried out in pre-monsoon season by

wildlife experts so as to ensure that no nesting of the species is present in and around project or corea area.

ii. Since Indian Peafowl is a ground nesting bird, construction activities could disturb their nesting activities. Therefore if nesting of peafowl is found, in core area, construction activities should not be carried out in that particular block. Construction activities should resume only after egg hatching is completed and the fledglings leave the nest.

iii. Avoid vehicle movement in the area where nesting is found. The movement of vehicles or humans shoul be prohibited in vicinity of the nesting area.

iv. Electric lines within the project area and outside the project area shall be designed to minimize the potential for electrocution of indian peafowl and other such large birds.

v. Lightings within the project area could potentially deter the species presence. Therefore, AEL shall ensure that minimum illumination comes out from the project area. This can be done by adjusting the angles of the light sources and using low intensity focused bulbs inside the project area.

vi. Tree Plantation shall be carried out by AEL in the surrounding villages and schools etc. in the buffer area. This would help the species and provide them much needed roosting place.

vii. Staff involved in construction and operation activities shall be trained and made aware of Indian Peafowl's status as National Bird of India, and Schedule-I species protected under Indian Wildlife Protection Act 1972. This is important because if there any casualties of the species are found then they should report to the project authorities and the local forest department to carryout further necessary actions.

6.2.3. BIRDS/ SCHEDULE-I RAPTORS

Status: Total 3 bird species i.e. terrestrial Raptors belonging to Schedule-I of Wildlife Protection Act 1972 are reported from the study area. These species are Black shoulder kite, Marsh Harrier, Shikra. Of these 3 species of Raptors, none are reported from the core area and all 3 are reported from buffer area. The species of Harriers are migratory bird species whereas, rest of the species are resident species. Most of the raptor species are recently added to Schedule-I list through amendment made in year 2013. Though, only 3 species of Schedule-I raptors reported during the study, there may be more Schedule-I birds/raptors present in the study area. Mitigation measures recommended for Schedule-I birds and raptors would potentially cover other missed out Schedule-I birds/raptors also.

Impacts: These 3 species of terrestrial raptors are predators and occupies tertiary consumers positions in the food chain and ecological pyramids. Therefore, any change in primary productivity would affect their distribution, density and population in the region. Therefore, project activities resulting in air, water and noise pollution, degradation of vegetation would potentially affect the habitat of these bird species and their population in the study area. Moreover, direct disturbance by presence of people, vehicle, their noise, vibrations, lights etc. can potentially displace most of the raptors species from the project area and its immediate surroundings.

Recommendations: It is recommended that AEL shall take utmost care in controlling dust, fugitive emissions using state of the art technologies and put in place all types of pollution control measures during construction and operation phases which would ensure minimum degradation of surrounding vegetation, forest area vegetation and waterbodies. Minimize vehicle

movements around the project areas. Adjust lightings within core area and ensure minimum illuminations spreads outside the project area. Keep all the machineries maintained so that minimum noise and vibrations are generated in the surrounding area. Since most of the raw materials and products are to be carried through conveyer belts the impact related to vehicle movements would be low.

6.2.4. CHINKARA (*Gazella bennettii*)

Status: The important herbivore present in the buffer area is Chinkara which is protected as Schedule-I species in Wildlife Protection Act 1972. During our survey, we reported presence of Chinkara through direct sightings in the buffer area in the study area. Indian gazelle is a shy animal and avoids human habitation. It stands at 65 centimetres and weighs about 23 kilograms. It can go without water for long periods and can get sufficient fluids from plants and dew. Although most individuals are seen alone, they can sometimes be spotted in groups of up to four animals. It lives in grasslands and desert areas in India. Its population as per latest census report total 71 chinkara are reported from the study area. Narayan Sarovar Wildlife Sanctuary and its surrounding areas are known for Chinkara population. The sanctuary is also known as Narayan Sarovar Chinkara Sanctuary. The species is common in landscape of Kutch and North Gujarat. The species is listed as Schedule-I in Wildlife Protection Act 1972 and as Least Concerned by IUCN. The species needs safe, undisturbed arid semi arid plains with open and sparse vegetation.

Impacts: This mammal species is likely to be using surrounding area for their feeding and breeding. They are also likely to be using waterbodies in the buffer area for their requirement of water. The impacts of copper refinery and allied development activities on herbivore are likely to be direct as they are primary consumers in the eco-system. Degradation of soil, vegetation

and habitat due to chronic pollution loads the species would lose its feeding ground and breeding area. Moreover, the direct loss of habitat worth the core area is also an irreversible loss to the species. Therefore, changes in overall habitat qualities in the buffer area are likely to affect these species. The direct disturbance to these species by vehicle traffic, poaching by workers, and human intrusion in wildlife habitat is also issue of some concern.

Recommendations: It is recommended that AEL shall comply with all the pollution control and other conditions imposed in the environmental clearance by MoEF&CC. Compliance of all the conditions in environment clearance by MoEF&CC would take care of major issue of habitat degradation for the species. AEL shall instruct their own staff members and workers not to indulge in chasing or killing of Chinkara in the study area. AEL shall also support forest department in conducting awareness of local people towards wildlife conservation and law reinforcement and anti poaching activities in the study area. AEL shall support forest department in installing sign boards on roads and strategic locations of villages informing prohibition of killing, poaching etc. under wildlife protection act 1972.

6.3. IMPACT – MITIGATION MATRIX & CONSERVATION PLAN

Based on our observation, literature review and consultation with local people, and NGO, we formulated following impact *vs* mitigation matrix (Table-6.2). The matrix is created using information and data collected during our field visits and the information available in public domain. We calculated distances of **sensitive** ecological receptors such as protected areas, their eco-sensitive zones, biodiversity heritage sites, important bird areas, mangrove, reserve forests, wetlands, rivers etc. from project core areas. Professional judgements and recommendations are made based on our experiences and the parameters used for predicting impacts.

Table-6.2: General Impacts vs. mitigation matrix & Conservation plan.

Issue		Status	Impacts	Mitigation
Ecosystems	Protected Areas	All the protected areas of Kutch are located beyond 70 km from the proposed project area. Marine National Park and Sanctuary areas are located beyond 30 km south of the proposed project in Gulf of Kutch.	No impacts are envisaged, as these areas are located at greater distances.	• Nil
	Eco-sensitive zone	No eco-sensitive zones of any Wildlife Sanctuary or Naitonal park are located within 30 km from the proposed project area.	No impacts are envisaged, as these areas are located at greater distances.	• Nil
	Wetlands & waterbodies	No major inland wetlands are located within study area. Marine wetlands include Kotdi creek (0.5 km, S), Baradimata creek (4.0km SE), Gulf of Kutch (3.9 km, S), Seasonal drainage/rivers are Nagavanti Nadi (4.7 km, E) and Phot Nadi (8.7 km, ENE), Khari Nadi (1.9 km, W), A drainage known as Dhaneshri Nadi flows through the western part of the project site and it drains into Kotdi Creek system. Small check-dams and nallah are present in the study area at distance.	• Kotdi creek system has sparse and dense mangrove growth on both sides. • Dhaneshri river/drainage may carry spilled out pollutant load from the project area to the mangrove eco-system of Kotdi creek. This may increase heavy metal toxicity in mangrove habitats. • If dusting, fugitive emission are not controlled, it could cause major damage to mangroves.	• Therefore, it is recommended that Dhaneshri River should be trained in such a way so that it does not carry pollutants with runoff from the project area. • Install state of the art technologies so that pollution from the project area remains within applicable standards. • Check health of mangrove eco-system at regular intervals. • Prepare a comprehensive mangrove conservation plan for Kotdi and Baradimata creek system's mangroves located in the study area.

	Important Bird Areas	Banni & Naliya grasslands are two major IBAs of Kutch	No impacts are envisaged, as these IBAs are located far away, 70 km from the project site.	Nil
	Forest Area	Reserve Forest, Unclassed forest areas are located adjacent to proposed project area. In fact part of the project area would be located on diverted Forest land of Siracha village. The south of the proposed project area there are mangroves which are also declared as reserve forest areas by state forest department. Navinal reserve forest area is also located at 500 mtrs distance only from the proposed project area in east direction.	Direct loss of forest land worth 102.39 ha. Pollution loads from project activities could potentially degrade remaining forest land located in Siracha village, Navinal forest area and mangrove reserve forests. As per EIA/air modelling, it is learnt that 2.2 km North-East direction there will be impacts of air pollution. This means it would affect reserve forest area of Navinal. As per literature survey, Navinal area has presence important native species of plants. This forest area would be affected due to chronic air pollution impacts.	• Compensate loss or damage to Forest area due to pollution by taking up plantation of native species. • Construct tall wall around project boundary so that dusting, possibility of fire etc. are minimized. • No roads or trespassing shall be done by staff or workers through Forest area. • No collection of fuel wood from forest land shall be allowed. • No worker camps, dumping of solid waste, over burden inside forest land shall be allowed. • Fire and safety precautions shall be in place during construction and operation phases. • Green belts as per conditions of Environment Clearance shall be created using native species of plants in the periphery of project area. • Install state of the art technologies so that pollution from the project area remains within applicable standards.
	Mangroves	Mangroves are located at 170 mtrs from the project boundary in Kotdi and Baradimata creek systems on the coast of Gulf of Kutch	• Kotdi creek system has sparse and dense mangrove growth on both sides. • Dhaneshri river/drainage may carry spilled out pollutant load from the project area to the mangrove eco-system of Kotdi creek. This may increase heavy metal toxicity in mangrove habitats.	• It is recommended that Dhaneshri River should be trained in such a way so that it does not carry pollutants with runoff from the project area. • Ensure that strict pollution control measures are implemented in the project. • Check health of mangrove eco-system at regular intervals. • Prepare a comprehensive mangrove

			• If dusting, fugitive emission are not controlled, it could cause major damage to mangroves.	conservation plan for Kotdi and Baradimata creek system's mangroves located in the study area. • Take up mangrove restoration and afforestation activities in consultation with Kutch East forest division.
	Intertidal mudflats	Extent of mudflats on Kutch district coast is yet to be identified officially on Coastal Zone Maps of Gujarat.	• Chronic spillage and flow of pollutants, dust sediments, untreated effluents, construction debris, oil, grease etc from the project site through runoff into Kotdi creek system could affect mangroves and mudflats if present.	• Ensure that strict pollution control measures are implemented in the project. • Project is required to be Zero Liquid Discharge (ZLD) plant. • Project proponent shall ensure zero pollution discharge into surrounding areas particularly the intertidal areas which may include mudflats • Take up mudflat conservation activities in consultation with Kutch East forest division.
Flora	General Vegetation	This area has native vegetation representative of semi arid zones. These include typical tropical thorn forest area comprising of *Acacia, Salvadora, Caparis, Ziziphus, Commphora species.*	There will be irreversible loss of native vegetation from the core area i.e. 256.58 ha. The native vegetation from the immediate surroundings of the proposed project site would also be affected due to pollution load.	• Remove minimum vegetation from core area. • Install state of the art technologies so that pollution from the project area remains within applicable standards. • Vehicle movements shall be minimum. • No vegetation shall be cut by workers from surrounding area. • No collection of fuel wood from surrounding land shall be allowed. • Fire and safety precautions shall be in place during construction and operation Thick green belts shall be created using native species of plants in the periphery of project site.
	Important plant Species	*Commiphora wightii is* an important plant which is listed as Critically Endangered by IUCN. This plant is present in core and buffer area.	This important plant species would be affected in the surrounding area due to air and water pollution loads from project activities.	• Thick green belts shall be created using native species of plants in the periphery of project area. • In order to compensate for the potential

			As per EIA/air modelling, it is learnt that 2.2 km North-East direction there will be impacts of air pollution. Chronic air pollution would affect plant growth in this area.	damage/degradation of *Commiphora wightii* habitats AEL shall carry out plantation through Kutch-East Forest Division, Bhuj.
Fauna	Threatened or Endemic fauna Species	No threatened fauna species are reported from the study area during survey. i.e. core or buffer area during study.	Though, not reported during the present study, there may be presence of these species in future. Degradation of overall habitat could affect these species.	• Install state of the art technologies so that pollution from the project area remains within applicable standards. • Thick green belts shall be created using native species of plants in the periphery of project site. • Carryout biophysical monitoring of intertidal zone located south of project area at every 6 months.
	Schedule-I Reptiles	The Indian Flap shell Turtle (*Lissemys punctata*) is present in ponds and small wetlands of buffer area. Indian Monitor Lizard is present in agriculture, open scrubland and thorny bushes in the project area.	Degradation of overall terrestrial and aquatic habitat qualities in the buffer area are likely to affect these species and their distributions.	• Install state of the art technologies so that pollution from the project area remains within applicable standards. • Monitoring of biodiversity including these species and take corrective measures if needed. • Carry out habitat improvement activities through forest department in surrounding reserve forest areas, which would ensure their long term survival in the region.
	Schedule-I Birds	Indian peafowl and 5 Schedule-I bird species i.e. terrestrial Raptors are present in study area.	Pollution load, overall habitat degradation, direct loss of habitat worth 256.58 ha. and direct disturbance due to vehicle movements, illuminations and project activities could displace and disturb these species from the immediate surroundings of the project area.	• Install state of the art technologies so that pollution from the project area remains within applicable standards. • Maintain machinery so minimum vibrations and noise is controlled within the applicable standards at the boundary of the project. • Adjust lightings in the core area so minimum illumination spread outside core area. • Thick green belts shall be created using native species of plants in the periphery of project

			boundary. • Cary out tree plantations in surrounding villages to augment habitat for Indian Peafowl and other schedule-I birds species. • Monitor biodiversity including bird species and take corrective measures accordingly. • Carryout habitat improvement activities through forest department in surrounding reserve forest areas, which would ensure their long term survival in the region.
Schedule-I Mammals	Only one species of Schedule-I mammal is reported i.e. Chinkara from the study area. None from core area. It is mostly reported from the reserve forest areas within the study area.	Overall degradation of habitat due to pollution. Direct disturbance due to Noise, vibration due to vehicle movements could displace or deter this species. Lighting and illumination could displace the species from surrounding area. Hunting, chasing, killing by workers, road kills etc. are also envisaged.	• Install state of the art technologies so that pollution from the project area remains within applicable standards. • Maintain machinery so minimum vibrations and noise is generated. • Adjust lightings in the core area so minimum illumination spread outside core area. • Thick green belts shall be created using native species of plants in the periphery of project area. • Monitor biodiversity including mammal species and take corrective measures accordingly. • Provide funds for habitat improvement activities by the forest department in surrounding reserve forest areas, this could ensure their long term survival in the region.
Wildlife Corridors	No wildlife corridor is identified under any legal framework in the study area.	Nil	• Nil

6.4. WILDLIFE MITIGATION MEASURES & RECOMMENDATIONS

Based on our field study, information collected and consultation with project proponent, local community etc. we recommend following mitigation measures as self regulatory, monitoring and compensatory measures for protection, conservation and betterment of wildlife and ecology in the surrounding area of project site.

6.4.1. REGULATORY MITIGATION MEASURES & RECOMMENDATIONS

i. Since project deals with heavy metals, acids and hazardous materials, it is recommended that strict control on fugitive emission, dust pollution shall be carried out using state of the art methods and technologies. Maximum area under intensive use shall be made of hard floor. Professional dust suction system from the area under intensive use shall be placed.

ii. Ambient noise pollution and vibrations during construction and operation phases of copper refinery plant shall be within limits of the standards mentioned.

iii. Plantation of thick green belt on periphery of the project site shall be created using native and hardy tree species.

iv. Ensure no movement of vehicles or people through Forest Areas located immediate north (Siracha) and east (Navinal) of proposed copper refinery plant area.

v. Ensure zero discharge of waste water from the project site into surrounding area.

vi. Ensure safe passage of runoff through drainages located within and nearby the project area. It is recommended that a seasonal drainage/river (Dhaneshri River) should be trained in such a way so that it does not carry pollutants from the project site into mangrove eco-system located immediate south of the project boundary.

vii. Ensure no dust, fly ash, sediments, or any raw materials spill out from project areas and flow into nearby drainage, forest areas during the operation phase of the project.

viii. AEL shall ensure that their construction workers and other staff during construction or operational phase shall not be involved in poaching and hunting activities of birds, reptiles or mammals around the project site.

ix. Implement state of the art technologies to control pollution caused form the proposed project.

x. No trespassing or vehicle or people shall be allowed through, surrounding forest area or the mangrove eco-system. This shall be instructed to the workers and staff in advance.

xi. No workers camps shall be established within the surrounding forest area. This shall be instructed to the workers and staff in advance.

xii. No resources (i.e. fuel wood, stones, sand, soil etc.) from the surrounding forest area shall be collected by staff or workers. This shall be instructed to the workers and staff in advance.

xiii. No workers or staff members shall be involved in poaching or killing of any wild animals throughout the project life cycle. This shall be instructed to the workers and staff in advance and sign boards to this effect within project area.

6.4.2. MONITORING MEASURES & RECOMMENDATIONS

xiv. AEL shall regularly monitor health of the forest areas (Siracha and Navinal village), mangrove eco-system (Kotdi and Baradimata creeks) and biodiversity in the study area.

xv. AEL shall carryout annual monitoring of mangrove eco-system in Kotdi and Baradimata creeks. Details of monitoring are provided in mangrove conservation plan.

xvi. After commencement of the project AEL shall carryout comprehensive ecological & biodiversity monitoring at every 2 years for 10 years. The monitoring shall include status of flora, fauna and health of reserve forests and mangrove eco-system present in the immediate proximity of the proposed project site. In case any changes, damage is reported

to them AEL shall take necessary corrective measures accordingly. AEL shall bear the cost of third party monitoring.

xvii. Overall official monitoring would be carried out by Kutch-East Forest Division, Bhuj. AEL shall pay the administrative and monitoring cost for the same.

6.4.3. COMPENSATORY MEASURES & RECOMMENDATIONS

xviii. In view of the probable impacts of construction and operation of copper refinery project on mangroves of Kotdi and Baradimata creek areas, AEL shall chalk out Mangrove Conservation plan.

xix. In order to compensate for the potential damage/degradation of *Commiphora wightii* habitats AEL shall carry out 10.0 ha. of plantation through Kutch-East Forest Division, Bhuj.

xx. In view of the distribution of species of higher conservation significance and the Schedule-I species, in the study area particularly within the reserve forests around the project area, it is recommended that AEL shall financially support wildlife habitat improvement activities being carried out by Kutch East Forest Division.

6.5. IMPLEMENTATION OF MITIGATION PLAN

- Since the project is located away from protected area and their eco-sensitive zones, most of the wildlife mitigation recommendations are self regulatory for user agency, therefore the implementation of these mitigation measures shall be carried out by the user agency (AEL) through their own staff and CER budget.
- A special emphasis on ecological conservation shall be given by extending special responsibility to senior environment authority within the management of the proposed project authority. A senior ecologist shall be employed / consulted on regular basis to oversee ecological/wildlife conservation activates under CER. The senior personal responsible for the conservation of ecology shall report directly to the head of the organization.

- Substantial budget shall be allocated to carryout ecological conservation activities by the user agency (AEL).
- Any additional conditions towards wildlife mitigation activities by any of the Environment Appraisal Committees at state or central levels or by the Forest department shall be complied with.
- Annual Compliance report for these activities shall be submitted to Kutch West East Forest Division, Bhuj, Gujarat.

6.6. MONITORING OF MITIGATION & COMPLIANCES

Though, most of the recommendations are self regulatory for user agency, monitoring of these recommendations and other conditions imposed by various agencies towards wildlife mitigation measures shall be monitored by a third party agency. Third party monitoring would involve comprehensive ecological/biodiversity study at interval of 2 years for 10 years. These studies would be carried out to evaluate long term impacts of the proposed project activities on the wildlife, biodiversity, ecology and forest areas present in the 10 km periphery of the project site. Therefore, as per guidelines issued by the Principle Chief Conservator of Forests, Wildlife dated 13th August 2018, user agency shall allocate up to 5% of the total cost of mitigation plan as third party monitoring cost. Total Rs. 443.5 Lakh shall be allocated by the AEL for monitoring of mitigation plan for the period of 10 years.

Since the area falls under the jurisdiction of Kutch East Forest Division, the overall official monitoring of the implementation of mitigation plan would be carried out by the Kutch East Forest Division, Bhuj. Therefore, as per guidelines issued by the Principle Chief Conservator of Forests, Wildlife dated 13th August 2018, user agency shall allocate and pay the monitoring and administrative cost to the forest department. For carrying out overall monitoring activities, user agency shall pay monitoring and administrative cost to the authorities of Kutch East Forest Division.

7. MANGROVE CONSERVATION PLAN

7.1. Background

M/s. Adani Enterprises Limited (AEL) intends to set up a Greenfield copper refinery project of 1.0 MTPA (10 LTPA) capacity which would include facilities like copper smelter, sulphuric acid plant, copper refinery, continuous cast copper wire rod plant, precious metal recovery plant, phosphoric acid plant, aluminium fluoride plant, effluent treatment plant, utilities storage of water and fuel, etc. with the state of the art environment friendly technology. These facilities would be located in 256.58 ha. of land which include 154.19 ha of APSEZ land and 102.39 ha. forest land. The Gulf of Kutch sea coast is located at 3.9 km south from the proposed project site.

As per Environmental Impact Assessment (EIA) Notification dated 14th September 2006, proposed project falls under category-'A' of project activity 3(a) and requires prior Environmental Clearance (EC) to be obtained from Ministry of Environment, Forest & Climate Change (MoEF&CC) before the commencement of ground activity. The application for prior EC for the proposed project has been submitted to MoEF&CC Terms of Reference (TORs) has been issued by MoEF&CC. The proposed industry is for handling heavy metals and hazardous chemicals which could lead to severe impacts on the surrounding environment and health of eco-systems if not done carefully. In view of the nature of proposed industry and processes involved, it is imperative to consider impacts of such industry on the surrounding eco-systems and take appropriate mitigation measures. Since mangrove eco-system is present south of project boundary, an action plan is proposed to protect and conserve the same.

7.2. Importance of Mangroves

In general, mangroves are known to provide multifold eco-system benefits to mankind. Mangrove ecosystems represent natural capital capable of producing a wide range of goods and services for coastal environments and communities and society as a whole. Some of these include protection of coast from cyclones and disasters, resistant against coastal erosion, carbon

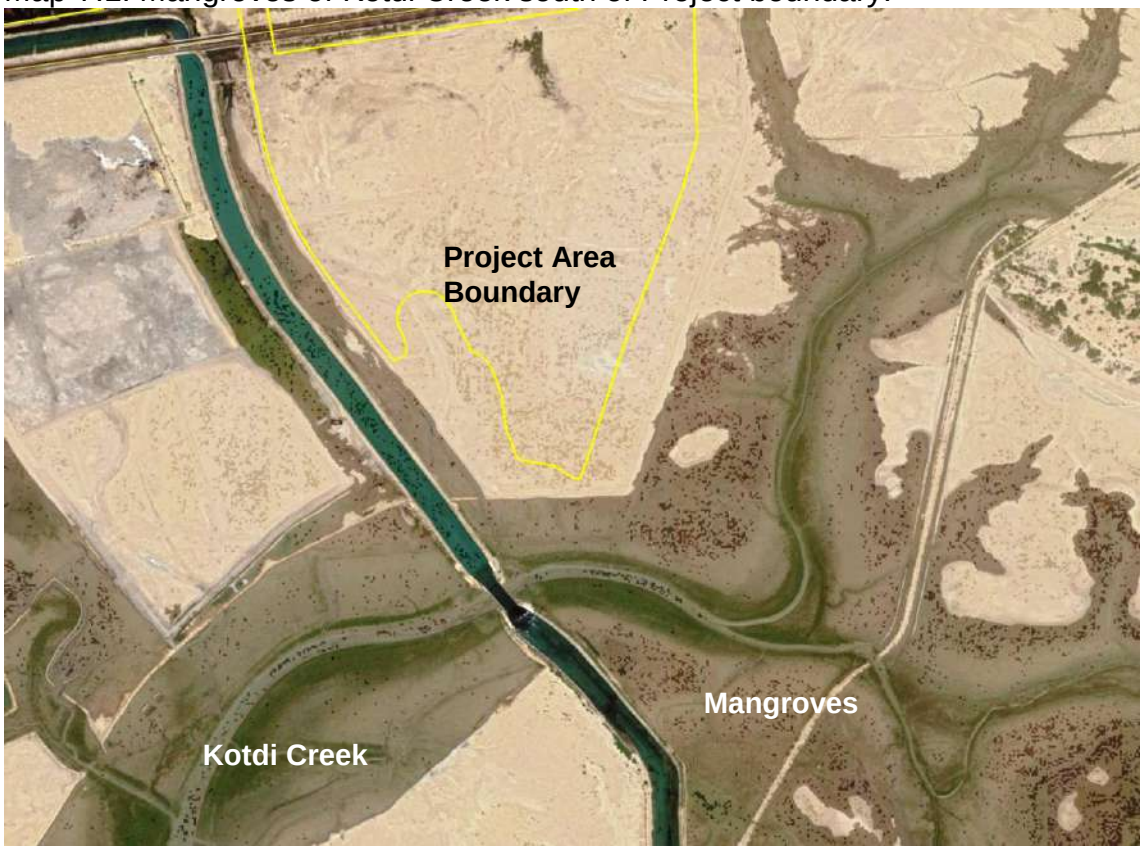
sequestration, provide fodder, timber, honey etc. Improved fish production in area where mangroves are present is also reported by many studies. Mangroves are believed to be the bio-filters of pollutants. Most importantly it provides substratum to a wide range of associated micro& macro flora and fauna which in turn constitutes a dynamic and functional mangrove eco-system that provides multifold socio-economic and environmental benefits to mankind.

7.3. Status of Mangroves Around Project Site

The baseline information suggests that the coastal area of Tunda, Navinal, Shiracha, Jarpara and Tragdi villages have patches of scattered, sparse and dense mangroves. Most of the mangrove areas are located in the notified reserve Mangrove Forest areas of Navinal, Shiracha and Jarpara village coasts. Closest mangrove distribution is located at 170 meters South form the project area on the bank of Kotdi creek (Plate-4.1, Map-4.2). The mangrove on the banks of Kotdi-I, Kotdi-II, Baradimata and Tragdi creeks fall within 10 km radius of the proposed project area. The mangroves of Kotdi–I and Kotdi-II creeks are closest mangrove (Map-7.1, Map-7.2).

There are total 3 species of mangroves present in the total three species of mangroves present these include *Avicennia marina, Ceriops tagal and Rhizophora mucronata.* A study carried out by National Centre for Sustainable Coastal Management (NCSCM), Chennai in year 2018, the total mangrove cover in Kotdi-I and Kotdi-II creeks was about 410 ha. out of which dense mangroves occurred to the extent of only 50 ha (12%), followed by sparse mangroves, distributed in 189 ha. The scattered mangrove covered an area of 171 ha. (Map-7.1). The above mentioned study reported an increase of 30.0 ha between year 2011 and 2016. A study by Thivakaran and Sawale (2016) reported 47 species of macrofauna in the Mundra mangrove eco-system. Total 12 species of gastropods, 14 species of crustaceans, 9 species of bivalves, 8 species of polychaetes and 4 species belonged to the category “others”. Increasing spread of mangrove area and high species richness of macrofauna suggests healthy and dynamic condition of mangrove ecosystem in this area.

Map-7.1: Mangroves of Kotdi Creek south of Project boundary.



Map-7.2: Status of mangroves of Kotdi – I & Kotdi – II creek systems in 2016-17. (Map source: study by NCSCM 2018).

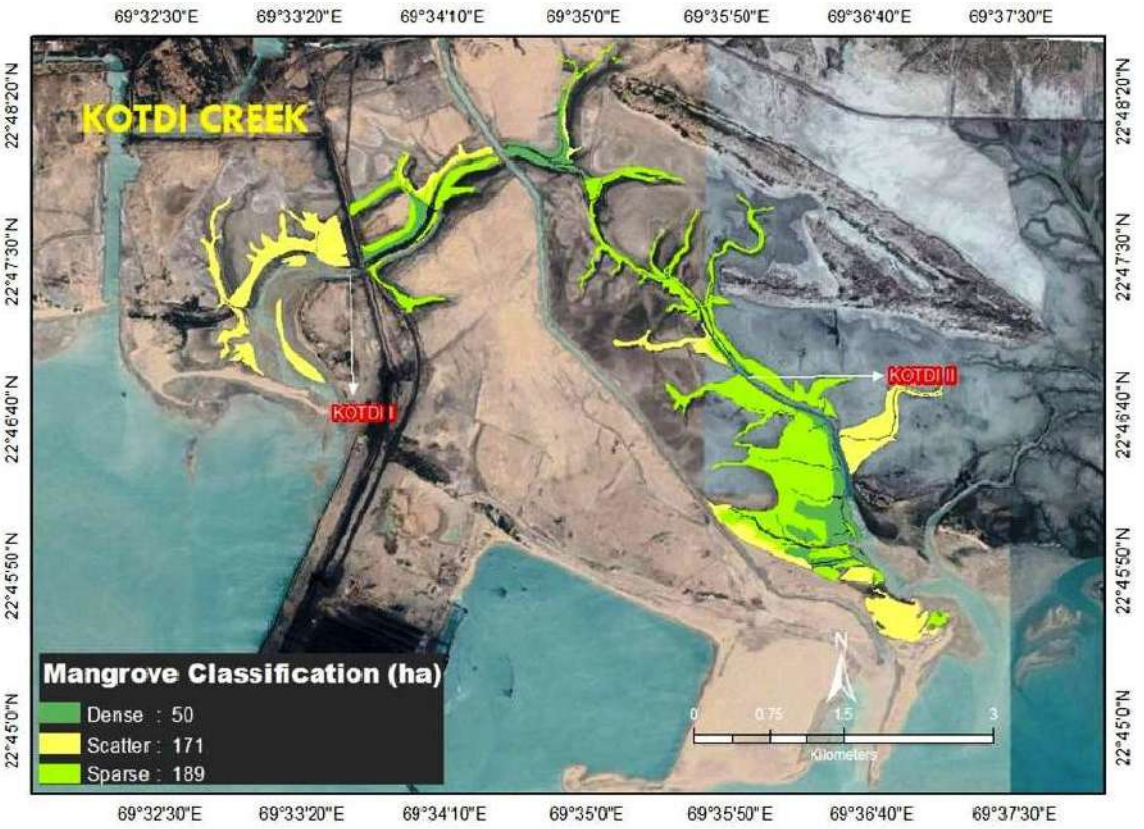


Plate-7.1: Mangroves of Kotdi-I creek.

7.4. Potential Impacts on Mangroves

Based on our survey and existing literature it is established that there are patches of scattered, sparse and dense mangroves located close to southern boundary of project area. The mangroves are located in Kotdi-I, Kotdi-II, Baradimata creeks. Since proposed project would involve large scale handling of heavy metals, hazardous chemicals and hazardous processes it could potentially affect mangroves located in the study area. Therefore, these mangroves which are located south of the project site are at higher risk of damage due to following impacts.

Air pollution: Though, the predominant wind direction is from south-west in the region, there are still chances of mangrove located on immediate southern boundary being impacted due to its close distance from the project site. Chances of damage to mangroves by fugitive emissions are high. The main sources of air pollution from the project will be from the processes and stacks. The pollutants from the plant include sulphur dioxide and particulate matter. Suspended particulate matter produced during construction and operational phases of the copper refinery plant would deposit in the surrounding mangrove ecosystem. Their direct deposition on mangrove could cause loss of chlorophyll content in leaves, arrest of photosynthesis

process, leaf injuries resulting in restricted growth and regeneration of mangrove plants. Toxic metal fumes could also increase heavy metal toxicity of the mangrove eco-system.

Water pollution: There is a drainage known as 'Dhaneshri Nadi' flows through the western part of the project site and it drains into Kotdi Creek system. Kotdi creek system has sparse and dense mangrove growth on both sides. Therefore, if the Dhaneshri river/drainage is not trained suitably, it may carry spilled out pollutant load from the project area to the mangrove eco-system of Kotdi creek. This may increase heavy metal toxicity to mangrove eco-system and its components. Among the various types of pollutants released from such industry, heavy metals are one of the most serious pollutants owing to their toxicity, persistence and bioaccumulation problems (Macfarlane & Burchett, 2002). The metal contamination is a major environmental problem as the metals in contaminated sediments may accumulate in the various organisms of the estuarine ecosystem and ultimately enter the food chain, thereby affecting the human well-being (Shakeri & Moore, 2010). The concentrations of heavy metals in the sediments usually exceed that of the overlying water (Zabetoglouet et al., 2002) and the high concentrations of these metals in water and sediments affect both plants and animals (Doganlar & Atmaca, 2011). Chronic heavy metal toxicity could prove to be lethal for a range of fauna present in the mangrove habitat and affect the overall function of mangrove eco-system.

7.5. MITIGATION MEASURES

In view of the above mentioned status, importance and role of mangroves and potential impacts of proposed copper refinery plant on mangroves, it is recommended to take up following measures so that the mangroves are not harmed and their health and spread improves in the study area.

7.5.1. Mitigation of Air Pollution:

- It is recommended that a tall wall around the project boundary be constructed so that dusting is controlled during construction and operation phases.

- Thick green belt around the project boundary shall be created so that particulate matters are arrested.
- State of the art technology for arresting dust pollution shall be implemented for controlling different types of pollutions from various sources in the plant areas.

7.5.2. Mitigation of Water Pollution:

- State of the art water pollution control measures shall be in place including treating industrial effluents with heavy metals.
- Train Dhaneshri river/drainage in such a way so that it does not carry spilled out pollutants from the project area to the mangrove eco-system of Kotdi creek.
- Do not release untreated sewage or effluents in to the creek areas having mangroves.

7.5.3. Plantation of Mangroves to Mitigate Heavy Metal Toxicity

Mangroves are considered as best natural bio-filters of pollutants. Mangrove trees are reported to tolerate high levels of heavy metals (MacFarlane, 2007) with *Avicennia* species exhibiting greater tolerance and accumulative properties to numerous metals than other mangrove species (MacFarlane and Burchett, 2002). The inorganic industrial waste composed basically by heavy metals do not degrade and although they can be diluted in the long run they will always be responsible for the environmental damage even if the source has ceased to operate. Mangroves have natural ability to act as a sink of anthropogenic and industrial pollutants. Mangroves are also known to arrest and carryout bioremediation of certain pollutants in local environment. Mangroves not only act as a sink or transfer the pollutants but they also oxidize the metals present in the sediment by exuding oxygen into the anoxic soil through aerial roots. Mangrove wetlands are therefore considered as low cost waste disposal site.

It is in this context, not only preservation of Kotdi and Baradimata creek mangroves are important but there is a need to increase mangrove spread in

this area so that it can mitigate the impacts of proposed industry on marine water and their biota. Therefore, it is recommended that AEL shall take up intensive mangrove plantation drive particularly on the bank of Kotdi-I, Kotdi-II and Baradimata creek systems. Total 50 ha. of plantation every year shall be taken up for 10 years period. It is recommended that mangrove plantation shall be carried out by Kutch East Forest Division as the area is under their jurisdiction and the staff has vast experience in mangrove plantation and management. Plantation shall be done using raised bed model.

7.5.4. Monitor Health of Mangroves:

- It is important to regularly check the health of mangrove eco-system located in the Kotdi-I, Kotdi-II and Baradimata creek systems.
- It is recommended to carryout monitoring of heavy metal contents in the sediments and mangrove plants (root & stem) at every 6 months intervals in the Kotdi-I, Kotdi-II and Baradimata creek systems. A minimum of 20 samples of sediments shall be collected and analyzed each time. The samples shall be collected at every 200 to 500 meters distances starting from northern most part of creeks to southern area.
- It is recommended to monitor the spread of mangroves in the Kotdi-I, Kotdi-II and Baradimata creek systems. This shall be done at the interval of every 2 years using standard high resolution satellite imageries and Remote-sensing & GIS techniques.
- The monitoring of floristic structure of mangrove stock shall be carried out annually to check if there are changes in its composition in terms of heights, girth and regeneration classes of Kotdi-I, Kotdi-II and Baradimata creek systems. This would enable us to check if the mangroves are degrading or healthy.
- It is recommended to monitor diversity and density of mangrove associated flora as well as macrofauna annually. This would help us monitor the functioning of food chains and food webs operating in mangrove eco-system of Kotdi-I, Kotdi-II and Baradimata creek systems. An initial baseline data shall be generated on this prior to commencement of the construction of the proposed project. It is

recommended to fix the location of sample plots and follow the same locations for subsequent monitoring efforts.

- It is recommended that the biological parameters of the mangrove eco-systems i.e. spread of mangroves, floristic structure, diversity, density, as well as diversity of mangrove associated flora and fauna shall be monitored by and independent NABET accredited experts.
- The samples collected from the mangrove plant and mangrove habitat sediments shall be analyzed only through NABL accredited laboratory.

7.5.5. Indicators for Monitoring of Mangroves.

Following are the indicators for monitoring of conservation plan. These indicators shall be monitored and the effectiveness of mangrove conservation plan shall be determined (Table-7.1.).

Table-7.1: Indicators for monitoring of Mangrove Conservation Plan.

No	Monitoring	Frequency	Negative Impacts	No Impacts
1	Spread of mangroves (area in ha.)	2 years	Decrease	Increase
2	Content of heavy metals in sediments	6 months	Increase	no increase
3	Content of heavy metals in mangrove plants	6 months	Increase	no increase
4	Mangrove stock structure (height, girth and regeneration classes)	Annual	Altered with decrease of area	Altered with increase area
5	Diversity of mangrove associate flora	Annual	Decrease	no increase or increase
6	Diversity of mangrove associated fauna	Annual	Decrease	no increase or increase

8. FINANCIAL LAYOUT

8.1. FINANCIAL ALLOCATION FOR WILDLIFE CONSERVATION ACTIVITIES

Following is the proposed budget estimated in consultation with forest department for 10 years towards wildlife conservation plan after approval from all statutory bodies permitting the project (Table-8.1).

Table-8.1: Proposed financial allocation for mitigation and conservation measures.

Sr No.	Activity	Implementing Agency	Duration Years	Rate/ Year (Lakh)	Total Amount (Lakh)
	Conservation Activities (Amount to be transferred by Project Proponent to KEFD)				
1	Mangrove & Mudflat conservation activities				
a	Carry out Mangrove Plantation activities through Forest Dept. 50 ha. per year for 10 years. by AEL @ Rs. 30000/ha. Reference: Raised bed model of Department of Forest, Govt of Gujarat.	Kutch East Forest Division (KEFD)	10 years	15	150
b	Forest department purchase/hire boat and satellite images for Mangrove & Mudflat monitoring and surveillance	KEFD	10 years	2.5	25
2	Habitat improvement for Schedule-I species in Reserve Forest areas	KEFD	10 yeas	10	100
3	Carryout plantation of *Commiphora wightii* 30.0 ha. in the first years (10ha/year) with maintenance @ Rs.95000/ha in Social Forestry Area Kutch district	KEFD	First 3 Years	0.95	28.5
4	Carry out tree plantation in surrounding villages habitat improvement for Schedule-1 birds species and Indian Peafowl	KEFD	10 years	2	20
	Subtotal for cost of activities				**323.5**
6	Monitoring and administrative activity cost (5% of total cost that is 323.5 Lc)	KEFD	10 years	5%	**16.2**
7	Contingencies @10% of total cost that is 323.5 Lc)	KEFD	10 years	10%	**32.4**
	Total Cost				**372.0**

8.2. JUSTIFICATION FOR FINANCIAL ALLOCATION

The present wildlife conservation plan is prepared as part of Environment Clearance process for the proposed Greenfield Copper Refinery project by Adani Enterprise Limited. As per Environmental Impact Assessment (EIA) Notification dated 14th September 2006, proposed project falls under category- A" of project activity 3(a) and requires prior Environmental Clearance (EC) to be obtained from Ministry of Environment, Forest & Climate Change (MoEF&CC) before the commencement of ground activity. Terms of Reference for EIA preparation has been issued by MoEF&CC vide letter reference F.No.J-11011/113/2016-IA.II(I) dated 21st June 2016. Approved ToR No. 5(v) reads as "*Wildlife Conservation Plan duly authenticated by the Chief Wildlife Warden of the State Government for conservation of Schedule-I fauna, if any exists in the study area is to be prepared"*.

The present document is a wildlife conservation plan prepared after primary and secondary survey of flora and fauna in the study area by a NABET accredited consultant. Since the present study identified several Schedule-I species of reptiles, birds and mammals, along with plant species of higher conservation significance (*Commiphora wightii* and Mangroves) in the study area of 10/15 km radius, several activities are proposed for their conservation and management. Plantation activities of *Commiphora wightii* shall be done as per existing plantation model of forest department i.e. 95000/ha. Total 500 ha. of plantation of Mangroves is proposed in the budget which would be as per "Raised Bed Plantation Model" which would aprox 30,000/ ha. Habitat improvements in the reserve forest areas is proposed through plantation activities in the reserve forest areas as per Coastal Border Plantation Model i.e. DF7. Mudflat conservation activities involve monitoring and surveillance activities by the forest department which would be carried by providing financial support of R. 25 Lakh. This could be used for hiring boat for surveillance activities or purchase of a boat for long term monitoring as per decision and discretion of the forest department.

The Stage-1 Forest Clearance has been obtained by the M/s APSEZ for 1576.81 Ha Forest Land in various patches. M/s APSEZ is under obligation to comply with all conditions of this Forest Clearance to secure Stage-2 clearance.

Copper project is proposed by separate company “M/s AEL” for which land shall be provided by M/s APSEZ as a clear land after all clearance. M/s AEL has obtained the TOR from MoEFCC for EIA of Copper Project and this Wildlife and Mangrove Conservation Plan is being prepared Condition No 5 (v) of the TOR received by M/s AEL. This conservation plan scope is to identify Schedule-I Fauna if any exist in the study area (10Km radius) and identify if may get impacted by the proposed copper project and prepare conservation plan for the same.

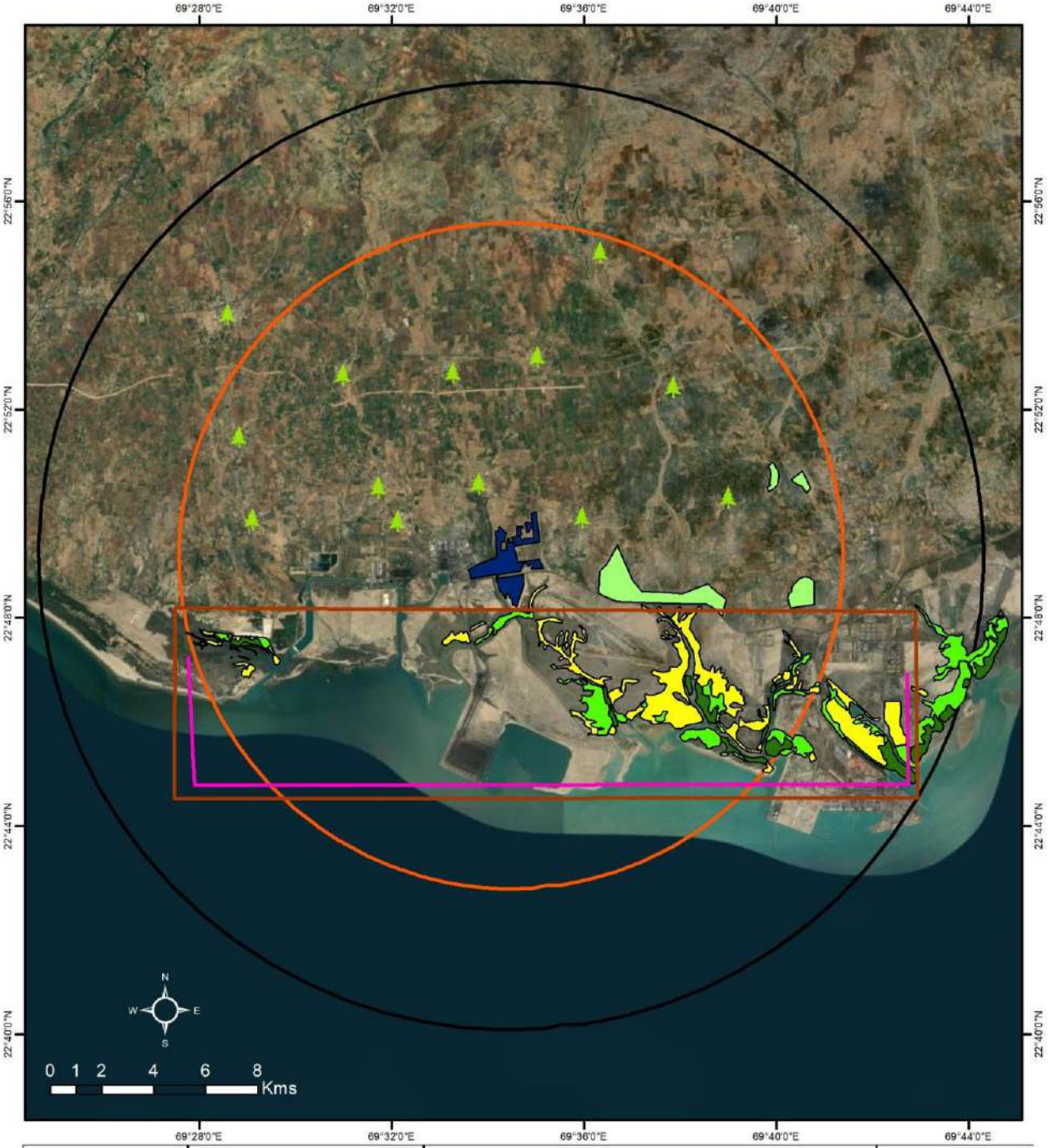
Proposed Copper project boundary does not fall inside any protected area or any ESZ of any protected area. There is guideline for wildlife conservation plan budget on the basis of percentage of total project cost only in case a project involves diversion of forest land in protected area which is not the case for Copper project of M/s AEL.

Hence, the conservation cost for wildlife and the mangroves for proposed Copper project has been arrived on the basis of scientific study and estimate for Schedule—I species in the study area (10 Km radius of copper project). Total Rs 372.0 Lakhs has been proposed as budget for conservation activities. Total cost of entire project shall be Rs 10,000 Cr.

Table-8.2: Year wise break up of cost for implementation of various activities by Kutch East Forest Division and AEL for 10 years.

Sr No	Activity	Implementing Agency	Years/ Cost in Lakh										
			1	2	3	4	5	6	7	8	9	10	Total
A	**Implementation & Monitoring Activities by Forest Dept.**												
1	Mangrove & Mudflat conservation activities												
a	Carry out Mangrove Plantation activities through Forest Dept. 50 ha. Per year for 10 years. By AEL @ Rs. 30000/ha. Reference: Raised bed model of Department of Forest, Govt of Gujarat.	Kutch East Forest Division (KEFD)	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	150.0
b	Forest department purchase/hire boat and satellite images for Mangrove & Mudflat monitoring and surveillance	KEFD	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	25.0
2	Habitat improvement for Schedule-I species in Reserve Forest areas	KEFD	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	100.0
3	Carryout plantation of *Commiphora wightii* 30.0 ha. in the first years (10ha/year) with maintenance @ Rs.95000/ha in Social Forestry Area Kutch district	KEFD	9.5	9.5	9.5								28.5
4	Carry out tree plantation in surrounding villages habitat improvement for Schedule-1 birds species and Indian Peafowl	KEFD	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	20.0
5	**Subtotal for activities**		39.0	39.0	39.0	29.5	29.5	29.5	29.5	29.5	29.5	29.5	**323.5**
6	Monitoring and administrative activity cost (5% of total cost that is 323.5 Lc)	KEFD	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	16.2
7	Contingencies @10% of total cost that is 323.5 Lc)		3.9	3.9	3.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0	**32.4**
	Total Cost		**44.9**	**44.9**	**44.9**	**33.9**	**33.9**	**33.9**	**33.9**	**33.9**	**33.9**	**33.9**	**372.0**

Map-8.1: Locations identified for wildlife and mangrove conservation interventions by Gujarat Forest Department & AEL



Legend	Intervention Location	Interventions	Agency
	Project Area	Pollution control measures	AEL
	10 Km Buffer Study Area	Periodical Biodiversity Monitoring	AEL
	15 Km Buffer Study Area	Periodical Biodiversity Monitoring	AEL
	Social Forestry in Villages	Tree Plantation for Peafowls & other schedule-I Birds	Forest Dept.
	Forest Area	Habitat Improvement for Schedule-I species	Forest Dept.
		Commiphora wightii (Gugal) Plantation	
	Dense Mangrove	Mangrove Health Monitoring	AEL
	Sparse Mangrove	Mangrove Plantation	Forest Dept.
	Scattered Mangroves	Mangrove Plantation	Forest Dept.
	Mudflats *	Mudflat conservation activities	Forest Dept.

* Area of Mudflats are not yet identified on CZMP maps of Kutch district. After finalization of CZMP, areas of mudflats would be identified on maps. However, budget for their conservation is earmarked in the report.

9. REFERENCES

BirdLife International (2001) Threatened birds of Asia: the BirdLife International Red Data Book. Cambridge, UK: BirdLife International.

Champion, H. G. & S. K. Seth. 1968. A Revised Survey of the Forest Types of India. Manager of Publications, Govt. of India, New Delhi.

Curtis, J.T. & R.P. McIntosh. 1950. The interrelations of certain analytic and synthetic phytosociological characters. Ecology 31: 434- 455.

Doganlar, Z.B., & Atmaca, M. (2011). Influence of Airborne Pollution on Cd, Zn, Pb, Cu, and Al accumulation and physiological parameters of plant leaves in Antakya (Turkey). Water, Air and Soil Pollution, 214, 509-513.

MacFarlane, G.R. and Burchett, M.D. (2002) Toxicity, growth and accumulation relationships of copper, lead and zinc in the Grey Mangrove Avicennia marina (Forsk.) Veirh. Marine Environmental Research, 54: 65-84.

MacFarlane, G.R., Koller, C.E. and Blomberg, S.P. (2007) Accumulation and partitioning of heavy metals in mangroves: A synthesis of field-based studies. Chemosphere, 69: 14541464.

NCSCM 2018. (Comprehensive and Integrated plan for preservation and conservation of mangroves and associated creeks in and around the Adani Ports and Special Economic Zone Ltd., Mundra, Gujarat').

Rodgers, W. A., Panwar, H. S. and Mathur, V. B. (2000) Wildlife Protected Area Network in India: A Review (Executive Summary). Wildlife Institute of India, Dehra Dun. Pp. 44..

Shakeri, A., & Moore, F. (2010). The impact of an industrial complex on freshly deposited sediments, Chener Rahdar river case study, Shiraz, Iran. Environmental Monitoring and Assessment, 169(2), 321-334.

Thivakaran G.A . and Sawale Amol Kumar.2016. Mangrove macrofaunal diversity and community structure in Mundra and Kharo, Kachchh, Gujarat. Indian Journal of Geo Marine Sciences Vol. 45 (11), November 2016, pp. 1584-1592.

Wildlife (Protection) Act (1972) 1993. Ministry of Environment and Forests, Government of India. http://envfor.nic.in/legis/wildlife/wildlife1.html [accessed 6 Nov 2008].

Zabetoglou, K., Voutsa, D. & Samara, C. (2002). Toxicity and heavy metal contamination of surficial sediment from Bay of Thessaloniki (Northwestern Aegean Sea) Greece. Chemosphere, 49, 17-26.

ANNEXURE-8

F. No. J-11011/113/2016-IA-II.(I)
Government of India
Ministry of Environment & Forests
(IA-II Division)

Paryavaran Bhawan,
CGO Complex, Lodhi Road,
New Delhi-110 003.
Email: sharath.kr@gov.in

Dated: 24th March , 2017

To
M/s Adani Enterprises Limited,
Sambhaav House,
Judges Bungalow Road, Bodakdev,
Ahmedabad, Gujarat -380015.

CORRIGENDUM

Sub: Greenfield Copper Refinery Plant (10 MTPA) project of M/s Adani Enterprises Limited located at Adani Port Special Economic Zone Land in Village(s) Siracha and Navinal, Taluka Mundra, District Kutch, Gujarat – regarding corrigendum to ToR

Ref: AEL/Copper/Mundra/MoEFCC/Env/Amd/Feb2017/out-1 dated 21.02.2017

This has reference this Ministrys letter of even No. J-11011/113/2016-IA.II(I) dated 21.06.2016 prescribing ToRs for the above mentioned proposal for preparation of EIA/EMP report under the provisions of Environment Impact Assessment Notification, 2006 as amended.

2. The Ministry of Environment, Forest and Climate Change has examined the request. In partial modification of this Ministry's letter of even no. dated 21.06.2016, the following changes are incorporated in the ToR letter.

For	Read as
Greenfield Copper Refinery Plant (10 MTPA) project of M/s Adani Enterprises Limited located at Adani Port Special Economic Zone Land in Village(s) Siracha and Navinal, Taluka Mundra, District Kutch, Gujarat	Greenfield Copper Refinery Plant **(1.0 MTPA)** project of M/s Adani Enterprises Limited located at Adani Port Special Economic Zone Land in Village(s) Siracha and Navinal, Taluka Mundra, District Kutch, Gujarat

3.0 All other conditions of the above referred Terms of Reference letter shall remain unchanged

This issues with the approval of competent authority.

24/3/17

(Sharath Kumar Pallerla)
Scientist 'F'

Copy to:-

1. The Secretary, Department of Environment, Government of Gujrat.
2. The Additional Principal Chief Conservator of Forests (C), Ministry of Environment, Forest and Climate Change, Regional Office (WZ), E-5, Kendriya Paryavaran Bhawan, E-5 Arera Colony, Link Road-3, Ravishankar Nagar, Bhopal – 462016.

ANNEXURE-8

F. No. J-11011/113/2016-IA.II(I)
Government of India
Ministry of Environment, Forest and Climate Change
(I.A. Division)

Indira Paryavaran Bhawan
Jor Bagh Road, Aliganj,
New Delhi - 110003
E-mail: satish.garkoti@nic.in
Tel: 011-24695316

Dated: 21st June, 2016

To

M/s Adani Enterprises Limited.
Sambhaav House,
Judges Bungalow Road, Bodakdev ,
Ahmedabad, Gujarat-380015.

Subject: Greenfield Copper Refinery Plant (10 MTPA) project of M/s Adani Enterprises Limited located at Adani Port Special Economic Zone Land in Village(s) Siracha and Navinal, Taluka Mundra, District Kutch, Gujarat - prescribing of ToRs regarding.

Sir,

This has reference to your online application No. IA/GJ/IND/53004/2016 dated 21st April, 2016 along with the application in prescribed format (Form-I), copy of pre-feasibility report and proposed TORs for undertaking detailed EIA study as per the EIA Notification, 2006 for the project mentioned above. The proposed project activity is listed at S.No. 3(a), under category 'A' of the Schedule of EIA Notification, 2006 and appraised at the Central level.

2.0 M/s. Adani Enterprises Limited proposes to install a new manufacturing unit for 10 LTPA copper project. It is proposed to set up the plant for Copper Cathode based on Pyrometallurgical process technology and Electro-refining process. The proposed unit will be located at Adani Port Special Economic Zone (APSEZ) land (Siracha and Navinal Villages), Mundra Taluka, Kutch District, Gujarat State. The proponent has provided 3 sites for the project and proposed to set up the plant at Site-II. The land required for the project is 256.58 ha, out of which 154.18 ha is for industrial use and 102.38 ha is forest land. It has been informed that state government has recommended the forest diversion proposal to the Central Government. The proponent has also informed that the merits for selecting Site-II for the project inter-alia include proximity to west port from where major raw material will be imported, major part of land is within the notified SEZ and also the forest land diversion proposal is forwarded by the State government to Central Government. The proposed site lies between 22°48'55.78" N Latitude and 69°34'32.02" E Longitude. There are no national parks/ wildlife sanctuary within 10 km radius. The project area falls under Seismic Zone V. The estimated project cost is Rs. 10,000 Crore and the estimated environment protection cost is Rs. 900 crores. Employment generation from proposed project will be about 2000 direct employment and about 5000 indirect employment. The proposed capacity for different products for new site area as below:

Name of Unit	No. of Units	Capacity of each Unit	Production Capacity
Copper Smelter plant	2	4.5 LTPA	9 LTPA
Copper Refinery plant	2	5.0 LTPA	10 LTPA

Continuous cast copper rod plant	2/3	2.5/ 1.67 LTPA	5 LTPA
Copper scrap melting facility	2	0.5 LTPA	1 LTPA
Sulphuric acid plant	2	15 LTPA	30 LTPA
Phosphoric acid plant	2	2.5 LTPA (100% P_2O_5)	5 LTPA (100% P_2O_5)
Aluminium Fluoride plant	2	15,000 TPA	30,000 TPA
Selenium Recovery plant	2	144 TPA	288 TPA
Precious metal recovery plant (Gold)	2	25 TPA	50 TPA
Precious metal recovery plant (Silver)	2	250 TPA	500 TPA
Oxygen (industrial) Plant (95% Purity)	2	45,000 TPM	90,000 TPM
Waste heat recovery boiler	2	25 MW	50 MW

3.0 The electricity load required is 300 MW, out of this, 40 MW will be generated from internal process steam by waste heat recovery; whereas the remaining 260 MW power will be sourced from APSEZ Ltd. through M/s. Mundra Utility Pvt Ltd. Company has also proposed to install 6 DG Set of 1200 - 2000 KVA Each, as a backup facility.

4.0 Proposed raw material requirement for project are Copper concentrate and Rock phosphate. Requirement would be fulfilled by importing as well as from domestic market. Fuel consumption will be mainly Furnace Oil, LPG/NG and Coal for process requirement. Water Consumption for the proposed project will be 32,800 KLD desalinated water and waste water generation will be nil outside the project boundary. Domestic waste water will be treated through Sewage treatment plant and industrial waste water generated will be treated in the Effluent Treatment Plant & through reverse Osmosis plant and reused in the process. ETP Sludge shall be disposed as per applicable hazardous waste management rules.

5.0 The above proposal was considered by the Expert Appraisal Committee (Industry) during its 6th meeting held on 3rd – 4th May, 2016 for prescribing TORs for undertaking detailed EIA/EMP study.

6.0 Based on the information furnished and presentation made by the project proponent, the Committee recommended prescribing following specific TORs for undertaking detailed EIA and EMP study in addition to the generic TOR enclosed at **Annexure I read with additional TORs at Annexure-2.**

i. The Public Hearing for the project should be conducted by Gujarat Pollution Control Board

ii. The issues raised during public hearing and commitment of the project proponent on the same along with time bound action plan to implement the commitment and financial allocation thereto should be clearly provided.

iii. The project proponent should carry out social impact assessment of the project as per the Office Memorandum No. J-11013/25/2014-IA.I dated 11.08.2014 issued by the Ministry regarding guidelines on Environment Sustainability and CSR related issues. The social impact assessment study so carried out should form part of EIA and EMP report.

iv. Plan for management of Arsenic bearing sludge should be submitted.

ANNEXURE –I

GENERIC TERMS OF REFERENCE (TOR) IN RESPECT OF INDUSTRY SECTOR

1. Executive Summary
2. Introduction
   - i. Details of the EIA Consultant including NABET accreditation
   - ii. Information about the project proponent
   - iii. Importance and benefits of the project

3. Project Description
   - i. Cost of project and time of completion.
   - ii. Products with capacities for the proposed project.
   - iii. If expansion project, details of existing products with capacities and whether adequate land is available for expansion, reference of earlier EC if any.
   - iv. List of raw materials required and their source along with mode of transportation.
   - v. Other chemicals and materials required with quantities and storage capacities
   - vi. Details of Emission, effluents, hazardous waste generation and their management.
   - vii. Requirement of water, power, with source of supply, status of approval, water balance diagram, man-power requirement (regular and contract)
   - viii. Process description along with major equipments and machineries, process flow sheet (quantative) from raw material to products to be provided
   - ix. Hazard identification and details of proposed safety systems.
   - x. Expansion/modernization proposals:
     - a. Copy of all the Environmental Clearance(s) including Amendments thereto obtained for the project from MOEF/SEIAA shall be attached as an Annexure. A certified copy of the latest Monitoring Report of the Regional Office of the Ministry of Environment and Forests as per circular dated 30th May, 2012 on the status of compliance of conditions stipulated in all the existing environmental clearances including Amendments shall be provided. In addition, status of compliance of Consent to Operate for the ongoing /existing operation of the project from SPCB shall be attached with the EIA-EMP report.
     - b. In case the existing project has not obtained environmental clearance, reasons for not taking EC under the provisions of the EIA Notification 1994 and/or EIA Notification 2006 shall be provided. Copies of Consent to Establish/No Objection Certificate and Consent to Operate (in case of units operating prior to EIA Notification 2006, CTE and CTO of FY 2005-2006) obtained from the SPCB shall be submitted. Further, compliance report to the conditions of consents from the SPCB shall be submitted.

4. Site Details
   - i. Location of the project site covering village, Taluka/Tehsil, District and State, Justification for selecting the site, whether other sites were considered.
   - ii. A toposheet of the study area of radius of 10km and site location on 1:50,000/1:25,000 scale on an A3/A2 sheet. (including all eco-sensitive areas and environmentally sensitive places)
   - iii. Co-ordinates (lat-long) of all four corners of the site.
   - iv. Google map-Earth downloaded of the project site.

v. Layout maps indicating existing unit as well as proposed unit indicating storage area, plant area, greenbelt area, utilities etc. If located within an Industrial area/Estate/Complex, layout of Industrial Area indicating location of unit within the Industrial area/Estate.

vi. Photographs of the proposed and existing (if applicable) plant site. If existing, show photographs of plantation/greenbelt, in particular.

vii. Landuse break-up of total land of the project site (identified and acquired), government/private - agricultural, forest, wasteland, water bodies, settlements, etc shall be included. (not required for industrial area)

viii. A list of major industries with name and type within study area (10km radius) shall be incorporated. Land use details of the study area

ix. Geological features and Geo-hydrological status of the study area shall be included.

x. Details of Drainage of the project upto 5km radius of study area. If the site is within 1 km radius of any major river, peak and lean season river discharge as well as flood occurrence frequency based on peak rainfall data of the past 30 years. Details of Flood Level of the project site and maximum Flood Level of the river shall also be provided. (mega green field projects)

xi. Status of acquisition of land. If acquisition is not complete, stage of the acquisition process and expected time of complete possession of the land.

xii. R&R details in respect of land in line with state Government policy

5. **Forest and wildlife related issues (if applicable):**

i. Permission and approval for the use of forest land (forestry clearance), if any, and recommendations of the State Forest Department. (if applicable).

ii. Landuse map based on High resolution satellite imagery (GPS) of the proposed site delineating the forestland (*in case of projects involving forest land more than 40 ha).*

iii. Status of Application submitted for obtaining the stage I forestry clearance along with latest status shall be submitted.

iv. The projects to be located within 10 km of the National Parks, Sanctuaries, Biosphere Reserves, Migratory Corridors of Wild Animals, the project proponent shall submit the map duly authenticated by Chief Wildlife Warden showing these features vis-à-vis the project location and the recommendations or comments of the Chief Wildlife Warden-thereon.

v. Wildlife Conservation Plan duly authenticated by the Chief Wildlife Warden of the State Government for conservation of Schedule I fauna, if any exists in the study area.

vi. Copy of application submitted for clearance under the Wildlife (Protection) Act, 1972, to the Standing Committee of the National Board for Wildlife

6. **Environmental Status**

i. Determination of atmospheric inversion level at the project site and site-specific micro-meteorological data using temperature, relative humidity, hourly wind speed and direction and rainfall.

ii. AAQ data (except monsoon) at 8 locations for PM10, PM2.5, SO2, NOX, CO and other parameters relevant to the project shall be collected. The monitoring stations shall be based CPCB guidelines and take into account the pre-dominant wind direction, population zone and sensitive receptors including reserved forests.

iii. Raw data of all AAQ measurement for 12 weeks of all stations as per frequency given in the NAQQM Notification of Nov. 2009 along with – min.,

max., average and 98% values for each of the AAQ parameters from data of all AAQ stations should be provided as an annexure to the EIA Report.

iv. Surface water quality of nearby River (60m upstream and downstream) and other surface drains at eight locations as per CPCB/MoEF&CC guidelines.

v. Whether the site falls near to polluted stretch of river identified by the CPCB/MoEF&CC.

vi. Ground water monitoring at minimum at 8 locations shall be included.

vii. Noise levels monitoring at 8 locations within the study area.

viii. Soil Characteristic as per CPCB guidelines.

ix. Traffic study of the area, type of vehicles, frequency of vehicles for transportation of materials, additional traffic due to proposed project, parking arrangement etc.

x. Detailed description of flora and fauna (terrestrial and aquatic) existing in the study area shall be given with special reference to rare, endemic and endangered species. If Schedule-I fauna are found within the study area, a Wildlife Conservation Plan shall be prepared and furnished.

xi. Socio-economic status of the study area.

7. Impact Assessment and Environment Management Plan

i. Assessment of ground level concentration of pollutants from the stack emission based on site-specific meteorological features. In case the project is located on a hilly terrain, the AQIP Modelling shall be done using inputs of the specific terrain characteristics for determining the potential impacts of the project on the AAQ. Cumulative impact of all sources of emissions (including transportation) on the AAQ of the area shall be well assessed. Details of the model used and the input data used for modeling shall also be provided. The air quality contours shall be plotted on a location map showing the location of project site, habitation nearby, sensitive receptors, if any.

ii. Water Quality modelling – in case, if the effluent is proposed to be discharged in to the local drain, then Water Quality Modelling study should be conducted for the drain water taking into consideration the upstream and downstream quality of water of the drain.

iii. Impact of the transport of the raw materials and end products on the surrounding environment shall be assessed and provided. In this regard, options for transport of raw materials and finished products and wastes (large quantities) by rail or rail-cum road transport or conveyor-cum-rail transport shall be examined.

iv. A note on treatment of wastewater from different plant operations, extent recycled and reused for different purposes shall be included. Complete scheme of effluent treatment. Characteristics of untreated and treated effluent to meet the prescribed standards of discharge under E(P) Rules.

v. Details of stack emission and action plan for control of emissions to meet standards.

vi. Measures for fugitive emission control

vii. Details of hazardous waste generation and their storage, utilization and disposal. Copies of MOU regarding utilization of solid and hazardous waste shall also be included. EMP shall include the concept of waste-minimization, recycle/reuse/recover techniques, Energy conservation, and natural resource conservation.

viii. Proper utilization of fly ash shall be ensured as per Fly Ash Notification, 2009. A detailed plan of action shall be provided.

ix. Action plan for the green belt development plan in 33 % area i.e. land with not less than 1,500 trees per ha. Giving details of species, width of plantation, planning schedule etc. shall be included. The green belt shall be around the project boundary and a scheme for greening of the roads used for the project shall also be incorporated.

x. Action plan for rainwater harvesting measures at plant site shall be submitted to harvest rainwater from the roof tops and storm water drains to recharge the ground water and also to use for the various activities at the project site to conserve fresh water and reduce the water requirement from other sources.

xi. Total capital cost and recurring cost/annum for environmental pollution control measures shall be included.

xii. Action plan for post-project environmental monitoring shall be submitted.

xiii. Onsite and Offsite Disaster (natural and Man-made) Preparedness and Emergency Management Plan including Risk Assessment and damage control. Disaster management plan should be linked with District Disaster Management Plan.

8. Occupational health

i. Details of existing Occupational & Safety Hazards. What are the exposure levels of above mentioned hazards and whether they are within Permissible Exposure level (PEL). If these are not within PEL, what measures the company has adopted to keep them within PEL so that health of the workers can be preserved,

ii. Details of exposure specific health status evaluation of worker. If the workers' health is being evaluated by pre designed format, chest x rays, Audiometry, Spirometry, Vision testing (Far & Near vision, colour vision and any other ocular defect) ECG, during pre placement and periodical examinations give the details of the same. Details regarding last month analyzed data of abovementioned parameters as per age, sex, duration of exposure and department wise.

iii. Annual report of heath status of workers with special reference to Occupational Health and Safety.

iv. Plan and fund allocation to ensure the occupational health & safety of all contract and casual workers.

9. Corporate Environment Policy

i. Does the company have a well laid down Environment Policy approved by its Board of Directors? If so, it may be detailed in the EIA report.

ii. Does the Environment Policy prescribe for standard operating process / procedures to bring into focus any infringement / deviation / violation of the environmental or forest norms / conditions? If so, it may be detailed in the EIA.

iii. What is the hierarchical system or Administrative order of the company to deal with the environmental issues and for ensuring compliance with the environmental clearance conditions? Details of this system may be given.

iv. Does the company have system of reporting of non compliances / violations of environmental norms to the Board of Directors of the company and / or shareholders or stakeholders at large? This reporting mechanism shall be detailed in the EIA report

10. Details regarding infrastructure facilities such as sanitation, fuel, restroom etc. to be provided to the labour force during construction as well as to the casual workers including truck drivers during operation phase.

11. Any litigation pending against the project and/or any direction/order passed by any Court of Law against the project, if so, details thereof shall also be included. Has the unit received any notice under the Section 5 of Environment (Protection) Act, 1986 or relevant Sections of Air and Water Acts? If so, details thereof and compliance/ATR to the notice(s) and present status of the case.

12. 'A tabular chart with index for point wise compliance of above TORs.

13. The TORs prescribed shall be valid for a period of three years for submission of the EIA-EMP reports along with Public Hearing Proceedings (wherever stipulated).

The following general points shall be noted:

i. All documents shall be properly indexed, page numbered.
ii. Period/date of data collection shall be clearly indicated.
iii. Authenticated English translation of all material in Regional languages shall be provided.
iv. The letter/application for environmental clearance shall quote the MOEF file No. and also attach a copy of the letter.
v. The copy of the letter received from the Ministry shall be also attached as an annexure to the final EIA-EMP Report.
vi. The index of the final EIA-EMP report must indicate the specific chapter and page no. of the EIA-EMP Report
vii. While preparing the EIA report, the instructions for the proponents and instructions for the consultants issued by MOEF vide O.M. No. J-11013/41/2006-IA.II (I) dated 4th August, 2009, which are available on the website of this Ministry shall also be followed.
viii. The consultants involved in the preparation of EIA-EMP report after accreditation with Quality Council of India (QCI) /National Accreditation Board of Education and Training (NABET) would need to include a certificate in this regard in the EIA-EMP reports prepared by them and data provided by other organization/Laboratories including their status of approvals etc. Name of the Consultant and the Accreditation details shall be posted on the EIA-EMP Report as well as on the cover of the Hard Copy of the Presentation material for EC presentation.
ix. TORs' prescribed by the Expert Appraisal Committee (Industry) shall be considered for preparation of EIA-EMP report for the project in addition to all the relevant information as per the 'Generic Structure of EIA' given in Appendix III and IIIA in the EIA Notification, 2006. Where the documents provided are in a language other than English, an English translation shall be provided. The draft EIA-EMP report shall be submitted to the State Pollution Control Board of the concerned State for conduct of Public Hearing. The SPCB shall conduct the Public Hearing/public consultation, district-wise, as per the provisions of EIA notification, 2006. The Public Hearing shall be chaired by an Officer not below the rank of Additional District Magistrate. The issues raised in the Public Hearing and during the consultation process and the commitments made by the project proponent on the same shall be
x. included separately in EIA-EMP Report in a separate chapter and summarised in a tabular chart with financial budget (capital and revenue) along with time-schedule of implementation for complying with the commitments made. The final EIA report shall be submitted to the Ministry for obtaining environmental clearance.

ANNEXURE-2

METALLURGICAL INDUSTRY (FERROUS AND NON-FERROUS)

1. Complete process flow diagram describing each unit, its processes and operations, along with material and energy inputs & outputs (material and energy balance).
2. Emission from sulphuric acid plant and sulphur muck management.
3. Details on installation of Continuous Emission Monitoring System with recording with proper calibration system
4. Details on toxic metals including fluoride emissions
5. Details on stack height.
6. Details on ash disposal and management
7. Complete process flow diagram describing process of lead/zinc/copper/ aluminium, *etc.*
8. Details on smelting, thermal refining, melting, slag fuming, and Waelz kiln operation
9. Details on Holding and de-gassing of molten metal from primary and secondary aluminum, materials pre-treatment, and from melting and smelting of secondary aluminium
10. Details on toxic metal content in the waste material and its composition and end use (particularly of slag).
11. Trace metals in waste material especially slag.
12. Plan for trace metal recovery
13. Trace metals in water

****

Format for Executive Summary

Executive summary of the report in about 8-10 pages incorporating the following:

i. Project name and location (Village, Dist, State, Industrial Estate (if applicable)

ii. Products and capacities. If expansion proposal then existing products with capacities and reference to earlier EC.

iii. Requirement of land, raw material, water, power, fuel, with source of supply (Quantitative)

iv. Process description in brief, specifically indicating the gaseous emission, liquid effluent and solid and hazardous wastes.

v. Measures for mitigating the impact on the environment and mode of discharge or disposal.

vi. Capital cost of the project, estimated time of completion

vii. Site selected for the project – Nature of land – Agricultural (single/double crop), barren, Govt/private land, status of is acquisition, nearby (in 2-3 km.) water body, population, with in 10km other industries, forest , eco-sensitive zones, accessibility, (note – in case of industrial estate this information may not be necessary)

viii. Baseline environmental data – air quality, surface and ground water quality, soil characteristic, flora and fauna, socio-economic condition of the nearby population

ix. Identification of hazards in handling, processing and storage of hazardous material and safety system provided to mitigate the risk.

x. Likely impact of the project on air, water, land, flora-fauna and nearby population

xi. Emergency preparedness plan in case of natural or in plant emergencies

xii. Issues raised during public hearing (if applicable) and response given

xiii. CSR plan with proposed expenditure.

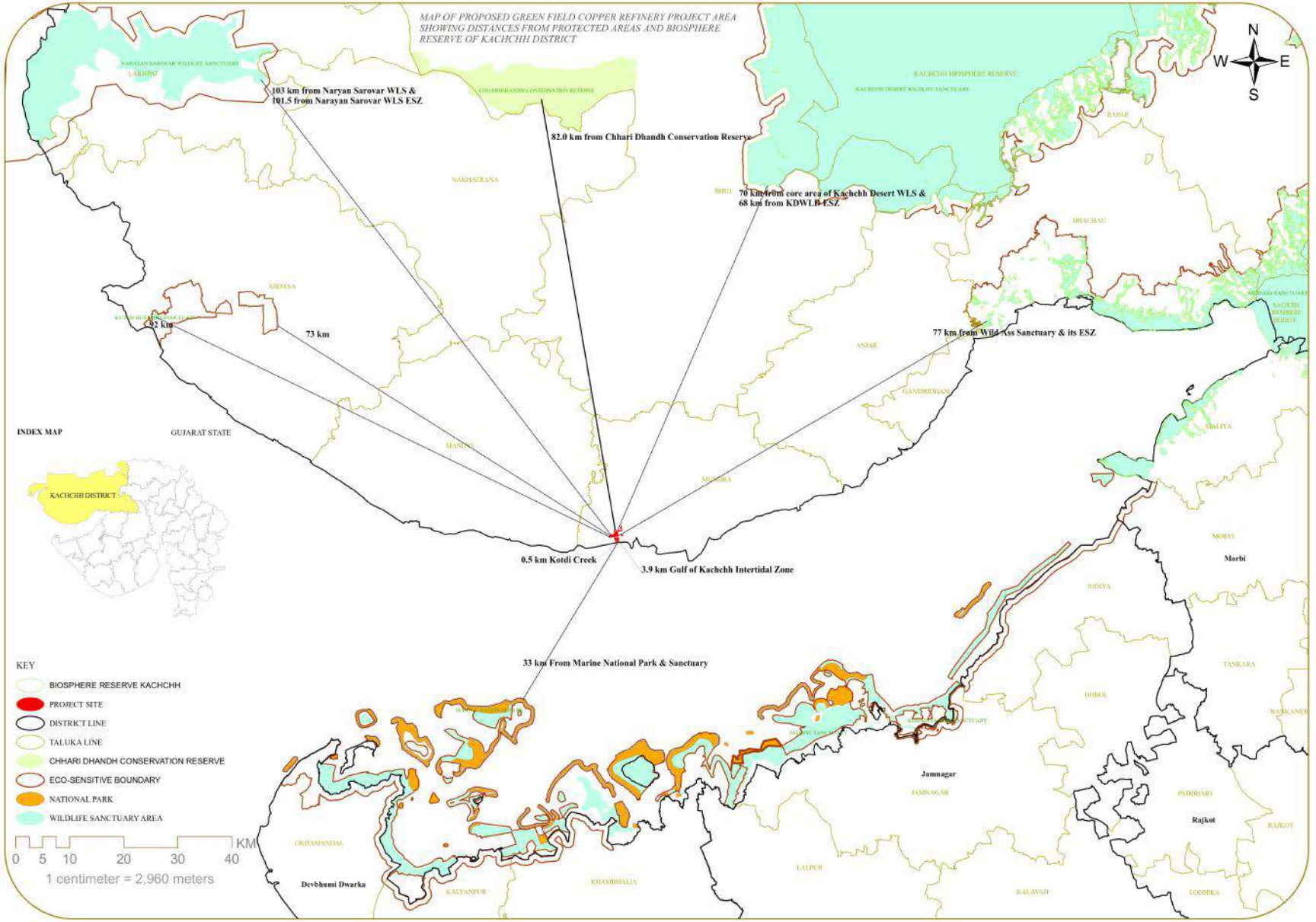
xiv. Occupational Health Measures

xv. Post project monitoring plan

Annexure-II: Coordinates of sampling locations in Buffer and Core areas of the study area.

Core area Sample Locations			
Plot No	**North**	**East**	**Habitat type**
1	22°48'43.26"N	69°34'26.89"E	Open saline land
2	22°48'47.78"N	69°34'36.48"E	Open saline land
3	22°48'40.92"N	69°34'13.65"E	Open saline land
4	22°49'30.25"N	69°34'50.59"E	Open land
5	22°49'27.38"N	69°34'34.17"E	Open scrubland
6	22°49'20.13"N	69°34'26.52"E	Open scrubland
7	22°49'16.23"N	69°34'20.21"E	Open scrubland
8	22°49'0.08"N	69°34'12.49"E	Dense Scrubland
9	22°49'21.99"N	69°34'12.60"E	Open scrubland
10	22°49'31.29"N	69°34'13.50"E	Open scrubland
Buffer area Sample Locations			
1	22°49'16.23"N	69°35'25.35"E	Open Scrubland
2	22°48'47.15"N	69°35'39.74"E	Open Scrubland
3	22°49'49.35"N	69°36'22.90"E	Fallow Agriculture
4	22°50'5.46"N	69°37'25.37"E	Open Scrubland
5	22°50'15.41"N	69°38'14.63"E	Open Scrubland
6	22°50'34.88"N	69°34'30.17"E	Open Scrubland
7	22°50'29.27"N	69°33'0.13"E	Fallow Agriculture
8	22°49'56.48"N	69°31'17.98"E	Open wetland edge
9	22°49'50.35"N	69°30'37.38"E	Open Scrubland
10	22°49'35.06"N	69°29'48.16"E	Open Scrubland
11	22°49'33.20"N	69°28'56.54"E	Fallow Agriculture
12	22°50'11.94"N	69°29'0.95"E	Open Scrubland
13	22°48'55.92"N	69°28'43.35"E	Dense Scrubland
14	22°51'50.67"N	69°32'15.60"E	Open Scrubland
15	22°52'25.78"N	69°32'32.67"E	Fallow Agriculture
16	22°53'13.44"N	69°32'51.48"E	Open Scrubland
17	22°53'38.09"N	69°32'44.84"E	Open Scrubland
18	22°53'4.82"N	69°34'12.08"E	Open Scrubland
19	22°52'57.20"N	69°34'35.93"E	Fallow Agriculture
20	22°53'0.63"N	69°37'22.55"E	Dry River bed
21	22°51'47.01"N	69°37'30.81"E	Dry River bed
22	22°50'29.42"N	69°37'35.47"E	Dry River bed
23	22°50'19.32"N	69°37'34.24"E	Dry River bed
24	22°48'18.47"N	69°36'19.97"E	Open saline land
25	22°48'21.81"N	69°37'0.83"E	Open saline land
26	22°48'15.62"N	69°37'42.99"E	Wet mudflat
27	22°48'23.89"N	69°37'39.89"E	Open saline land
28	22°48'15.97"N	69°38'41.74"E	Open saline land
29	22°48'45.25"N	69°38'58.00"E	Dense Scrubland
30	22°49'30.21"N	69°38'58.00"E	Open saline land

Annexure-III: Map of proposed green field copper refinery project area showing distances from protected areas and biosphere reserve of Kachchh district.



Annexure-IV: Stage-I Clearance for Forest Area to be diverted by APSEZ.

F. No. 8-04/2016-FC
Government of India
Ministry of Environment, Forest and Climate Change
(Forest Conservation Division)
****

Indira Paryavaran Bhawan
Aliganj, Jorbagh Road
New Delhi – 110 003
Dated: 16th November, 2018

To,

The Principal Secretary (Forests),
Department of Forests & Environment,
Government of Gujarat,
Gandhi Nagar.

Sub: Diversion of 1576.81 ha Reserved Forest Land in favour of Adani Ports and Special Economic Zone Ltd. (APSEZL) for the development of Special Economic Zone (SEZ) and Industrial Park at Village – Siracha, Navinal, Dhrub, Mundra, Baroi, Gorasama, Luni, Bhadreshwar, Tehsil Mundra, under Forest Division and District Kutch, Gujarat (Online Proposal No. FP/GJ/IND/17613/2004):- Reg.

Sir,

I am directed to refer to the APCCF (Land Management) and Nodal Officer, (FCA), Govt. of Gujarat letter No. FCA-1014/10-11/14/S.F-66/F dated 21.01.2016 for seeking prior approval of Central Government under Section-2 of the Forest (Conservation) Act, 1980. The proposal has been examined by the Forest Advisory Committee (FAC) constituted by the Central Government under Section-3 of the aforesaid Act.

2. After careful consideration of the proposal of the State Government of Gujarat and on the basis of the recommendations of the Forest Advisory Committee (FAC), the Central Government hereby agrees to accord *"In-principle"* approval under Section-2 of the Forest (Conservation) Act, 1980 for diversion of 1576.81 ha Reserved Forest Land in favour of Adani Ports and Special Economic Zone Ltd. (APSEZL) for the development of Special Economic Zone (SEZ) and Industrial Park at Village – Siracha, Navinal, Dhrub, Mundra, Baroi, Gorasama, Luni, Bhadreshwar, Tehsil Mundra, under Forest Division and District Kutch, Gujarat, subject to the following conditions:-

(i) Legal status of the diverted forest land shall remain unchanged;

(ii) *The entire forest area being diverted, should not be cleared off the vegetation in one go after diversion. The UA may clear vegetation for the purpose of basic/essential infrastructure to be developed in the SEZ. Thereafter, as and when a specific project / industry is to come up in the SEZ, the corresponding area shall be marked on the ground and cleared off vegetation. Till then the remaining areas shall be maintained as green cover. It shall be ensured that the lease agreement is made within six months of such clearing. A detailed land use for the marked area, on which clearing of vegetation is proposed shall be submitted to the Regional Office of MoEF&CC before start of work on the area, for information. The Regional Office of MoEF&CC shall ensure that the user agency carries out the work which is in conformity with the broad land use submitted by it. It shall be ensured that minimum number of trees are cleared. The user agency shall explore the possibility of trees of 10 cm dia at breast height and above, proposed for felling/clearing are translocated to suitable location within or outside the SEZ in consultation with State Forest department;*

(iii) Felling of tress on the forest land being diverted shall be reduced to the bare minimum and the trees should be felled under strict supervision of the State Forest Department;

(iv) *The diverted forest land shall not be proposed to be utilized for Golf Course, Beach Resort, Park or Residential purposes, or any other activity prohibited by FCA 1980, FC Rules and/or guidelines made there under*

(v) *The diverted forest land shall not be used for the construction/expansion of any private Aerodrome. The forest land may be considered, in future on merits, in case of commercial Airport is developed with the approval of DGCA.*

(vi) *The detailed existing land use with maps of all forest land 2008.41 ha (1840ha + 168.41 ha) for which the approval was granted vide letter dated 30.09.2009 and details of complete land use including forest land for the existing private Aerodrome and power plants within the SEZ may be provided for information;*

(vii) *Forest areas proposed within of Mundra survey no. 141/P, Baroi survey no. 207/P, Goversama survey no. 52/P, Luni survey no. 468/P and Bhadreswar survey no. 733/P are having sea front. 100mt shelter belt/green belt in above villages be included in the Master plan of the SEZ, excluding stretches where use of water front is inevitable;*

(viii) *All the conditions as recommended by the Chief Wildlife Warden shall be complied with the User Agency;*

(ix) *The State Government shall clarify whether any non-forest land situated in and around the SEZ but not forming part of the SEZ at present, can be acquired by/allotted to the APSEZ before Stage-II approval;*

(x) *If 683 ha land of GMB or any other non-forest land is allotted for this SEZ, then the equivalent forest land shall be reduced from the forest land diverted/being diverted for the SEZ;*

(xi) *The State Government and the UA shall make effort to include 122 ha of non-forest land in village Jarapara in the SEZ. Accordingly, it is recommended that 122 ha of forest land in Bhadreswar Block shall be maintained as green belt at the cost of UA;*

(xii) *State government will provide details of lease period, terms and conditions on which the forest land is proposed to be diverted in favour of the Use Agency;*

(xiii) *All other conditions imposed in the approval granted for diversion of 2008.41 ha (1840ha + 168.41 ha) forest land on 30.09.2009 shall be complied;*

(xiv) *Only site-specific activities, permissible under the Rules and guidelines framed under the FC Act, shall be taken up in the forest land to be diverted;*

(xv) *The recommendation of the FAC is subject to the condition that in case of conflicts, the provisions of FC Act, 1980, shall prevail over those of SEZ Act 2005;*

(xvi) *All other conditions/recommendations made by FAC on this proposal in its meeting on 25.01.2018, not in conflict with the recommendation of FAC on 20.09.2018 shall remain unchanged.*

(xvii) *The User agency shall identify suitable land for Compensatory Afforestation over double the forest area being diverted. The land shall be mutated in the name of State Forest Department before the Stage-II approval;*

(xviii) *The User Agency shall deposit in the designated account the estimated amount towards compensatory afforestation to be carrying out by the State Forest Department;*

(xix) The Compensatory Afforestation shall be done over double non-forest land (NFL) i.e *3154 ha* to the forest area proposed to be diverted, as per the recommendation of Government of Gujarat, vide its GR No. FCA-1013/11-10/SF-24/F, dt 12.06.2015. The Compensatory Afforestation shall be done within a period of three years with effect from the date of issue of Stage-II clearance and maintained thereafter in accordance with the approved plan in consultation with the State Forest Department at the cost of the User Agency. CA at rate of 1000 saplings per hectares shall be planted over *3154.00* ha.

(31,54,000 plants). If this is not possible to plant these many seedlings in the identified NFL, the balance seedlings will be planted in degraded forest land as per the prescriptions of the Working Plan at the cost of the User agency. In such case CA cost will be revised and duly approved by competent authority and will be deposited online in the Adhoc-CAMPA account of the state concerned;

(xx) The User agency shall identify and mutate in the name of State Forest Department of Government of Gujarat, 3154 ha of suitable non-forest land for CA adjacent to notified Forest for raising Compensatory Afforestation (CA) shall be notified as reserved Forest under Section-4 or Protected Forest under Section-29 of the Indian Forest Act, 1927 or under the relevant Section(s) of the local Forest Act. The Nodal officer must report compliance within a period of 6 month from the date of grant of final approval and send a copy of the notification declaring the non-forest land under Section 4 or Section 29 of the Indian Forest Act, 1927, or under the relevant section of the local Forest Act as the case may be, to this Ministry for information and record;

(xxi) The State Government shall submit a certificate, that site for CA is suitable and free from all encroachments and other encumbrances, under the signature not below the rank of Nodal Officer (FCA) in the State Government;

(xxii) The land identified for the purpose of CA shall be clearly depicted on a Survey of India toposheet of 1:50,000 scale;

(xxiii) *The Compensatory Afforestation land shall be surveyed at the cost of User Agency and the User Agency shall erect pillars and barbed wire fencing or trench under the consultation of CCF, Kutch Circle;*

(xxiv) The User Agency shall deposit the cost of raising and maintaining the compensatory afforestation at the current wage rate in the account of Adhoc-CAMPA of the state concerned through online e-portal only. The scheme may include appropriate provision for anticipated cost increase for works scheduled for subsequent years;

(xxv) The User Agency shall provide additionally 25% of the CA cost towards Soil and Moisture Conservation measures in the proposed CA area as per site requirement and the said amount shall be deposit in the account of Adhoc-CAMPA of the state concerned through online e-portal only;

(xxvi) The User Agency shall deposit, the Net Present Value (NPV) of the forest land being diverted under this proposal, as per the orders of the Hon'ble Supreme Court of India dated 28.03.2008, 24.04.2008 and 09.05.2008 in Writ Petition (Civil) No. 202/1995 and the guidelines issued by this Ministry vide its letter No. 5-3/2007-FC dated 05.02.2009. The requisite funds shall be deposited in the account of Adhoc-CAMPA of the state concerned through online e-portal only;

(xxvii) At the time of payment on the Net Present Value (NPV) at the then prevailing rate, the User Agency shall furnish an undertaking to pay the additional amount of NPV, if so determined, as per the final decision of the Hon'ble Supreme Court of India;

(xxviii) The user agency should ensure that the compensatory levies (CA cost, NPV etc.) are deposited through challan generated online on web portal and deposited in appropriate bank online only. Amount deposited through other modes will not be accepted as compliance of Stage-I clearance;

(xxix) The forest clearance will be for a period co-terminus with the lease period specified in the lease agreement. The State Government will submit the lease agreement documents specified in the lease agreement;

(xxx) The User agency shall obtain the Environment Clearance as per the provisions of the Environment (Protection) Act, 1986, if required;

(xxxi) *Complete compliance of CRZ regulations shall be ensured;*

(xxxii) Layout plan of the proposal shall not be changed without the prior approval of the Central Government;

(xxxiii) The User Agency will abide by the applicable recommendations of the State Government including State Forest/Wildlife Departments;

(xxxiv) State Government shall complete settlement of rights, in terms of the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, if any, on the forest land to be diverted and submit the documentary evidence as prescribed by this Ministry in its letter No. 11-9/1998-FC (pt.) dated 03.08.2009 read with 05.07.2013 in support thereof;

(xxxv) The user agency shall provide alternate fuels (LPG) to the labourers and the staff working at the site so as to avoid any damage and pressure on the nearby forest areas;

(xxxvi) Boundary of the forest land proposed to be diverted shall be demarcated on ground at the project cost, by erecting four feet high reinforced cement concrete pillars, each inscribed with its serial number, forward and back bearing, distance from pillar to pillar and GPS co-ordinates;

(xxxvii) Any other condition that the concerned Regional Office of this Ministry may stipulate, from time to time, in the interest of conservation, protection and development of forests & wildlife;

(xxxviii) The user agency shall submit the annual self-compliance report in respect of the above conditions to the State Government, concerned Regional Office and this Ministry by the end of March of every year regularly; and

(xxxix) The user agency and the State Government shall ensure compliance to provisions of the all Acts, Rules, Regulations, Guidelines, relevant Hon'ble Court Order (s) and National Green Tribunal (NGT) Order(s), if any, pertaining to this project for the time being in force, as applicable to the project.

3. After receipt of the report on compliance to the conditions stipulated in the paragraph-2 above, from the State Government of Gujarat, Final/Stage-II approval for diversion of the proposed forest land under Section-2 of the Forest (Conservation) Act, 1980 will be issued by this Ministry. Diversion of the proposed forest land to the user agency shall not be effected by the State Government of Gujarat, till Final/Stage-II approval is issued by this Ministry.

Yours faithfully,

16/11/2018

(Shrawan Kumar Verma)
Dy. Inspector General of Forests (FC)

Copy to:-

1. The PCCF, Govt. of Gujarat, Gandhinagar.
2. The Addl. PCCF (Central), Regional Office (Western Zone), Bhopal.

3. The Nodal Officer FCA, 1980, Forest Department O/o PCCF, Govt. of Gujarat, Gandhinagar.
4. User Agency.
5. Monitoring Cell, FC Division, MoEF & CC, New Delhi, for uploading.
6. Guard File.

16/11/2018

(Shrawan Kumar Verma)
Dy. Inspector General of Forests (FC)

EAC OBSERVATION NO.-9

EAC OBSERVATION:

Storm water management plan to be revised based on peak rainfall. Rainwater Harvesting calculations to be provided.

REPLY:

All the plants such as Copper smelter, refinery, SAP, PAP, AlF_3 plant, CCR, PMR will have their internal process water network for collection of spillages and floor washings. The same will be collected in the sumps provided in the respective areas. Sumps will be built with RCC concrete and lined with suitable lining. Sump pumps with valve and piping arrangement will be provided for utilising within the respective plant for process requirement and balance will be pumped to ETP for treatment.

The peak rainfall in the study area is about 467.9 mm/day (in Year 1959), while the average peak rainfall is about 41.38 mm/day in the region.

The runoff from roads & paved area and green belt/cover only will be carried by storm water drains. The runoff coefficients considered for estimating the runoff from these areas of the plants is based on CGWA guidelines and are as given below:

- Roads & paved area - 0.9; and
- Green belt/ green cover - 0.25

Strom water management system is designed using a simple drainage system considering peak/design discharge and sizing the drain to cope with the design peak run-off rate. In the absence of short duration rainfall data, India Meteorological Department (IMD) empirical reduction formula has been used for estimation of 1 hour rainfall (44.72 mm/hr).

As per CWC guidelines, discharge estimation for the watershed/catchment area less than 25 sq km can be done for a maximum flood of 50 years return period. The entire plant area is divided into four sections:

Section-I: Plant area (South) of Unit-I: Collection Pond – 5,500 M^3
Section-II: Plant area and slag storage (West) of Unit-II: Equalisation Pond – 8,000 M^3
Section-III: Plant area of (East) Unit-II: Collection Pond – 5,500 M^3
Section-IV: All storage areas (North) Unit-I & II: Equalisation Pond – 15,000 M^3

Above mentioned land use categories are considered as catchment areas and peak discharge from these catchments are calculated using modified Rational Method Qp = 1/36(KPcA)

where Qp = Discharge in m^3/s (for the 50 years return period)

K = Run-off Coefficient (calculated using catchment characteristics and 50-year 24-hour point rainfall)
Pc = Critical rainfall intensity in cm/hr (50 years rainfall intensity)
A = Catchment area in ha

The size of the drain is calculated with formula

$$Q = 1000 \times \left(\frac{A \times (R)^{0.67} \times (S)^{0.5}}{N} \right)$$

where Q = capacity of discharge of the drain (in l/s)
A = cross section of the flow (in m^2)
R = hydraulic radius of the drain
S = gradient of the drain
N = Manning's roughness coefficient

Section wise peak discharge and storm water drain dimensions worked based on above given formula are as given in table below:

TABLE-2:
SECTION WISE PEAK DISCHARGE AND STORM WATER DRAIN DIMENSIONS DETAILS

Section	Preliminary Areas Considered (ha)	Discharge (m^3/s)	Drain Width (m)	Drain Depth (m)	Drain cross sectional area (m^2)	Collection Sump Capacity (m^3)
I	22.89	1.52	0.8	1.2	0.96	5500
II	15.45	1.03	0.6	1.2	0.72	-
III	31.69	2.11	0.9	1.6	1.44	5500
IV	43.58	3.89	1.4	1.8	2.52	-

Note:- The drains will be laid on either side of the road. The design may be suitably modified based on detailed engineering.

All the solid waste storages will be constructed as per CPCB guideline with garland drains. Garland drains around respective solid waste facilities will be connected to the intermediate sumps. Water collected in these intermediate sumps will be pumped through pipeline network to two collection sumps of 8,000 m^3 and 15,000 m^3.

Storm water drainage system will be provided along the side of plant roads with required gradient. Intermediate sumps with gate valve arrangements, sump pumps and piping network will be provided to pump collected water to two collection sumps of 5500 m^3 each. The initial rain water will be collected in the proposed collection sumps and will be recycled for plant operation particularly in slag granulation system and MOL preparation. Any additional rain water post initial rainfall during monsoon will be discharged outside plant premises, after conforming with the discharge standards, in case of non-availability of space in proposed collection sumps.

Rainwater Harvesting (RWH) Structures

The RWH structure shall be designed as per the quantification of the rainwater run-off based on the average rainfall in the region. To understand the quantum of water available from the project area for rain water harvesting, reuse and ground water recharge, a tentative run-off estimation based on different land uses in the area is worked out and presented in **Table-1**. The annual volume of rain water available from the project site spread in 256.58 ha (634 acres) is estimated at 6,11,007 m^3 (0.61 MCM) and during SW and NE monsoon periods is 6,00,057 m^3 (0.60 MCM).

TABLE-1:
ANNUAL & MONSOON RUN-OFF FROM PROJECT SITE

Sr. No.	Land Use	Preliminary Area (ha)	Run-off Coefficient	Annual Rainfall (m)	Annual Run-off (m^3)	Monsoon Rainfall (m)	Monsoon Run-off (m^3)
1	Buildings/sheds	2.30	0.7	0.432	6957.44	0.425	6832.75
2	Plant & utilities	56.76	0.7	0.432	171817.06	0.425	168737.83
3	Roads & paved area	59.13	0.9	0.432	230131.59	0.425	226007.28

EAC OBSERVATION NO.-9

Sr. No.	Land Use	Preliminary Area (ha)	Run-off Coefficient	Annual Rainfall (m)	Annual Run-off (m^3)	Monsoon Rainfall (m)	Monsoon Run-off (m^3)
4	Green belt	89.84	0.25	0.432	97126.02	0.425	95385.37
5	Storage of Waste (slag yard, gypsum & Secured Landfill - Undeveloped land/clay loam)	48.55	0.5	0.432	104974.81	0.425	103093.50
Total/average		**256.58**	**0.61**	**0.432**	**611006.93**	**0.425**	**600056.73**

The total project site, rain water from plant area, and secured landfill areas will be treated and used for plant and other purposes as described under 7.3. Admin building & canteen, HSE office building and engineering stores (shown as building area in **Table-1**) are found to be feasible for roof top water harvesting and use. An amount of 6,832 m^3 (0.007 MCM) of rain water will be available from these roof areas. Considering only 80% of the run-off as available volume after evaporation, spillage and first flush wastage, 5,566 m^3 (0.006 MCM) of rain water is available from the roof top areas for harvesting and use. A typical roof top rain water harvesting model is presented in **Figure-1**.

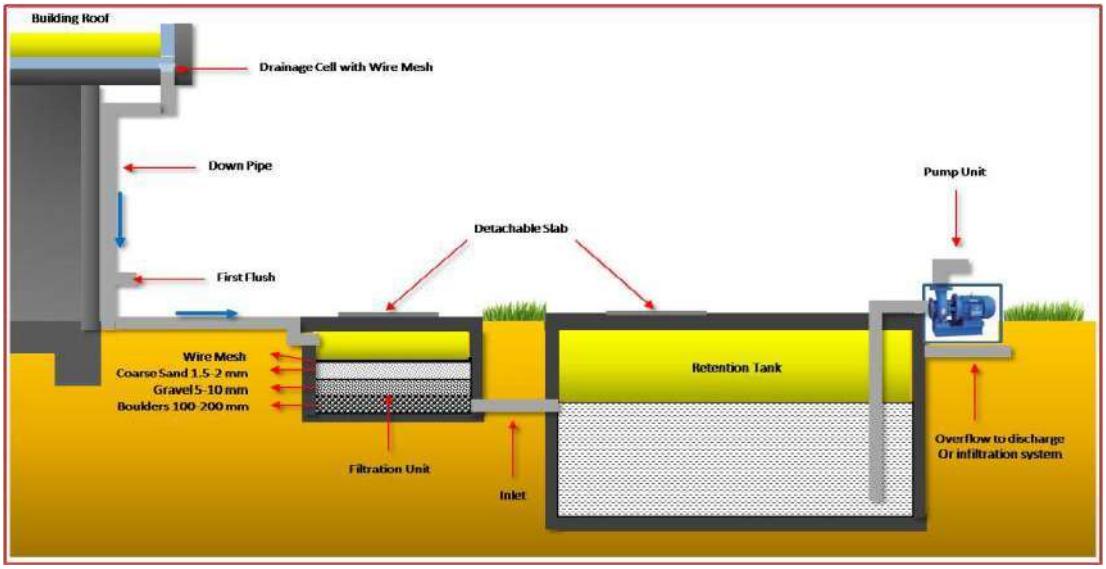


FIGURE-1:
TYPICAL ROOF TOP RAIN WATER HARVESTING MODEL

To hold 80% of rainfall from these buildings during wettest months of July and August (308.1 mm) and use for the project during non-monsoon period, the volume of storage structure(s) shall be 4096 m^3. This storage may be spread in 3 locations with pit sizes of 32 m x 32 m x 4 m. For simultaneous use, the volume of storage structure may be reduced to 50%. Considering 25% of the roads and paved area 50% of the green belt area free from contamination, 84,877 m^3 (0.085 MCM) of run-off from the rainfall collected in these areas is available for harvesting after 20% of this run-off accounting for evaporation, spillage and other losses.

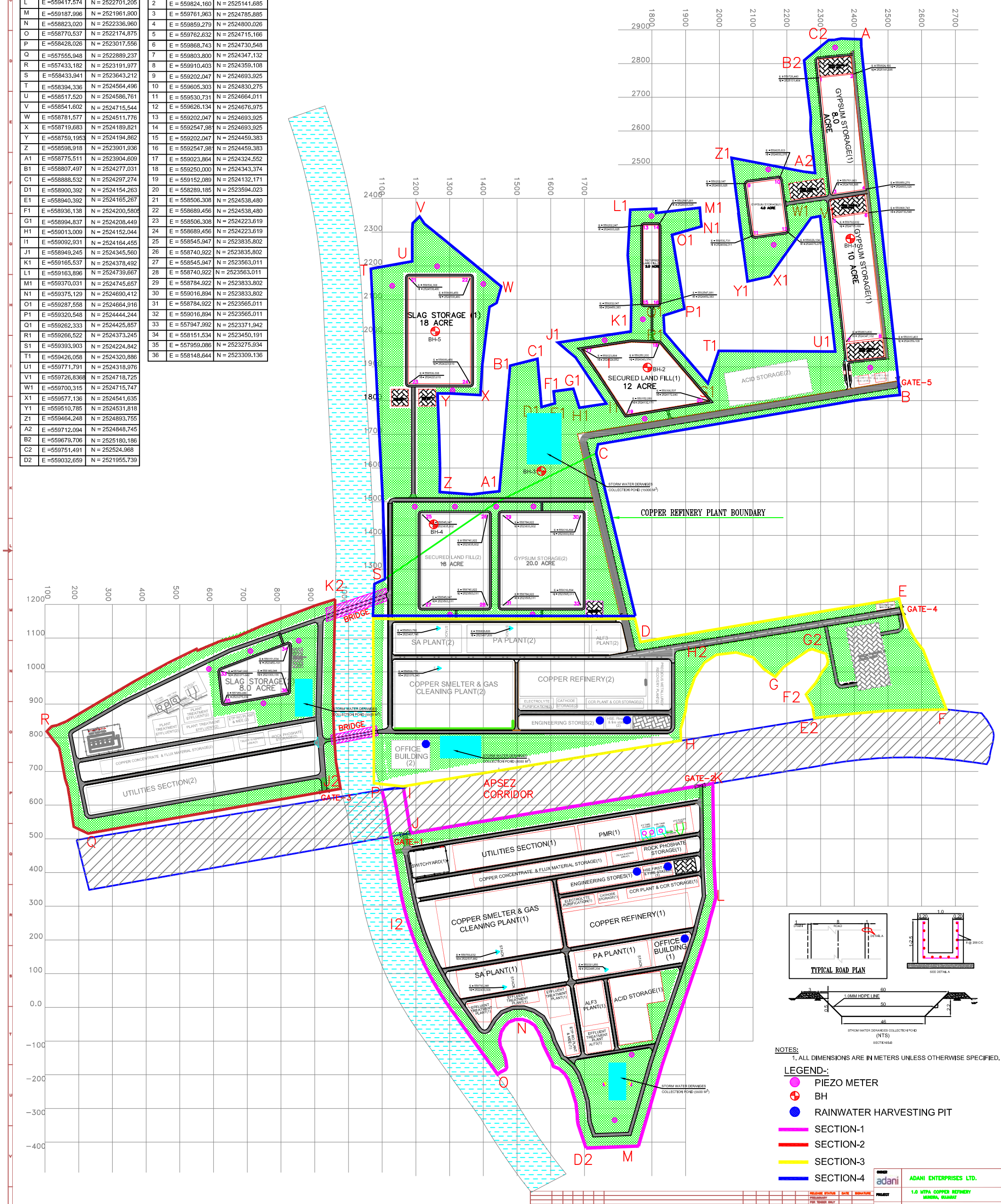
The amount of run-off available from the above areas if managed with at least 70% efficiency will be **63,310 m^3 (0.063 MCM),** which would meet 69.96% of proposed green belt water requirement.

ANNEXURE-9

SR.	EASTING	NORTHING
A	E =559848.328	N = 2525243.163
B	E =559963.374	N = 2524190.380
C	E =559071.249	N = 2524044.332
D	E =559194.182	N = 2523457.258
E	E =559960.721	N = 2523586.315
F	E =556010.2428	N = 2523257.270
G	E = 559594.1246	N = 2523353.9571
H	E =558823.020	N = 2522336.960
I	E =558492.116	N = 2523029.111
J	E =558513.043	N = 2522890.177
K	E =559407.330	N = 2523037.264
L	E =559417.574	N = 2522701.205
M	E =559187.996	N = 2521961.900
N	E =558823.020	N = 2522336.960
O	E =558770.537	N = 2522174.875
P	E =558428.026	N = 2523017.556
Q	E =557555.948	N = 2522889.237
R	E =557433.182	N = 2523191.977
S	E =558433.941	N = 2523643.212
T	E =558394.336	N = 2524564.496
U	E =558517.520	N = 2524586.761
V	E =558541.602	N = 2524715.544
W	E =558781.577	N = 2524511.776
X	E =558719.683	N = 2524189.821
Y	E =558759.1953	N = 2524194.862
Z	E =558598.918	N = 2523901.936
A1	E =558775.511	N = 2523904.609
B1	E =558807.497	N = 2524277.031
C1	E =558888.532	N = 2524297.274
D1	E =558900.392	N = 2524154.263
E1	E =558940.392	N = 2524165.267
F1	E =558936.138	N = 2524200.5805
G1	E =558994.837	N = 2524208.449
H1	E =559013.009	N = 2524152.044
I1	E =559092.931	N = 2524164.455
J1	E =558949.245	N = 2524345.560
K1	E =559165.537	N = 2524378.492
L1	E =559163.896	N = 2524739.667
M1	E =559370.031	N = 2524745.657
N1	E =559375.129	N = 2524690.412
O1	E =559287.558	N = 2524664.916
P1	E =559320.548	N = 2524444.244
Q1	E =559262.333	N = 2524425.857
R1	E =559266.522	N = 2524373.245
S1	E =559393.903	N = 2524224.842
T1	E =559426.058	N = 2524320.886
U1	E =559771.791	N = 2524318.976
V1	E =559726.8368	N = 2524718.725
W1	E =559700.315	N = 2524715.747
X1	E =559577.136	N = 2524541.635
Y1	E =559510.785	N = 2524531.818
Z1	E =559464.248	N = 2524893.755
A2	E =559712.094	N = 2524848.745
B2	E =559679.706	N = 2525180.186
C2	E =559751.491	N = 252524.968
D2	E =559032.659	N = 2521955.739

SR.	EASTING	NORTHING
E2	E =559705.888	N = 2523228.702
F2	E=559684.6685	N=2523301.4207
G2	E=559743.9055	N=2523422.4579
H2	E=559418.3173	N=2523419.2137
I2	E = 558513.781	N = 2522601.441
J2	E = 558304.785	N = 2523022.272
K2	E = 558289.185	N = 2523594.023

SR.	EASTING	NORTHING
1	E = 559726.440	N = 2525131.464
2	E = 559824.160	N = 2525141.685
3	E = 559761.963	N = 2524785.885
4	E = 559859.279	N = 2524800.026
5	E = 559762.632	N = 2524715.166
6	E = 559868.743	N = 2524730.548
7	E = 559803.800	N = 2524347.132
8	E = 559910.403	N = 2524359.108
9	E = 559202.047	N = 2524693.925
10	E = 559605.303	N = 2524830.275
11	E = 559530.731	N = 2524664.011
12	E = 559626.134	N = 2524676.975
13	E = 559202.047	N = 2524693.925
14	E = 5592547.981	N = 2524693.925
15	E = 559202.047	N = 2524459.383
16	E = 5592547.981	N = 2524459.383
17	E = 559023.864	N = 2524324.552
18	E = 559250.000	N = 2524343.374
19	E = 559152.089	N = 2524132.171
20	E = 558289.185	N = 2523594.023
21	E = 558506.308	N = 2524538.480
22	E = 558689.456	N = 2524538.480
23	E = 558506.308	N = 2524223.619
24	E = 558689.456	N = 2524223.619
25	E = 558545.947	N = 2523835.802
26	E = 558740.922	N = 2523835.802
27	E = 558545.947	N = 2523563.011
28	E = 558740.922	N = 2523563.011
29	E = 558784.922	N = 2523833.802
30	E = 559016.894	N = 2523833.802
31	E = 558784.922	N = 2523565.011
32	E = 559016.894	N = 2523565.011
33	E = 557947.992	N = 2523371.942
34	E = 558151.534	N = 2523450.191
35	E = 557959.086	N = 2523275.934
36	E = 558148.644	N = 2523309.136



EAC OBSERVATION NO.-10

EAC OBSERVATION:

OHS monitoring plan based on ICMR-NIOH study and ILO guidelines to be included.

REPLY:

Occupational health hazards assessment & monitoring plan study was carried out by **M/s. Indian Council of Medical Research-National Institute of Occupational Health (ICMR-NIOH);** Department of Health Research, Ministry of Health & Family Welfare, Government of India and report is submitted.

Report prepared by ICMR-NIOH has used following references for preparation of "**Occupational Health Assessment and Monitoring Plan for the Proposed Copper Refinery Project**"

1) Indian factories act.
2) CPCB Guidelines.
3) OSHA Guideline.
4) NIOSH Guidelines.
5) American Industrial hygiene association.

Recommendation provided by ICMR-NIOH and as per International Labour Organization (ILO) guidelines as well as applicable standards/regulations will be implemented.

- Study covers the following:

  - Potential Health Hazards
  - Health Effects and Prevention
  - Summary of Occupational Health and work place monitoring unit-wise with frequency.
  - Occupational Health Assessment/ Medical Evaluation

- Based on the comprehensive Occupational Health study, by ICMR-NIOH following tests and frequency of the test based on area of work have been identified.

  Clinical assessments, Electrocardiogram (ECG) for persons aged > 45 years, Blood investigations, Biological monitoring programme, Liver function test, Renal function test, Audiometry, Ophthalmic evaluation, Dermatological evaluation, Neurological evaluation and Biological monitoring.

- Based on the study budget of **Rs. 2000/ person/ year** has been estimated for monitoring the health of the human resources engaged at the Copper Refinery Project.

EAC OBSERVATION NO.-10

Following general medical test (Clinical Examination and Questionnaire) will be conducted for the employees (company & contract) working within the copper refinery plant:

Clinical Examination and Questionnaire:

- Age
- Sex
- Education
- Tobacco usage, alcohol usage pattern (habits & addiction)
- Details of previous and present medical illness / diseases or symptoms or on medicines.
- Family history of diseases and illnesses
- Menstrual & obstetric history (females)
- General physical examination:
- Temperature
- Pulse
- Respiratory rate
- Blood pressure
- Anthropometry (height, weight, hip circumference, waist circumference)
- Pallor
- Icterus
- Lymphadenopathy (swelling of lymph nodes)
- Oedema
- Clubbing
- Cyanosis
- Thyroid swelling
- Prominent veins (neck, lower limbs)

Respiratory system evaluation:

- Clinical evaluation will include detailed history of respiratory symptoms, dyspnea, exertional dyspnea, cough, cough with expectoration, pharyngitis, laryngitis, sore throat, respiratory tract infections etc.
- Pulmonary function tests (spirometry)
- Chest X-ray PA View

Cardiovascular system:

Electrocardiogram (ECG) for persons aged > 45 years.

Blood investigations:

- Complete hemogram: Hemoglobin, cell count (TC, DC), blood grouping, platelet, RBC count, peripheral blood smear (PBS), bleeding time (BT), clotting time (CT), erythrocyte sedimentation rate (ESR),
- Random blood sugar (RBS)
- Liver function test:
  - Clinical examination: change in appetite, jaundice, nausea, vomiting, dyspepsia etc.
  - Laboratory investigation: Albumin, globulin, AG ratio, SGOT, SGPT, ALP, serum bilirubin, GGT
- Renal function test:
  - Blood: Serum urea & creatinine, uric acid

- Urine examination: Protein, sugar

Ophthalmic evaluation:

- History such as burning, dryness, redness, water of eyes etc. will be enquired along with clinical evaluation of conjunctiva, cornea, sclera, lens etc.

The above test will be conducted as part of pre-employment, pre-exit and periodical for regular employees. Additionally, the Colour blindness test will be carried out as part of pre-employment examination.

It is proposed to have following frequency for periodical medical examination

a) Administrative staff once in two years
b) Operational and maintenance staff once in year
c) Specific test mentioned in the below table will be conducted once in six months

There will be workplace monitoring will be carried out as per prevailing legislation.

EAC OBSERVATION NO.-10

Following operational area specific test will be conducted frequency every 6 months:

Test	Copper Smelter	Copper Refinery	CCR Plant	PMR Plant	SAP	PAP	AlF_3 Plant	ETP
Respiratory system	✓	✓	✓	✓	✓	✓	✓	✓
Cardiovascular system	✓	✓	✓	✓	✓	✓	✓	✓
Central nervous system	✓	✓	✓	✓	✓	✓	✓	✓
Gastrointestinal system	✓	✓	✓	✓	✓	✓	✓	✓
Dermatological assessment	✓	✓	✓	✓	✓	✓	✓	✓
Musculoskeletal system	✓			✓				✓
Serum copper	✓			✓				
Ceruloplasmin ferroxidase	✓			✓				
Urinary copper	✓			✓				
Screen for heavy metals	✓			✓				✓
Delta amino levulinate dehydratase levels				✓				✓
Measure fluoride levels in blood and urine						✓	✓	✓
Dental (Gingival tissue) examination (Fluorosis)						✓	✓	
Audiometric test	✓	✓	✓	✓	✓	✓	✓	✓
Hepatic (liver)	✓	✓	✓	✓				✓
Detect acidosis	✓			✓	✓			

EAC OBSERVATION NO.-11

EAC OBSERVATION: -

Provide linkage between Public Hearing, Social Impact Assessment and CER proposed.

REPLY:

Many of the participants in public hearing were in the support of the project as recorded in Public Hearing (PH) proceedings videos. The consolidated point-wise issues raised and responses along with action plan for implementation has been provided in Chapter-7 of final EIA Report.

A budgetary provision of Rs 1044 Cr for Environmental protection and provision of Rs. 58 Cr has been allocated as Corporate Environment Responsibility (CER). The allocation of fund in CER has been arrived on the basis of issues raised in public hearing and the Social Impact Assessment (SIA) study findings was based on the interactions, focused group discussions with different stakeholders at the village level community based institutions. Keeping in view of the community's interests and opinion expressed during interactions, focused group discussions with different stakeholders, the suitable interventions have been planned under CER plan. During implementation of CER interventions M/s AEL will promote communities participation and ensure that the intended outcomes realized through community.

The budgetary provision of Rs 1044 Cr for Environmental protection has been allocated for Air protection: Rs. 639 Cr, Water protection: Rs.360 Cr, Solid waste & EMS: Rs. 45 Cr has been detailed in the **chapter-6 of EIA in table-6.5**.

The details about CER is provided in **Annexure-33 of Reply of 23rd August 2019 EAC observation-33.**

Details of PH proceedings along with action plan is attached as **Annexure-20(a) Reply of 23rd August 2019 EAC observation-20.**

Details of PH hardcopy representations along with action plan is attached as **Annexure-20(b) of Reply of 23rd August 2019 EAC observation-20.**

Based on the issues discussed in PH, study conducted for SIA various projects has been proposed as part of CER. The details of the same is presented in table below:

EAC OBSERVATION NO.-11

PROPOSED CER BUDGET EXPENDITURE:

Sr. No.	Key Area Identified for intervention through CER activities by proposed Copper Smelter Plant		Proposed Expenditure in Project construction phase (Rs.)					Total Proposed Expenditure (Rs.)	Linkage
			1st Year	2nd Year	3rd year	4th Year	5th Year		
A	**Education Initiatives**		**11,880,000**	**15,002,000**	**15,492,000**	**11,172,000**	**9,492,000**	**63,038,000**	
	1	Development of Smart Classes facilities	5,880,000	9,002,000	9,492,000	5,172,000	5,492,000	35,038,000	**PH**
	2	Renovation/development of primary/middle school infrastructure for education and sports facilities	6,000,000	6,000,000	6,000,000	6,000,000	4,000,000	28,000,000	**PH**
B	**Community Health Initiatives**		**19,250,000**	**31,250,000**	**36,000,000**	**33,500,000**	**0**	**120,000,000**	
	1	Fully Furnished and equipped Trauma Centre with Burnt Care Unit at Bhuj Hospital	14,250,000	23,750,000	28,500,000	28,500,000	0	95,000,000	
	2	Burnt Care Unit at Mundra	5,000,000	7,500,000	7,500,000	5,000,000	0	25,000,000	
C	**Sustainable livelihood**		**14,500,000**	**15,200,000**	**20,200,000**	**6,400,000**	**6,400,000**	**62,700,000**	
	1	Development of 3 Cowsheds at Kandagara	1,000,000	1,000,000	0	0	0	2,000,000	**PH**
	2	Skill Development Centre (SDC) to make the youth for achieving their Goals in life by becoming Skilled Professionals.	5,000,000	5,000,000	10,000,000	0	0	20,000,000	**PH**
	3	Support for tissue culture and soil laboratory development for farmers in the area.	1,500,000	2,000,000	3,000,000	3,000,000	3,000,000	12,500,000	**PH**
	4	Support for Drip Irrigation for farmers in the area.	2,000,000	2,200,000	2,200,000	2,400,000	2,400,000	11,200,000	**PH**
	5	Infrastructure improvement for Fisherman community and fund creation for fisherman life insurance to cover risk in fishing.	5,000,000	5,000,000	5,000,000	1,000,000	1,000,000	17,000,000	**SIA**
D	**Community Environment development**		**2,500,000**	**2,500,000**	**13,500,000**	**1,100,000**	**1,800,000**	**21,400,000**	
	1	Provide samplings of forest species and development of Eco-clubs of Teachers & Students for Waste mangemnet and Mass plantation in Schools & community land in the Villages.	1,500,000	1,500,000	12,500,000	100,000	800,000	16,400,000	
	2	Support and provide plant saplings of *Commiphora Wightii* (Guggal Dhoop) Plantation in schools and panchayat lands and other common lands.	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	5,000,000	
E	**Community Rural Infrastructure Development**		**33,400,000**	**63,505,000**	**69,117,350**	**80,737,565**	**63,866,194**	**310,626,109**	
	1	**Drinking Water Facility**	**20,000,000**	**40,000,000**	**40,000,000**	**40,000,000**	**20,000,000**	**160,000,000**	
		i Overhead Water Tanks of 500kL at 8 locations	20,000,000	40,000,000	40,000,000	40,000,000	20,000,000	160,000,000	**PH**
	2	**Water Conservation Ground water recharge**	**9,500,000**	**19,500,000**	**25,000,000**	**36,500,000**	**36,000,000**	**126,500,000**	
		i Deepening of Ponds	4,500,000	4,000,000	4,000,000	4,500,000	4,500,000	21,500,000	**PH**
		ii Check Dams/Milli Micro water shade management	5,000,000	15,500,000	21,000,000	32,000,000	31,500,000	105,000,000	**PH**
	3	**Solar Street Lights**	**1,500,000**	**1,605,000**	**1,717,350**	**1,837,565**	**1,966,194**	**8,626,109**	**PH**
F	**Institutionalize development for Key areas in Education, Community Health Initiatives, Sustainable livelihood, Community Environment development, Community Rural Infrastructure Development**		**2,400,000**	**2,400,000**	**2,400,000**	**2,400,000**	**5,900,000**	**15,500,000**	
G	**Contingency Fund to cover shortfall in above segments or additional investment in infrastructure development in education and sports**		**400,000**	**400,000**	**400,000**	**400,000**	**900,000**	**2,500,000**	
Total Expenditure (Rs)			**69,430,000**	**128,727,000**	**144,801,350**	**135,709,565**	**88,358,194**	**580,264,109**	

EAC OBSERVATION NO.-11

The following issues were raised by the public and the following actions plan has been prepared:

Issue Related to Need for project:

Sr. No.	Issues Represented	Proponent Response	CER Budget
1	Plant will produce 30 lakh tons of Sulphuric acid, so why do you want to establish this plant here? We want clean environment	India import ~ 1.5 MMTPA of Sulphur for production of Sulphuric Acid (equivalent qty of Sulphuric Acid 4.5 MMTPA) and 1 MMTPA as a Sulphuric Acid product. Sulphuric Acid is by-product of Copper Refinery Project (Copper Smelter Plant); which is widely used for manufacture of fertilisers and other chemicals. This will reduce import for acids requirement of India and thereby foreign exchange. Mundra location for this project has been selected based on the following advantages: 1. Proximity to Market. 2. Availability of land; and 3. Availability of infrastructure such as port facilities, water, power, road, rail etc. Environmental Management Plan has been developed to keep the environmental parameters within the stipulated limits as per NAAQMS. The comparison of salient features of alternative sites done and details are presented in Table-5.1 and shown in Figure-5.1 of the EIA report.	-

EAC OBSERVATION NO.-11

Issue Related to Community Development

Sr. No.	Issues Represented	Proponent Response	CER Budget
1	Develop 3 Cowsheds in Kandagara.	Cowshed will be construction in Kandagara village as per Panchayat resolution.	Under CER a budget of Rs. 20 Lakhs has been allocated for Cowshed construction in the said village.
2	What will Adani do for the education, health and fodder for cattle?	Various education and health program is ongoing in the area by Adani Foundation. Establishment of a full fledged a burn care facility at Bhuj District Hospital Fodder issue will be addressed through CSR activities.	It is proposed to establish a full fledged a burn care facility at Bhuj of Rs. 9.5 Crores and Burn care unit at Mundra of Rs. 2.5 Crores. Establish Smart Classes and Renovation/development of primary/middle schools of Rs. 6.7 Crores.
3	Develop fisheries harbour	Bhadreshwar is outside the study area of this project.	Under CER a budget of Rs. 1.7 Crore has been allocated for Infrastructure improvement for Fisherman community and fund creation for fisherman life insurance to cover risk in fishing
4	He represented that this project is only 5 km away from our village. Therefore it is submitted that our village should also be given priority in the manner that Navinal and Shiracha are given priority.	CER Project village wise to be prepared.	-
5	Farming gets affected due to sea water, High TDS in borewell water	Drinking water facility has been proposed by providing overhead tank in the project area villages (Moti Khakhar, Desalpar and Siracha). To reduce the salinity ingress, it is planned to adopt program which is inline with state government activities for watershed management by check dams in upstream areas with due engineering details in consultation with Water Recourses Department.	CER budget (Rs. 16 Crores) for drinking water project by providing overhead tank in the project area villages (Siracha, Jarpara, Desalpar and Moti Khakhar village) has been proposed. Watershed management by check dams in upstream areas with due engineering details in consultation with Water Recourses Department under CER budget (Rs. 10.5 Crores).
6	Dates agriculture development should also take place. Adani Company should establish a laboratory at Mundra for Tissue culture development of date farming.	Tissue cuture laboratory in local dates palm Research Institute, Govt of Gujarat in Mundra, will be established.	Under CER budget Rs. 1.25 Crores has been allocated for development of tissue culture laboratory in local dates palm Research Institute, Govt of Gujarat in Mundra.
7	Jobs and livelihood opportunities for women to be created. How ladies will be given employment?	Local ladies will be made capable by providing training for getting employed in services like horticulture, housekeeping and canteen etc. Apart from this other livelihood opportunities under Self Help Group through Adani Foundation under CSR will be created.	-

EAC OBSERVATION NO.-11

Issue Related to Employment

Sr. No.	Issues Represented	Proponent Response	CER Budget
1	Will I be given job at the new plant? What is the duty time and salary of on roll employees? what is the percentage of local public that will get employment?	Locals will be given preference to employment based on skill set & eligibility requirement as per the job. Facility and infrastructure will be added in existing skill development centre run by Adani Foundation at Mundra. Plant will be operated round o'clock basis. There will be 3 shifts for the plant people and day shift for the non-plant employee and administrative staff. Salary will be based on the skill set, Job experience and role offered. As per the existing regulations of central & state government and availability of skillsets, local people will be provided preference for employment.	Fund of Rs. 2 Crores has been allocated for facility and infrastructure addition in existing skill development centre run by Adani Foundation at Mundra.
2	A committee should be constituted so that the local public gets employment and an open discussion / meeting should be held between the company officers and committee for the purpose of providing employment to local public. Create a database for the qualified persons for providing job opportunities.	Database exchange center facility, in the exiting skill development center run by Adani Foundation; so that records of skilled people from the area will be maintained and will be made available to other industries.	Under CER for proposed project, fund of Rs. 2 Crores has been allocated for database exchange center facility, in the exiting skill development center run by Adani Foundation
3	What steps will been taken to develop the unskilled people to give them the right opportunity? What kind of employment will be given to the unskilled people? How will employment be provided in this plant? what is the percentage of local public that will get employment?	Locals will be given preference to employment based on skill set & eligibility requirement of the job. Required Skillset for the proposed project: • Mechanical Maintenance • Electrical Maintenance • HEMM Operations & Maintenance • Horticulture • C&I Unskilled people will be made capable by providing training for getting employed in services like horticulture, housekeeping and canteen etc.	Under CER for proposed project, fund of Rs. 2 Crores has been allocated for facility and infrastructure addition in existing skill development centre run by Adani Foundation at Mundra.

EAC OBSERVATION NO.-11

Issue Related to Environment

Issue Related to Environment Note:- Project Site Environmental protection: Air-Rs. 639 Cr, Water-Rs.360 Cr, Solid waste & EMS- Rs. 45 Cr			
Sr. No.	**Issues Represented**	**Proponent Response**	**CER Budget**
1	Which organization has conducted the study? Which laboratory has conducted the monitoring? Provide certificate of the same.	M/s. Vimta Labs Limited (VLL), Hyderabad is a QCI/NABET accredited and MoEF&CC recognized and NABL accredited Laboratory; who has conducted study and laboratory analysis.	-
2	VIMTA is a Private organization, we don't accept VIMTA's report.	M/s. Vimta Labs Limited (VLL), Hyderabad is a QCI/NABET accredited and MoEF&CC recognized and NABL accredited Laboratory. The credentials of M/s. Vimta Labs Limited are given in Chapter-11 of the EIA Report.	-
3	How many villages of the Mandvi and Mundra taluka are affected in this project? Provide the details about distance.	The study area of 10 km radial distance from the boundary of the proposed project consists of 16 villages. This includes 12 villages from Mundra Taluka (Tunda, Siracha, Navinal, Deshalpar, Khakhar Moti, Kandagara Mota, Nani Bhujpur, Jarpara, Moti Bhujpar, Borana, Pratappar and Dhrab), 4 villages from Mandvi Taluka (Nani Khakhar, Nana Bhadiya, Mota Bhadiya, and Tragadi). The list of Number and locations of monitoring stations (as per CPCB guidelines) are decided based on the nature of project, meteorological conditions, Topography, selected pollution pockets in the area and likely impact areas. Based on the impact assessment modelling, the GLC to land around 2.1 km in NE direction. Total cumulative concentration of pollutants is found to be well within the prescribed limits.	-
4	At the time of making this report, how many numbers of villages have been visited by the company and were the local people present at that relevant point of time?	Baseline monitoring was carried out in the study area of 10 km radial distance from the boundary of the proposed project. It consists of 16 villages. This includes 12 villages from Mundra Taluka (Tunda, Siracha, Navinal, Deshalpar, Khakhar Moti, Kandagara Mota, Nani Bhujpur, Jarpara, Moti Bhujpar, Borana, Pratappar and Dhrab), 4 villages from Mandvi Taluka (Nani Khakhar, Nana Bhadiya, Mota Bhadiya, and Tragadi). Focussed Group Discussion for Social Impact Assessment was also carried out in these villages.	-
5	At the time of presentation, the list of only 8 villages is shown. Why other villages are not included? Why is monitoring done in only 8 villages? Show us the list of 16 villages. Give the proof of 08 villages visited.	The baseline ambient air quality, noise and soil monitoring was carried out at 8 location s per the TOR prescribed by MoEF&CC. The monitoring locations were selected based on the nature of project, meteorological conditions, topography, land use conditions, existing pollution pockets in the area and the likely impact areas. Photograph to be attached/ Hyperlinked.	-
6	1) The photographs of place and equipment used shall be shown from where the samples were	1) The photographs of place and equipment used shall be shown from where the samples were collected. 2) You are showing the photographs of your proposed project, show the photographs of the	1) The photographs of sampling place and

EAC OBSERVATION NO.-11

Issue Related to Environment Note:- Project Site Environmental protection: Air-Rs. 639 Cr, Water-Rs.360 Cr, Solid waste & EMS- Rs. 45 Cr			
Sr. No.	**Issues Represented**	**Proponent Response**	**CER Budget**
	collected. 2) You are showing the photographs of your proposed project, show the photographs of the monitoring carried out.	monitoring carried out.	equipment used for monitoring had been shown during the public hearing. 2) Monitoring photographs along with the respective sampling locations have been given Annexure-VIII in the EIA report.
7	As per the EIA report, you state that no perennial river is present within the project land.	Dhaneshwari, a seasonal river and not a perennial river flows in the western part of the proposed site.	-
8	The project proponent has concealed the information in Form-1. As per the S.No. 16 and 26 of Basic Information of Form-1, with reference to the Gochar land, PIL no. 17/2011 judgment, the project proponent has mentioned that there is no pending PIL for this land. This information is not mentioned in Form-1.	We have not concealed any information in Form-1. The PIL has been disposed. The application has been filed for the diversion of forest land. Under the Form-1, it is stated that the non-forest land is of APSEZ and the application for forest land is under process.	-
9	In the S.No. 2 and 10 of Form-1, it is not mentioned that the Daneshwari river passes through the forest land.	In the EIA report, maps are provided and Daneshwari river is shown in it. Dhaneshwari river also referred as Danesri Nadi (as per Topo sheet no: F42 J9 & 10) stream passing within site (west side). Dhaneshwari, a seasonal river which flows in the western part of the proposed site. The river will not be diverted. The flow of the river will be maintained, as shown in the plant layout on Figure-2.1 of EIA report.	-
10	The sr. no. 10 on page C1-4 of the draft EIA report states that, there is no archaeological place at this site. However, at a distance of around 500 to 1000	As per Archaeological Survey of India, there is no notified archaeological site present within 10 km radius from the proposed project site. The nearest archaeological site is Kotai Sun Temple, which is 70 km from the project site.	-

EAC OBSERVATION NO.-11

Issue Related to Environment Note:- Project Site Environmental protection: Air-Rs. 639 Cr, Water-Rs.360 Cr, Solid waste & EMS- Rs. 45 Cr			
Sr. No.	**Issues Represented**	**Proponent Response**	**CER Budget**
	meters from the proposed project site, the site of Navinal Archaeological site is present. I have the report of the MS University which states that it relates to the Harappa civilization.		
11	How many villages are affected? What is the radius of affected area? How many people were met? How many villages were visited?	The study area of 10 km radial distance from the boundary of the proposed project consists of 16 villages. This includes 12 villages from Mundra Taluka (Tunda, Siracha, Navinal, Deshalpar, Khakhar Moti, Kandagara Mota, Nani Bhujpur, Jarpara, Moti Bhujpar, Borana, Pratappar and Dhrab), 4 villages from Mandvi Taluka (Nani Khakhar, Nana Bhadiya, Mota Bhadiya, and Tragadi). The list of Number and locations of monitoring stations (as per CPCB guidelines) are decided based on the nature of project, meteorological conditions, Topography, selected pollution pockets in the area and likely impact areas. Based on the impact assessment modelling, the GLC to land around 2.1 km in NE direction. Total cumulative concentration of pollutants is found to be well within the prescribed limits.	-
12	What effect will this project produce on sea creatures that have direct connection with fishermen?	No treated effluent will be released into the sea. The proposed project has been designed based on zero liquid discharge system consisting of effluent treatment plant, RO plant and Multi Effect Evaporator. No treated effluent will be discharged outside the plant premises. Rain water collection pond (4*4000 m3) will also be constructed to collect runoff from the process areas. This collected water will be recycled in plant operation. A total of Rs 360 crores will be invested for ETP design and wastewater management.	-
13	What would be the constituents in raw material that would be stored?	Raw materials Copper Ore Concentrate contains mainly copper, iron, sulphur, trace of precious metals and traces of heavy metals. Rock Phosphate contains mainly Calcium Phosphate and Calcium Fluoride. Detailed analysis is provided in the ADS point no:	-
14	which water will be used in the upcoming plant?	APSEZ will provide desalinated water from its Desalination plant.	-
15	You have mentioned that you will make road from the waste. Which waste will be used for road making?	Copper Slag is useful for road making ad NHAI has issued a directive for use of copper slag in road construction.	-
16	Is there any chance of any kind of blast?	HIRA study has been done. There is a chance of blast, if water comes in contact with hot metal. Based on HIRA study as well as recommendation from the technology supplier, adequate measures will be put in place to avoid such incidents. There will be continuous monitoring of flow and temperature of cooling water circulating within the furnace copper	-

EAC OBSERVATION NO.-11

Issue Related to Environment Note:- Project Site Environmental protection: Air-Rs. 639 Cr, Water-Rs.360 Cr, Solid waste & EMS- Rs. 45 Cr			
Sr. No.	**Issues Represented**	**Proponent Response**	**CER Budget**
		cooling elements.	
17	How much water will be obtained for this project and from which place will it be taken? Have you conducted study for the impact of desalination plant on the marine ecology? What is the impact?	The proposed project will require about 32,800 m^3 desalinated water per day, supplied by desalination plant of APSEZ, who has already obtained the Environmental Clearance.	-
18	Sulphur Di-Oxide impact in a radius of 20-25 km	Modelling studies reveal that the maximum incremental short term 24 hourly ground level concentrations (GLC) will be 17.90 µg/m^3 for SO_2 at a distance of 2.2 km in NE direction. The resultant concentrations are predicted to be well within the standards specified by CPCB.	-
19	concentration of Sulphur Dioxide and height of its release quantity of Sulphur Dioxide will be released in air and density of Sulphur Dioxide?	Sulphur Dioxide Concentration in residual gases post tail gas scrubbing and FGD system will be 300 mg/Nm^3 at the outlet of Process Stack. Proposed stack height will be 150 m. About ~375 kg per hour of Sulphur Dioxide will be released in air which will be dispersed quickly with atmospheric air flow and Ground level concentration for SO_2 will remain well within the NAAQ standards as modelling has been done.	-
20	Where the Acidic Water and Chemicals will be released?	No treated effluent will be released into the sea. The proposed project has been designed based on zero liquid discharge system consisting of effluent treatment plant, RO plant and Multi Effect Evaporator. No treated effluent will be discharged outside the plant premises. Rain water collection pond (4*4000 m^3) will also be constructed to collect runoff from the process areas. This collected water will be recycled in plant operation. A total of Rs. 360 Crores will be invested for ETP design and wastewater management.	-
21	In the production of copper plant, Sulphur is to be used and this will have acidic processes.	Installation of Sulphuric Acid Plant for conversion of sulphur di-oxide off-gases generated from the smelting and converting furnaces into sulphuric acid. Installation of Scrubbers for treating fugitive and tail gas emission generated during the production processes with the help of high suction hoods.	-
22	The project is entirely chemical based, which will have impact on water, air, noise, land, etc. and it will affect the agricultural land. What are the measures for protection from such kind of project?	Based on the baseline monitoring and the impact assessment modelling Environmental Management plan has been prepared to safeguard the environment. Air Pollution Protection: High suction hoods for collection of fugitive gases and scrubbing system to treat the same before releasing through process stack in the atmosphere. Water Pollution Protection: Plant will be operated under Zero Liquid Discharge (ZLD) System and all the treated water will be recycled within the plant process. No treated water will be released outside the plant boundaries.	-

EAC OBSERVATION NO.-11

Issue Related to Environment Note:- Project Site Environmental protection: Air-Rs. 639 Cr, Water-Rs.360 Cr, Solid waste & EMS- Rs. 45 Cr			
Sr. No.	**Issues Represented**	**Proponent Response**	**CER Budget**
	Such projects are welcome. We are 100% in favour of the development but not at the cost of environment.	Ground/ Soil Pollution: All the raw material will be stored in concrete paved and covered storage. Solid waste generated will be handled and stored as per CPCB Guidelines. Rs 1,044 Crore environmental protection budget has been proposed for pollution control equipment's within the proposed project site.	
23	It is required that 33% green belt shall be provided	Total of > 33% Greenbelt has been proposed including 15 m wide greenbelt around the plant boundary. Native species with rich canopy will be planted. Following Species will be planted: 1) Neem (Azadirachta indica) 2) Sisoo, Shisham (Dalbergia sissoo) 3) Babul (Acacia nilotica) 4) Imli (Tamarindus indica) 5) Karanj (Pongamia pinnata) 6) Piloo (Salvadora persica) The trees will be planted in several rows with a tree density of 2000-2500 trees/ha with adequate width around the plant boundary and maintained as per CPCB guidelines.	-
24	No one is against development. The fishermen should also not be affected	No treated effluent will be released into the sea. The proposed project has been designed based on zero liquid discharge system consisting of effluent treatment plant, RO plant and Multi Effect Evaporator. No treated effluent will be discharged outside the plant premises. Rain water collection pond (4*4000 m^3) will also be constructed to collect runoff from the process areas. This collected water will be recycled in plant operation. A total of Rs. 360 crores will be invested for ETP design and wastewater management. Take additional input from SIA findings.	Under CER a budget of Rs. 1.7 Crore has been allocated for Infrastructure improvement for Fisherman community and fund creation for fisherman life insurance to cover risk in fishing
25	how will you control the air emissions that will be released in the atmosphere? What is the facility that is done by you as for this? How impact of sulphur dioxide on environment is reduced? The sulphur dioxide that is released in air will damage health and so what steps have	Installation of Sulphuric Acid Plant for conversion of sulphur di-oxide off-gases generated from the smelting and converting furnaces into sulphuric acid. Installation of Scrubbers for treating fugitive and tail gas emission generated during the production processes will the help of high suction hoods. The residual SO_2 gases post manufacturing of Sulphuric Acid and treatment in tail gas scrubbing & fugitive gas desulphurization approx. **~300 mg/Nm^3, which is lower than the stipulated standard.**	-

EAC OBSERVATION NO.-11

Issue Related to Environment Note:- Project Site Environmental protection: Air-Rs. 639 Cr, Water-Rs.360 Cr, Solid waste & EMS- Rs. 45 Cr			
Sr. No.	**Issues Represented**	**Proponent Response**	**CER Budget**
	been taken by the company?		
26	This area is under the CRZ-1 area. There is no provision for approval of such land.	The proposed project is outside the CRZ area and project boundaries superimposed on CRZ Map prepared in 2011 by MoEF&CC authorised agency is submitted Chapter1 In EIA. Further, NCSCM has also been engaged by MoEFCC for CRZ mapping of entire country and CZMP approval of Kutch district is in process at state government level. M/s. AEL has engaged NCSCM to superimpose proposed project boundary on the approved CZMP maps.	-
27	Different CRZ maps are submitted in the Public Hearing for the years 1991, 2008, 2010 and 2017, which is the correct map out of those? If one map is correct out of four then this shows that the other three are false which indicates the Company has violated the rules of CRZ.	The proposed project is outside the CRZ area and project boundaries superimposed on CRZ Map prepared in 2011 by MoEF&CC authorised agency is submitted. In EIA. Further, NCSCM has also been engaged by MoEF&CC for CRZ mapping of entire country and CZMP approval of Kutch district is in process at state government level. M/s AEL has engaged NCSCM to superimpose proposed project boundary on the approved CZMP maps.	-
28	If the company comes and if there are any chances of environmental degradation, then the government authority should consider it seriously. The work should not remain only on paper.	Based on the baseline monitoring and the impact assessment modelling Environmental Management plan has been prepared to safeguard the environment. Considering possibility of worst case scenarios during plant operation disaster management plan has been prepared.	-
29	why you have selected site No. 2?	3 alternate sites were analysed and the site-2 was selected based on the following parameters; a) Distance from west port (Bulk material handling) b) Distance from Water Source c) Distance from power Source d) Closeness to Railway e) Closeness to State and National highway f) Social and R& R related issues. The details of the same has been already provided in EIA Report Chapter-5.	-

EAC OBSERVATION NO.-11

Issue Related to Health & Safety

Sr. No.	Issues Represented	Proponent Response	CER Budget
1	How you will control the dust? How many doctors will be available?	Dust will be captured at source of generation by providing suction hoods and bag filter. Dust collected will be recycled back into plant process. Dust emission outlet of the bag filter will be < 50 mg/Nm^3. Total of Rs. 639 Crores budget has been allocated for protection of Air Pollution.	CER Budget of Rs. 1.64 Crores has been allocated for the mass plantation in the 10 km radius area of the plant site.
2	Provide about the side effects, risk, etc. from the project.	M/s. NIOH; had been engaged to identify the various health hazards. NIOH had also suggested type and frequency of the various medical test to be carried out. M/s. TALEEM Foundation had been engaged to carry out the base line health index study. M/s. Safety Consultancy Services operated by former Regional Labour Institute (RLI) Director, had been engaged to carry out the HIRA and subsequent remedial measures for reduce the risks. Based on the risk assessment, disaster management plan is prepared. Worst case scenario for the following has been worked out. 1. LPG & Fuel oil Fire 2. Sulphuric Acid and Phosphoric Acid Tank Leakage 3. SO2 Gas leak 4. Furnace Metal Leak	-
3	provide the information that what diseases are possible due to the dust of copper?	Dust will be captured at source of generation by providing suction hoods and bag filter. Dust collected will be recycled back into plant process. Dust emission outlet of the bag filter will be < 50 mg/Nm^3. The PM emission will be well within the prescribed limit set by MoEF&CC. Total of Rs. 639 Crores budget has been allocated for protection of Air Pollution.	CER Budget of Rs. 1.64 Cr has been allocated for the mass plantation in the 10 km radius area of the plant site.

EAC OBSERVATION NO.-11

Issue Related to Material Handling & Storage

Sr. No.	Issues Represented	Proponent Response	CER Budget
1	How sludge from ETP will be disposed?	Arsenic bearing sludge will be collected from ETP in Truck/ Tractor trolley and will be stored in secured land fill. Arsenic Bearing ETP Sludge will be stored in Secured land fill with double HDPE Liner of 2 mm thick and will be constructed as per CPCB Guidelines. Chemical gypsum will be collected from ETP in Truck/ Tractor trolley and will be stored in Gypsum storage. Further, it will be sold to cement industries.	-
2	How raw material will be stored & transferred?	Raw material will be stored in covered storage paved with concrete. Raw material (Copper Ore Concentrate and Rock Phosphate) will be transported through closed conveyor system from port to plant.	-
3	How finished product will be transported?	Finished product such as Copper Cathode, Copper Rods will be transported through trucks & container, Sulphuric Acid will be transported through Acid Tankers made of SS316L and Phosphoric Acid will be transported through Rubber lined Acid Tankers.	-
4	List of waste material generating from the plant. What chemicals will be present in the waste? Will mercury come out from this waste? What is the arrangement for waste material storage?	Arsenic bearing sludge will be generated from ETP. Truck/ Tractor trolley and will be used for transporting to secured land fill for storage purpose. Chemical gypsum will be generated from ETP. Truck/ Tractor trolley will be used for transporting to gypsum storage area. Copper slag will be generated as by-product from copper smelter. The same will be transported to slag storage area through conveying system. Phospho-Gypsum will be generated from phosphoric acid plant. The same will be transported to gypsum storage area through closed conveying system. Mercury will be recovered during the manufacturing process of Sulphuric Acid as Calomel and will be sold in the market. The detailed chemical analysis for arsenic bearing sludge (ETP sludge), Phospho-Gypsum, Copper slag has been provided in Chapter-2 in the Final EIA report. Arsenic Bearing ETP Sludge will be stored in Secured land fill with double HDPE Liner of 2 mm thick and will be constructed as per CPCB Guidelines. approx. 13 ha land has been marked for construction of SLF, capacity of storage for 20 years operation. Gypsum will be stored in gypsum storage lined with 1.5 mm HDPE liner and will be constructed as per CPCB Guidelines. Chemical gypsum and phospho-gypsum will be sold for cement manufacturing. Copper slag will be sold for road construction as well as for cement manufacturing.	-

EAC OBSERVATION NO.-11

Issue Related to PH

Sr. No.	Issues Represented	Proponent Response	CER Budget
1	All our questions shall be replied to in Gujarati language. The project representative does not reply in Gujarati language and therefore this means that the local public will not receive employment. The project officer should provide his qualification and identification before giving reply in Gujarati. Company officers should make submissions in the local Gujarati language.	Project Officer has introduced himself with name, qualification and provided photo ID proof for identification. The project presentation was detailed in Gujarati language and responses were provided in Gujarati and Hindi by project proponent.	-
2	When was the report submitted to Mandvi Taluka Panchayat? Is the report provided to community leaders?	the copy of report and CD is provided to Mandvi Taluka Panchayat office on 27.03.2017.	-
3	It is our expectation that the plant will be established by considering the rules framed by the Government of Gujarat and Central Government as well as considering the public interest.	The plant will be established by considering the rules framed by the Government of Gujarat and Central Government as well as considering the public interest. Budget of Rs 1,044 has been allocated for pollution control equipment within the plant for environmental protection.	-
4	The person providing the reply on behalf of the company must provide the company photo ID card, only then he will be allowed to reply. Our boys are not permitted to enter the company without an ID-card.	ID Card was shown on the screen.	-
5	At which five places were the EIA reports placed?	As per the EIA notification of the Government of India, the draft EIA report is made available at following offices: i. District Collector office, Kutch-Bhuj ii. Office of District Development officer, Kutch-Bhuj iii. District Industrial Center, Bhuj-Kutch, iv. Office of the Taluka Development officer, Mundra v. Office of the Taluka Development officer, Mandvi	-
6	How can the public hearing be conducted for this project when the process of forest clearance is still going on?	Public Hearing was organised (Date of Public Hearing: 29th April 2017) by state pollution control board upon considering all the requisite requirement for the public hearing. During the public hearing response was provided by the project proponent that forest clearance for the forest land identified for this project has already been applied (Date of Forest diversion application:8-04/2016) before receipt of the TOR (Date of TOR received - 21st June 2016).	-

EAC OBSERVATION NO.-12

EAC OBSERVATION:

Confirm suitability of air model used as per site characteristics in view of the complex atmospheric conditions of the coastal line and fumigation scenario. Superimpose air modeling isopleth on the land use map of the study area considering worst case scenario of the pollutants. Mitigations measures based on the receptor points and path to be submitted.

REPLY:

- **Details of Mathematical Modeling**

As the proposed copper refinery project site is located in coastal environment, air dispersion modeling studies were conducted using CALPUFF model. CALPUFF is an advanced, integrated multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time and space varying meteorological conditions on pollution transport, transformation and removal. CALPUFF can be applied on scales of tens to hundreds of kilometers. This model has been adopted by the United States Environmental Protection Agency (EPA) in its Guideline on Air Quality Models as a preferred model for assessing long range transport of pollutants.

The model builds on the CALMET gridded wind field, and contains modules for complex terrain, overwater transport and coastal interaction effects, building downwash, wet scavenging, dry deposition, and simple chemical transformation.
The integrated modeling system consists of 3 main components and a set of preprocessing and post processing programs. The main components of the modeling system are CALMET (a diagnostic 3-dimensional meteorological model), CALPUFF (an air quality dispersion model), and CALPOST (a post processing package).

In addition to these components, there are numerous other processors that may be used to prepare geophysical (land use and terrain) data in many standard formats, meteorological data (surface, upper air, precipitation, and buoy data), and interfaces to other models such as the Penn State/NCAR Mesoscale Model (MM5), the National Centers for Environmental Prediction (NCEP) Eta model and the RAMS meteorological model.

The CALPUFF model is designed to simulate the dispersion of buoyant, puff or continuous point and area pollution sources as well as the dispersion of buoyant, continuous line sources.

The components of the CALPUFF system include:
- **CALPUFF**
- **CALMET**
- **CALPOST**

➢ **CALPUFF**

CALPUFF is a puff model that is capable of fully accounting hour-by hour and spatial variations in wind and stability. Puff models, in general, perform well at downwind distances from a few kilometers to more than 100 km. CALPUFF contains additional algorithms that allow it to emulate AERMOD (or ISCST3) at short distances where puff model are generally less reliable. CALPUFF has been evaluated and found to be reasonably accurate at a distance up to 300 km.

EAC OBSERVATION NO.-12

- **CALMET**

CALMET is a diagnostic meteorological model which includes a diagnostic wind field generator containing objective analysis and parameterized treatments of slope flows, kinematic terrain effects, terrain blocking effects, a divergence minimization procedure, and a micro meteorological model for overland and overwater boundary layers.

- **CALPOST**

CALPOST is a post-processing program with options for the computation of time-averaged concentrations and deposition fluxes predicted by the CALPUFF model. CALPOST computes visibility impacts in accordance with IWAQM and FLAG recommendations. CALPOST requires only the CALPUFF outputs, although the final visualization often requires multiple additional programs.

- **Model Set-up and Scenarios**

In Calpuff, the modeling domain has set-up by 25 X 25 km horizontal grid with each grid cell spacing of 4 X4 km to provide adequate resolution of terrain features. Calpuff has run with 10 different layer options with default cell face heights of 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1200 m, 2000 m, 3000 m and 4000 m. The Calpuff model set-up details are presented in **Table-1** below:

TABLE-1
CALPUFF MODEL SET-UP

Sr. No.	Parameter	Details
1	Model Name	CALPUFF (Version 8.6.1)
2	Model Type	Non-Steady-State Puff Dispersion model
3	Topography	Rural, Flat and Coastal
4	Averaging Time	15 m, 1, 3, 8 & 24 hours
5	Source Type	Point Source
6	Boundary Limits	25 km X 25 km
7	Co-ordinate System	Uniform Cartesian Grid
8	Meteorological data	MM5 (Fifth-Generation Penn State/NCAR Mesoscale Model) 1st January 2018 to 31st December 2018

Sulphur dioxide (SO_2), Oxides of Nitrogen (NOx) and Particulate Matter (PM) emissions are the main pollutants in the copper refinery plant. Air Dispersion modeling studies have been conducted considering 2 scenarios for the above pollutants. The annual wind rose diagram is presented in **Figure-1** and the 3D view of vertical wind field distribution for the same period is presented in **Figure-2**.

EAC OBSERVATION NO.-12

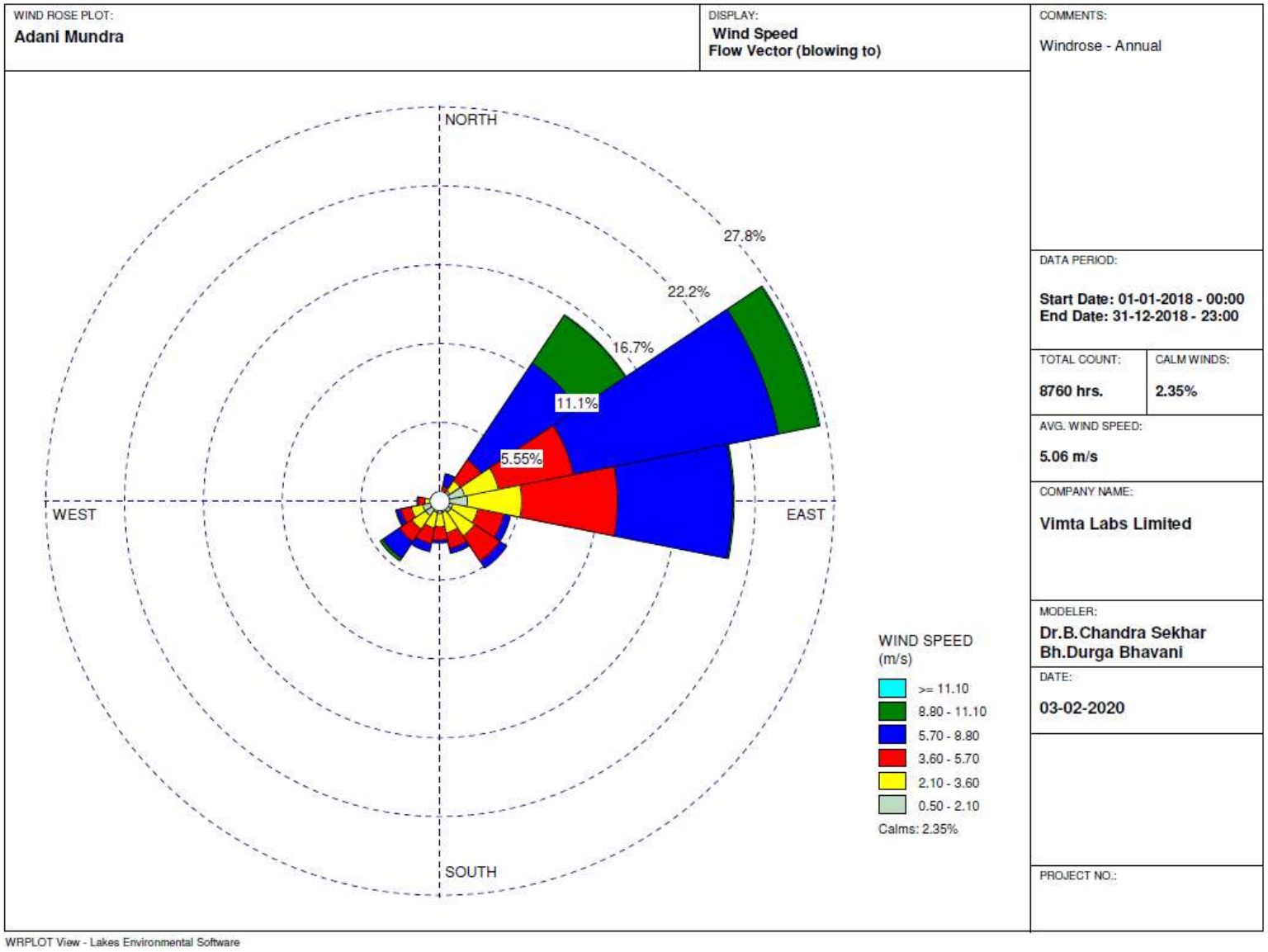


FIGURE-1

WIND ROSE DIA GRAM (1ST JANUARY 2018-31ST DECEMBER 2018)

EAC OBSERVATION NO.-12

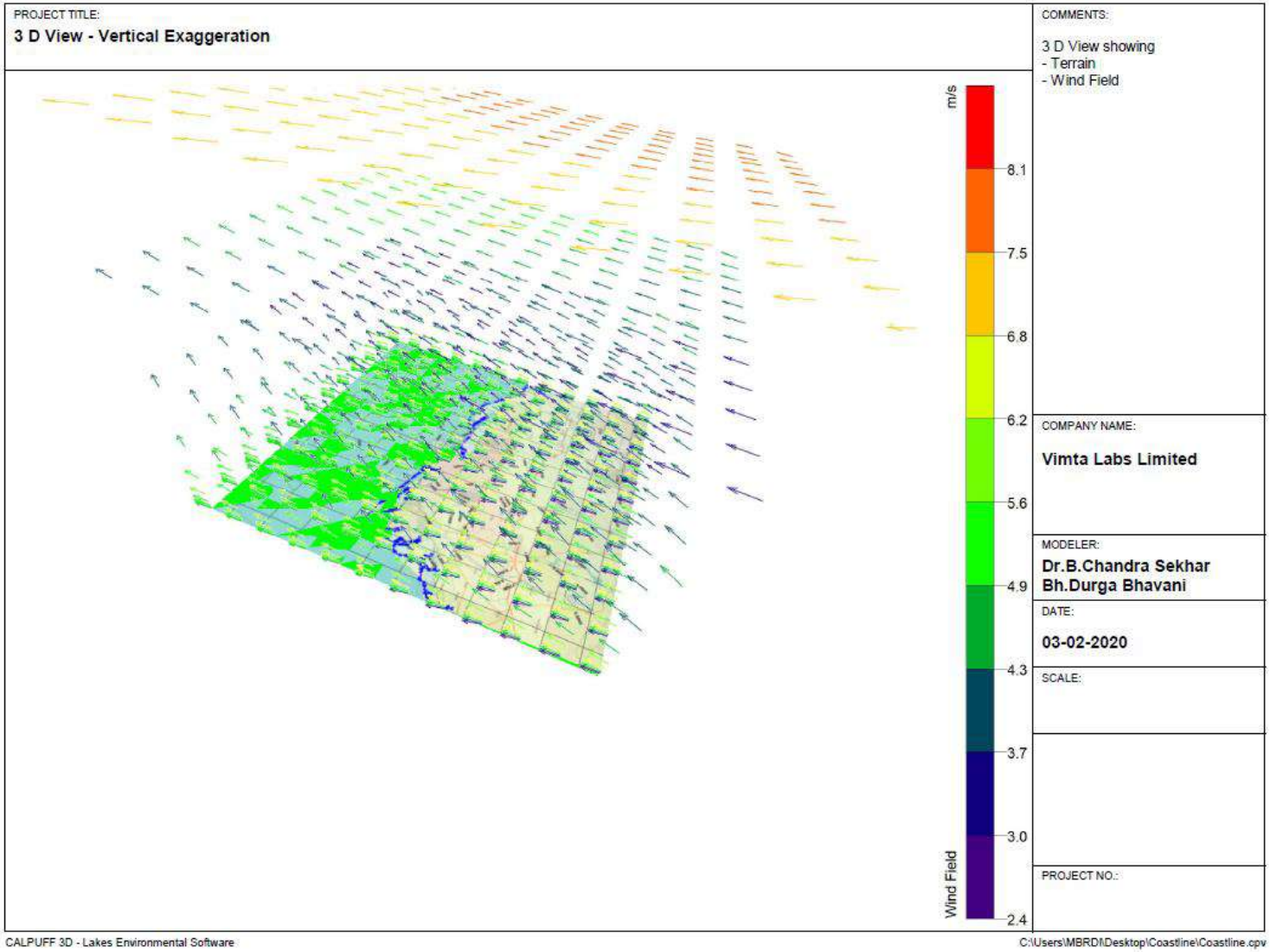


FIGURE-2
VERTICAL WIND FIELD DISTRIBUTION

EAC OBSERVATION NO.-12

Model Limitations:

An attempt has been made to determine incremental concentrations during daytime and nighttime. However, the model limitation (selection option) permits 5 AM-5 PM and 24 Hour average only. Hence, model predictions were carried out for 24 Hour average and 12 Hour option. The model predictions were carried out with a model domain of 25 km X 25 km.

Scenario-1: Normal Operating conditions with coast line fumigation (24 hourly average);
Scenario-1A: Normal Operating conditions with coast line fumigation (Day time 12 hourly average);
Scenario-2: Under pollution control system failure (representing Worst case) with coastline fumigation (24 hourly average); and
Scenario-2A: Under pollution control system failure (representing Worst case) with coastline fumigation (Day time 12 hourly average).

- ***Model Input Data***

  The details of stack emissions of proposed copper refinery project considered for conducting air dispersion modelling are presented in **Annexure-I.**

- **Results and Discussions**

  Scenario-1: Normal Operating conditions with coast line fumigation (24 hourly average)

  The simulations have been carried out to evaluate incremental concentration of Sulphur dioxide (SO_2), Oxides of Nitrogen (NOx) and Particulate Matter (PM) likely to be contributed by the proposed project on various land uses. The maximum concentrations of SO_2 and PM are occurring at X-556.212 km and Y-2519.521 km and NOx maximum concentrations are occurring at X-560.212 km and Y-2523.521 km. The maximum SO_2 concentrations are occurring at a distance of 2.55 km in NE direction on a barren land and the nearest settlement is Bhujpar Mota village which is located at a distance of 1.2 km NE direction.

  The predicted incremental concentrations of SO_2, NOx and PM (98^{th} percentile) due to the proposed project on various land uses are presented in **Table-2** and the isopleths of the same are shown in **Figure-3** to **Figure-5** respectively**.**

TABLE-2
INCREMENTAL CONCENTRATIONS UNDER NORMAL OPERATING CONDITIONS WITH COASTLINE FUMIGATION – 24 HOUR AVERAGE

All values are in µg/m^3

Parameter	Barren Land	Streams & Canals	Range Land	Agriculture Land	Max Conc.
PM	1.96	0.90	1.00	0.50	1.96
SO_2	8.00	13.90	8.00	4.00	13.90
NO_x	0.30	0.47	0.08	0.004	0.47

EAC OBSERVATION NO.-12

Scenario-1A: Normal Operating conditions with coast line fumigation (Daytime 12 hourly average)

The simulations have been carried out to evaluate daytime (5 AM – 5 PM) incremental concentration of Sulphur dioxide (SO_2), Oxides of Nitrogen (NOx) and Particulate Matter (PM) likely to be contributed by the proposed project on various land uses. The maximum concentrations of SO_2, and PM are occurring at X-568.212 km and Y-2527.521 km and for NOx the maximum concentrations are occurring at X-560.212 km and Y-2523.521 km.

The predicted incremental concentrations for SO_2, NOx and PM (98% percentile) are presented in **Table-3** and isopleths of the are shown in **Figure-6** to **Figure-8** respectively**.** Further, the 3D view of the same is given in **Figure-9 to Figure-11.**

TABLE-3
INCREMENTAL CONCENTRATIONS UNDER NORMAL OPERATING CONDITIONS WITH COASTLINE FUMIGATION – DAYTIME 12 HOURS

All values are in μg/m^3

Parameter	Barren Land	Streams & Canals	Range Land	Agriculture Land	Max Conc.
PM	0.90	0.10	0.41	0.080	0.41
SO_2	0.80	0.50	3.29	0.10	3.29
NO_x	0.09	0.053	0.008	0.00053	0.053

From the above observations, it can be concluded that the maximum concentrations are occurring at streams and canals. The concentrations of PM, SO_2 and NOx over agricultural land were observed to be 0.080, 0.10 and 0.00053 μg/m^3 respectively. It is to be noted that the SO_2 incremental concentrations resulting from the plant operations are occurring on range land.

EAC OBSERVATION NO.-12

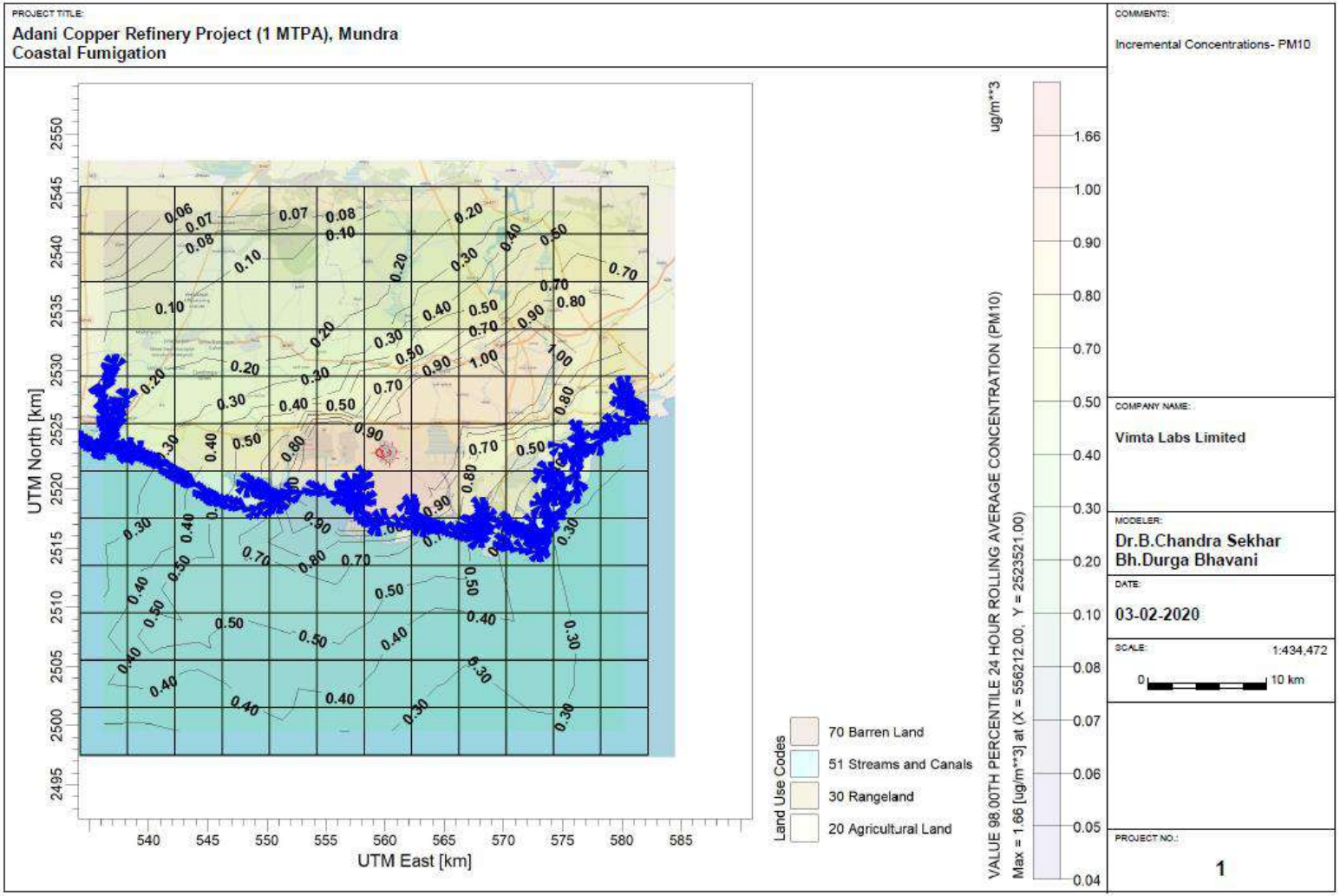


FIGURE-3
ISOPLETHS SHOWING THE INCREMENTAL CONCENTRATIONS - PARTICULATE MATTER (NORMAL OPERATING CONDITIONS – 24 HRS)

EAC OBSERVATION NO.-12

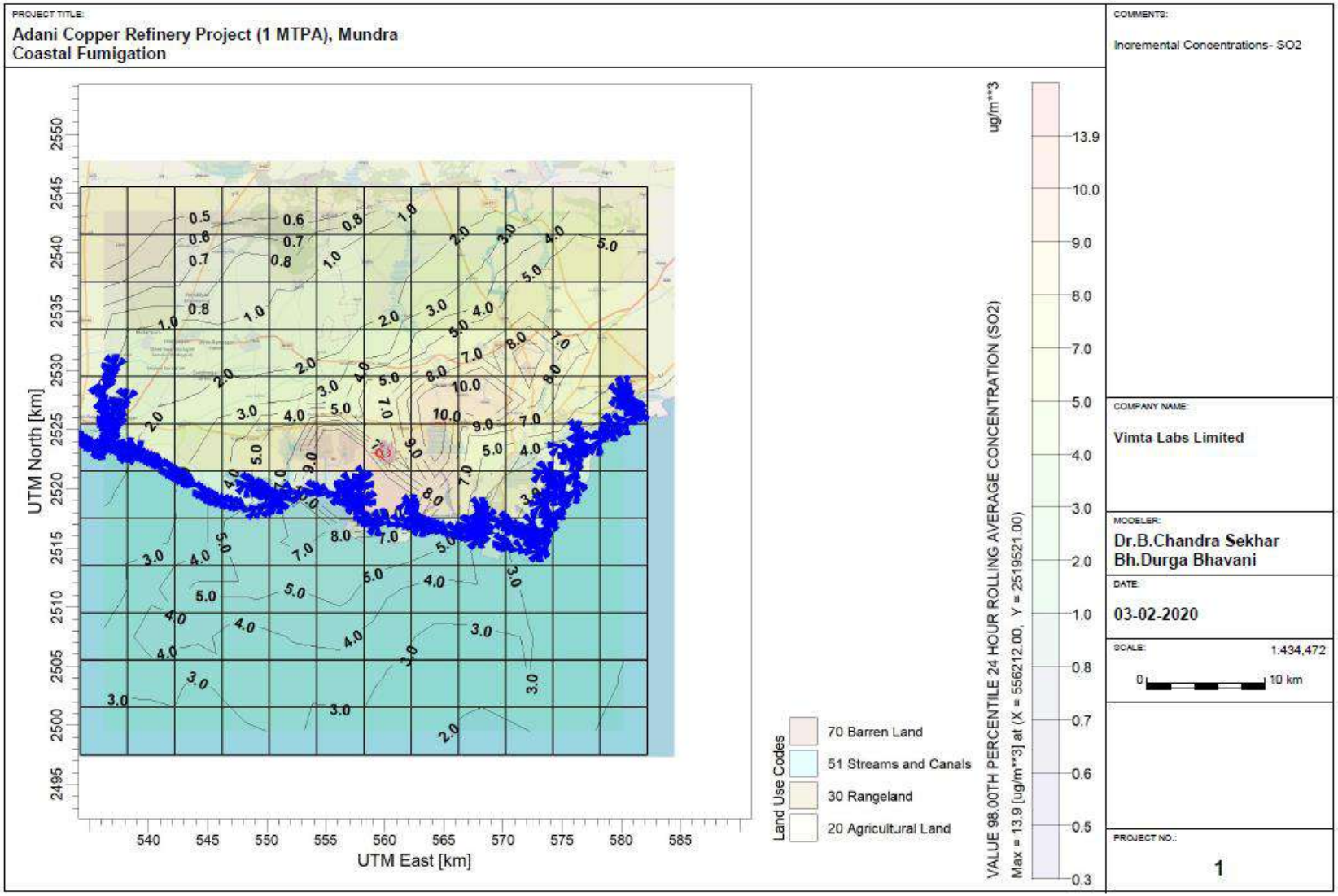


FIGURE-4
ISOPLETHS SHOWING THE INCREMENTAL CONCENTRATIONS - SO_2
(NORMAL OPERATING CONDITIONS – 24 HRS)

EAC OBSERVATION NO.-12

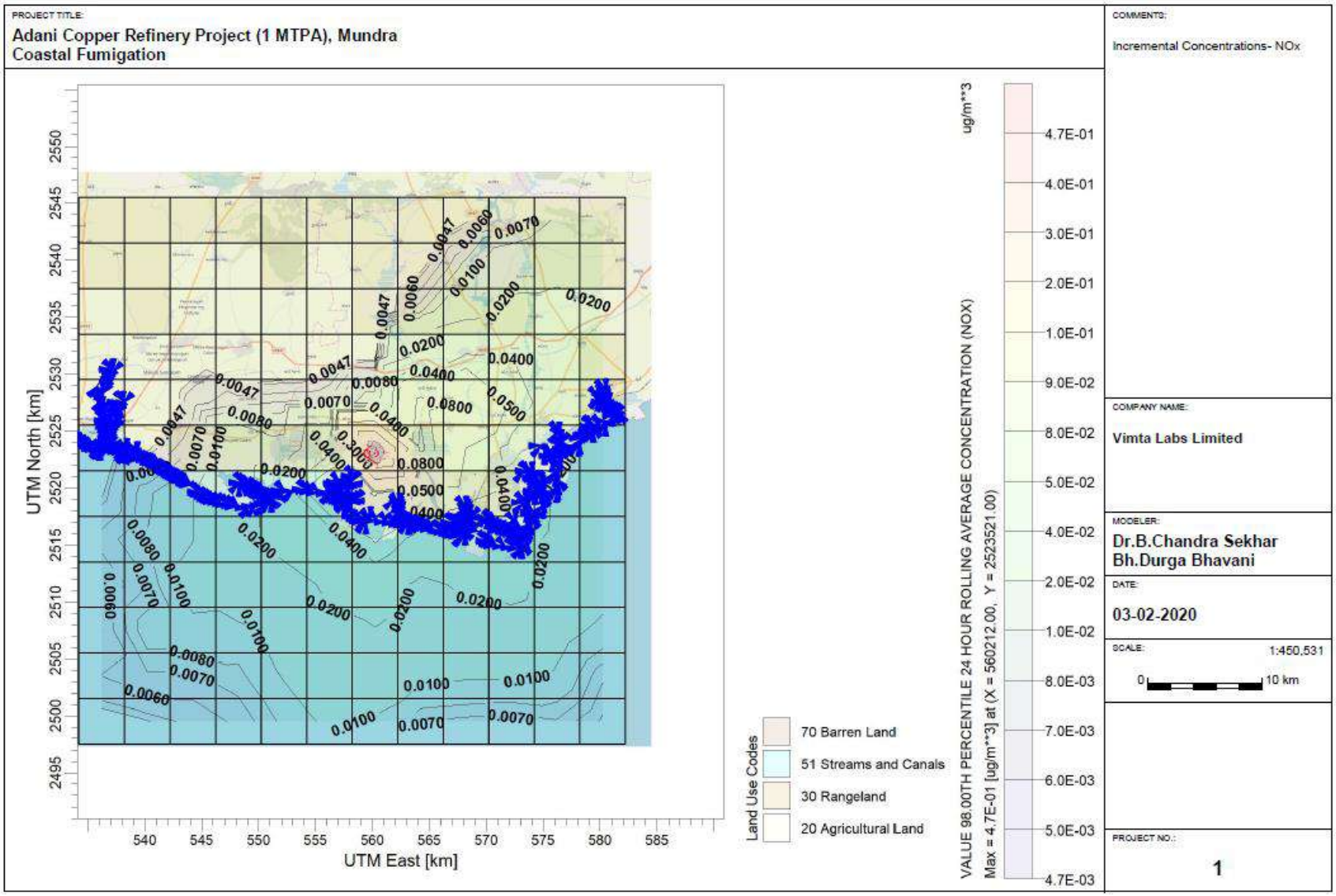


FIGURE-5
ISOPLETHS SHOWING THE INCREMENTAL CONCENTRATIONS - NOx
(NORMAL OPERATING CONDITIONS – 24 HRS)

EAC OBSERVATION NO.-12

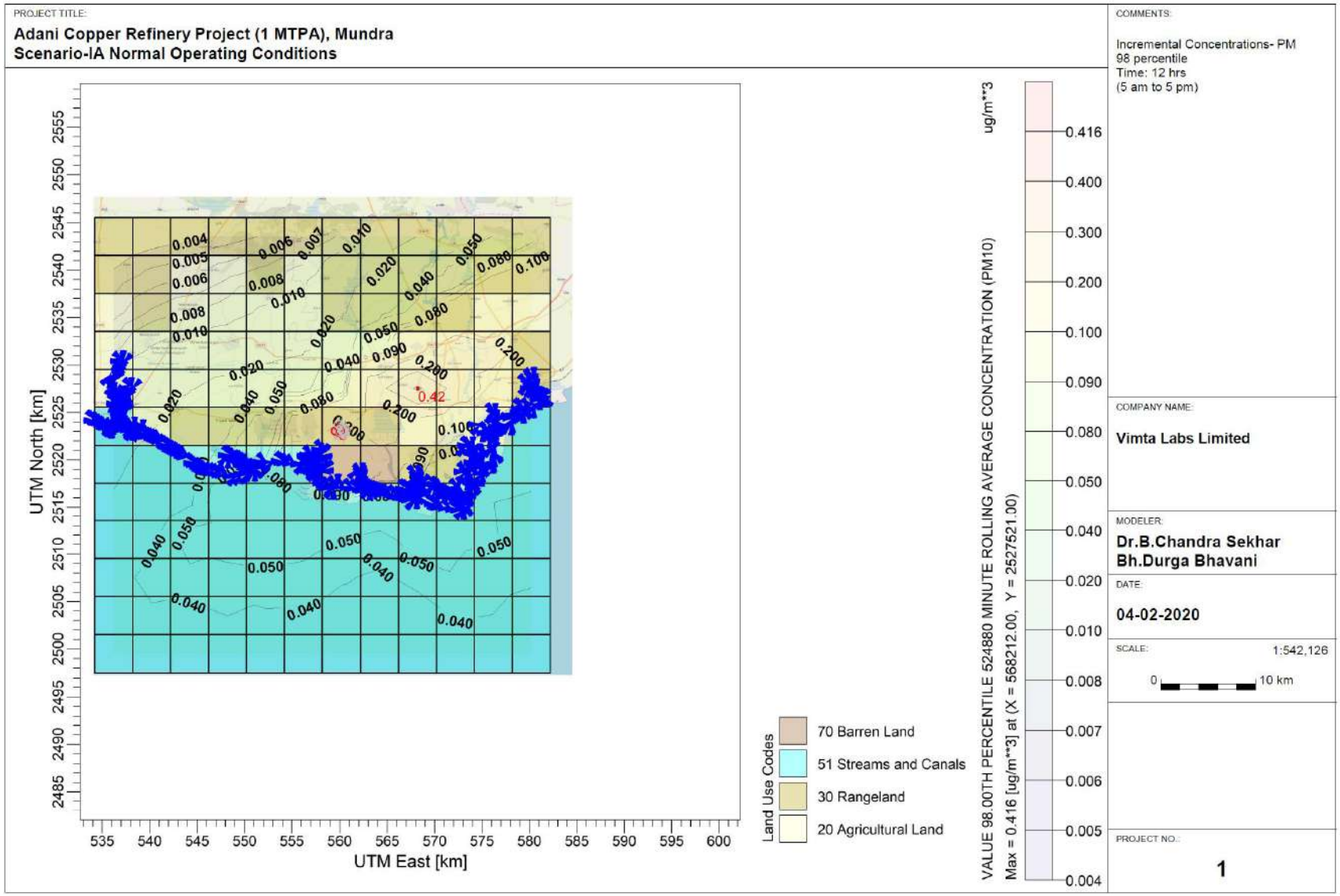


FIGURE-6

ISOPLETHS SHOWING THE INCREMENTAL CONCENTRATIONS - PARTICULATE MATTER (NORMAL OPERATING CONDITIONS 12 HRS)

EAC OBSERVATION NO.-12

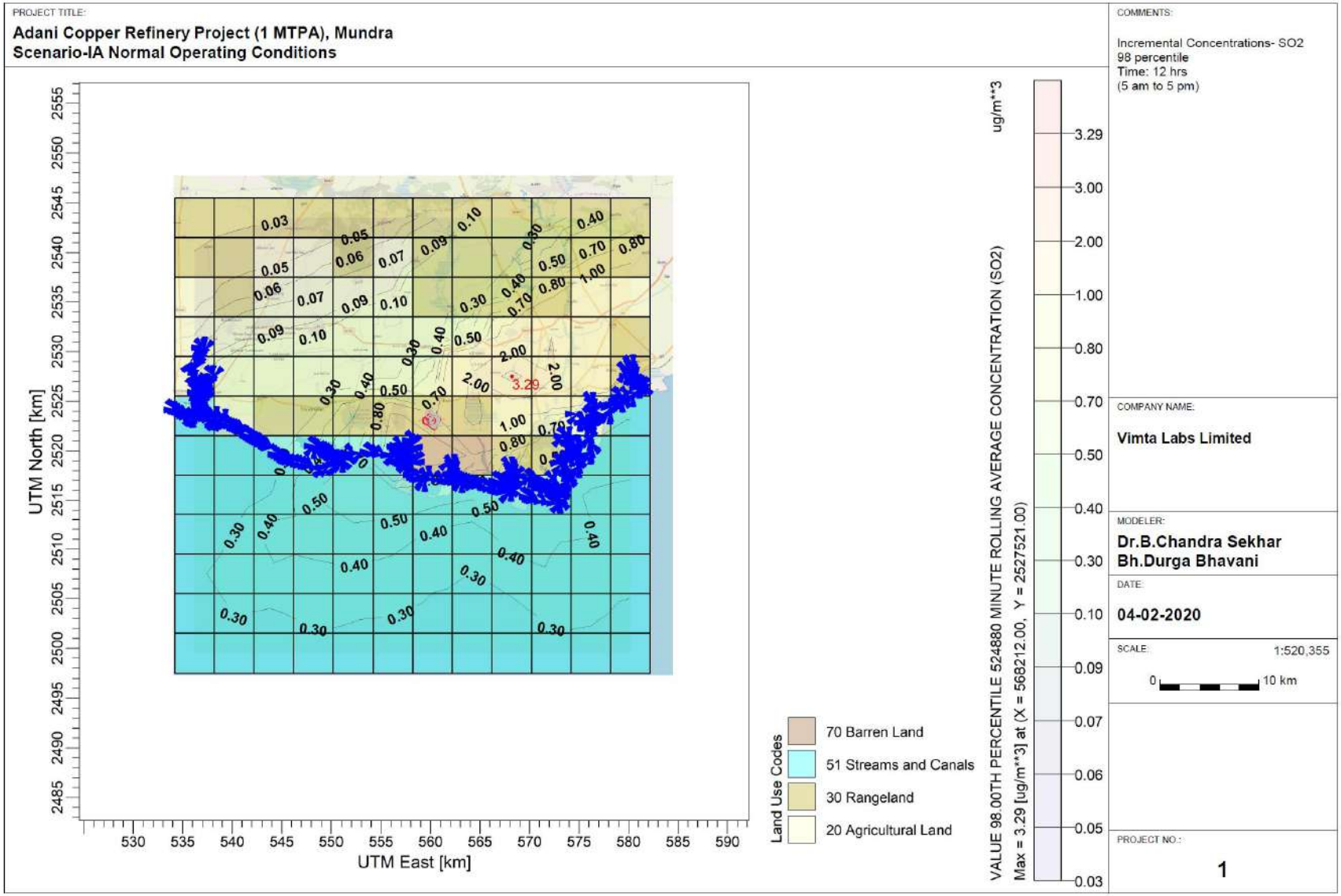


FIGURE-7
ISOPLETHS SHOWING THE INCREMENTAL CONCENTRATIONS – SO_2
(NORMAL OPERATING CONDITIONS 12 HRS)

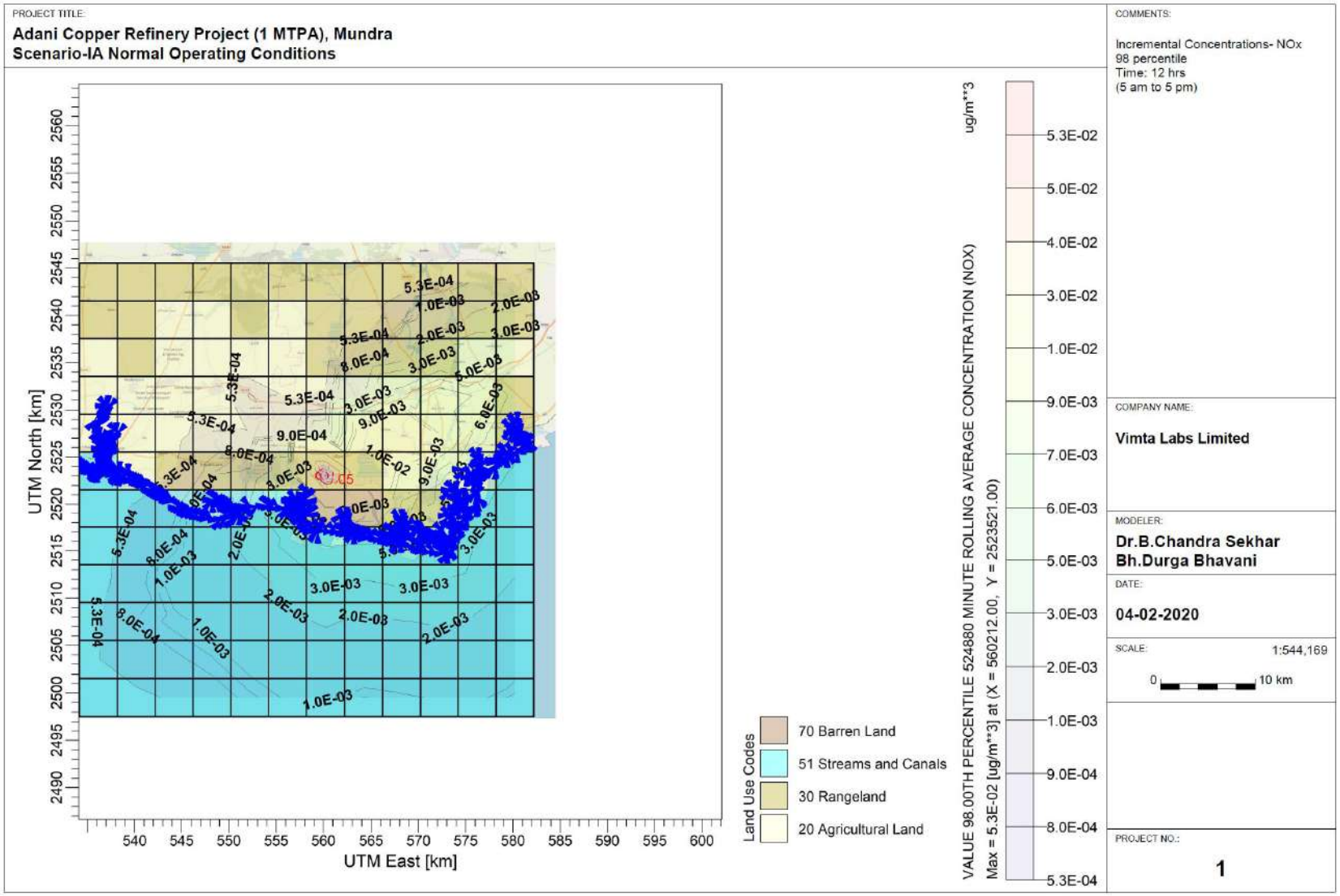


FIGURE-8
ISOPLETHS SHOWING THE INCREMENTAL CONCENTRATIONS – NOx
(NORMAL OPERATING CONDITIONS 12 HRS)

EAC OBSERVATION NO.-12

Scenario-2: Under pollution control system failure (representing Worst case) with coastline fumigation

The simulations have been carried out to predict maximum incremental concentrations of Sulphur dioxide (SO_2), Oxides of Nitrogen (NOx) and Particulate Matter (PM) likely to be contributed by the proposed project during upset conditions on various land uses. The simulations carried out for 1minute interval. The isopleths showing the incremental concentrations on various land uses are shown in **Figure-12** to **Figure-14** respectively.

The long-term incremental concentrations due to the proposed project on various land use pattern is presented below:

TABLE-4
INCREMENTAL CONCENTRATIONS UNDER POLLUTION CONTROL SYSTEM FAILURE REPRESENTING WORST CASE – 1 MINUTE INTERVAL

All values are in $\mu g/m^3$

Parameter	Barren land	Streams & Canals	Range Land	Agriculture Land	Max Conc.
PM	31.69	5.0	3.0	0.3	31.69
SO_2	21534	10000	5000	215	21534
NO_x	6.24	1.0	1.0	0.06	6.242

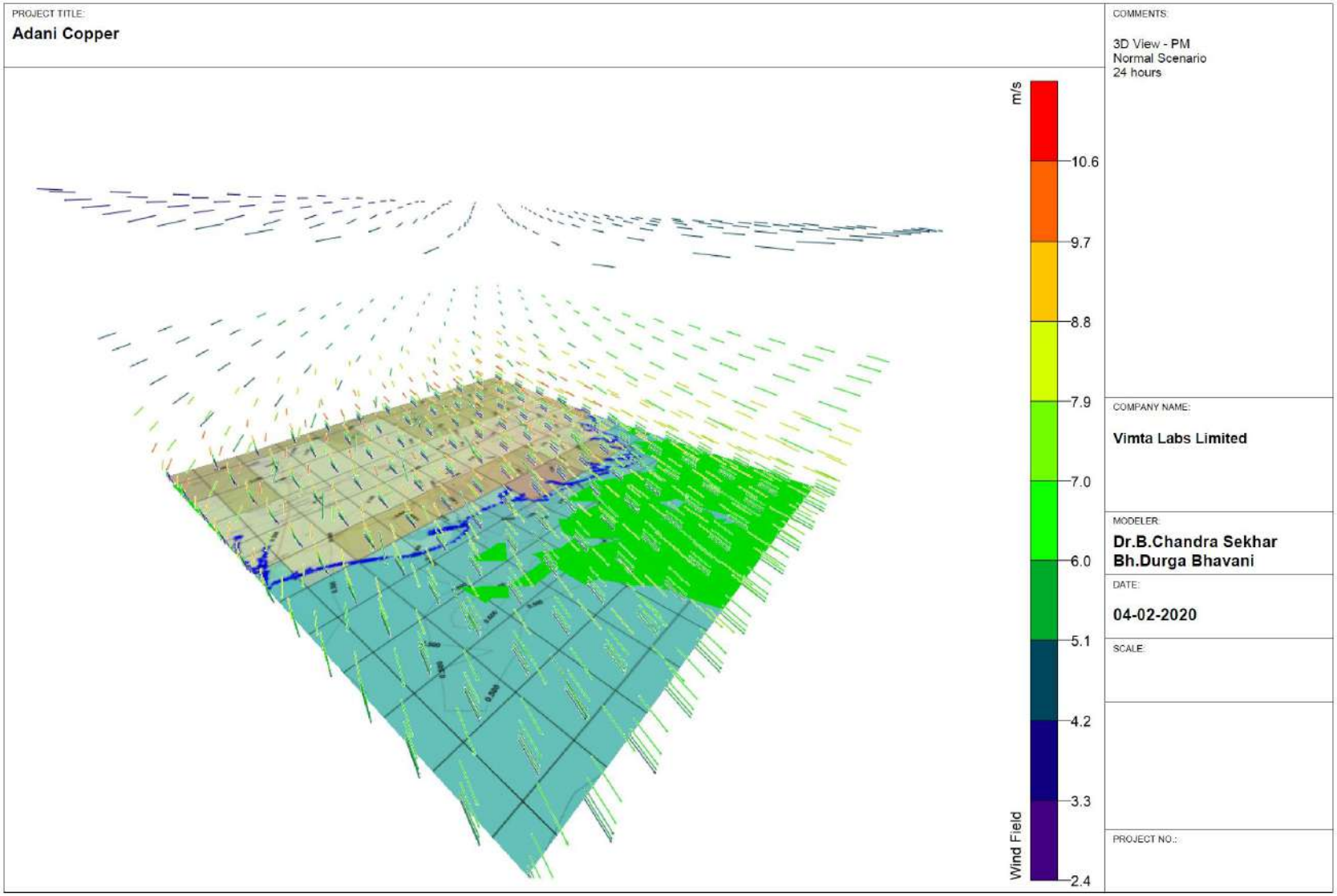


FIGURE-9
ISOPLETHS SHOWING THE INCREMENTAL CONCENTRATIONS – PARTICULATE MATTER (NORMAL CONDITIONS-24 HRS AVG -3D VIEW)

EAC OBSERVATION NO.-12

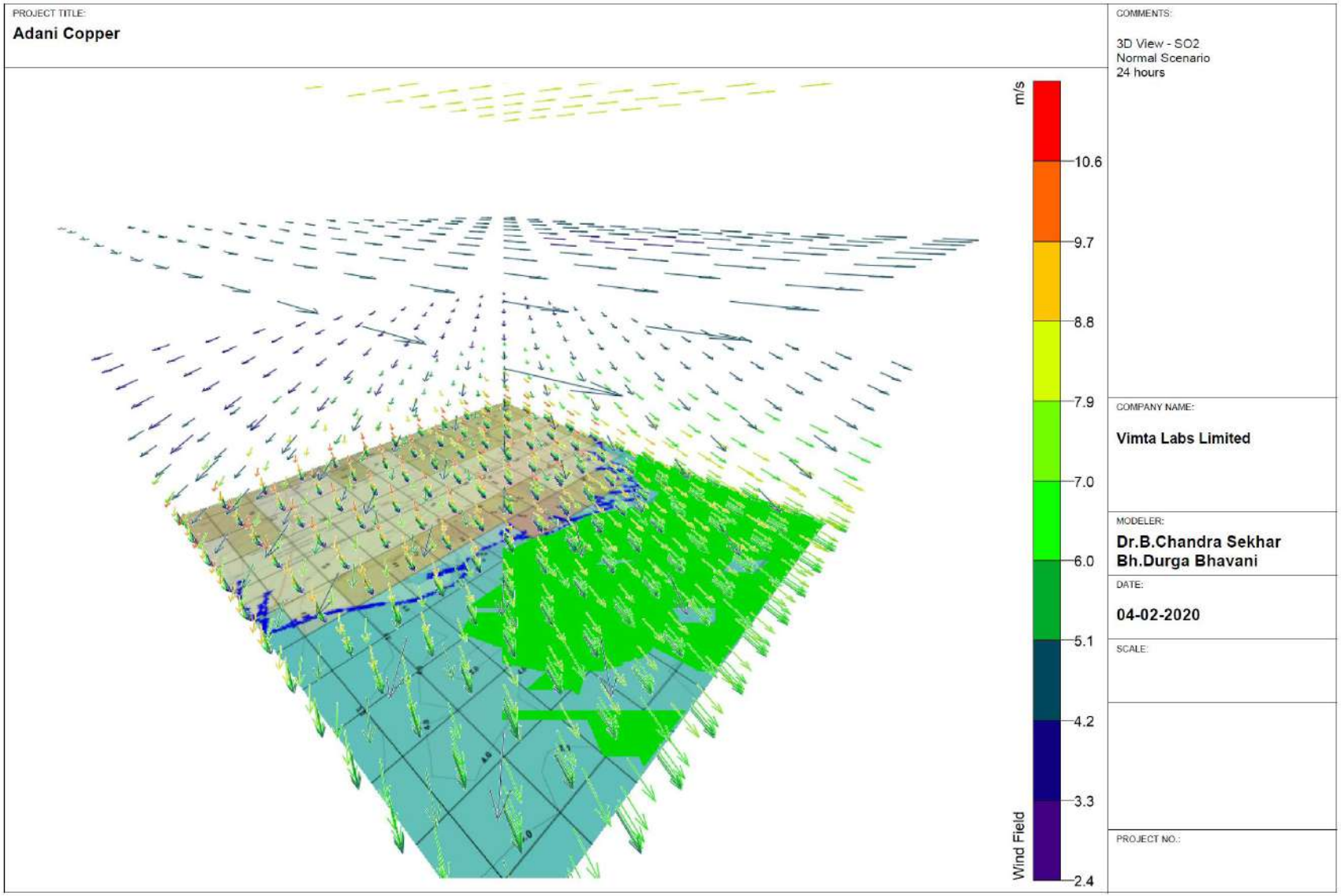


FIGURE-10
ISOPLETHS SHOWING THE INCREMENTAL CONCENTRATIONS – SO2
(NORMAL CONDITIONS – 24 HRS AVG - 3D VIEW)

EAC OBSERVATION NO.-12

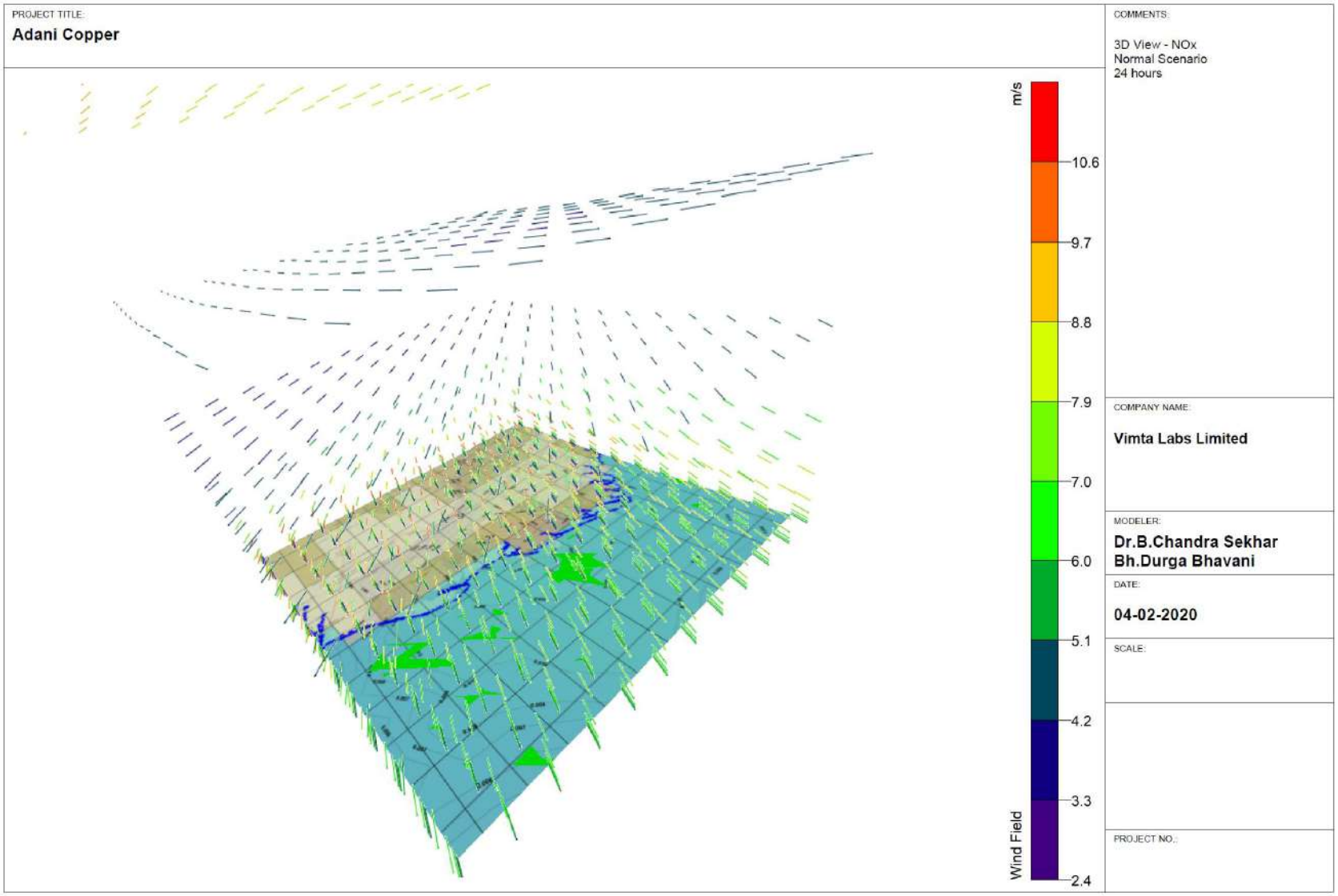


FIGURE-11
ISOPLETHS SHOWING THE INCREMENTAL CONCENTRATIONS – NOX (NORMAL CONDITIONS – 24 HRS AVG - 3D VIEW)

EAC OBSERVATION NO.-12

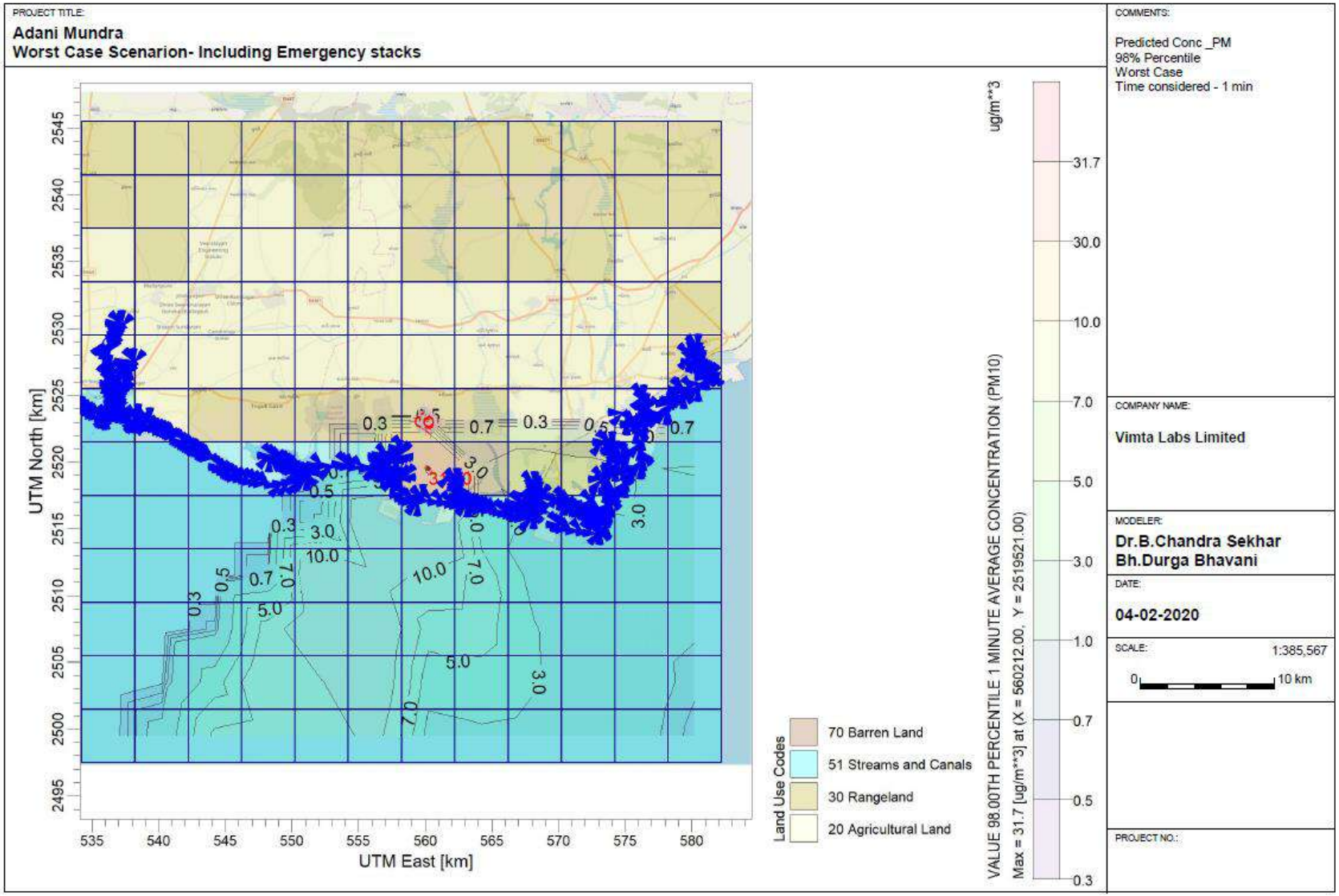


FIGURE-12
ISOPLETHS SHOWING THE INCREMENTAL CONCENTRATIONS - PARTICULATE MATTER (WORST CASE SCENARIO-1 MIN)

EAC OBSERVATION NO.-12

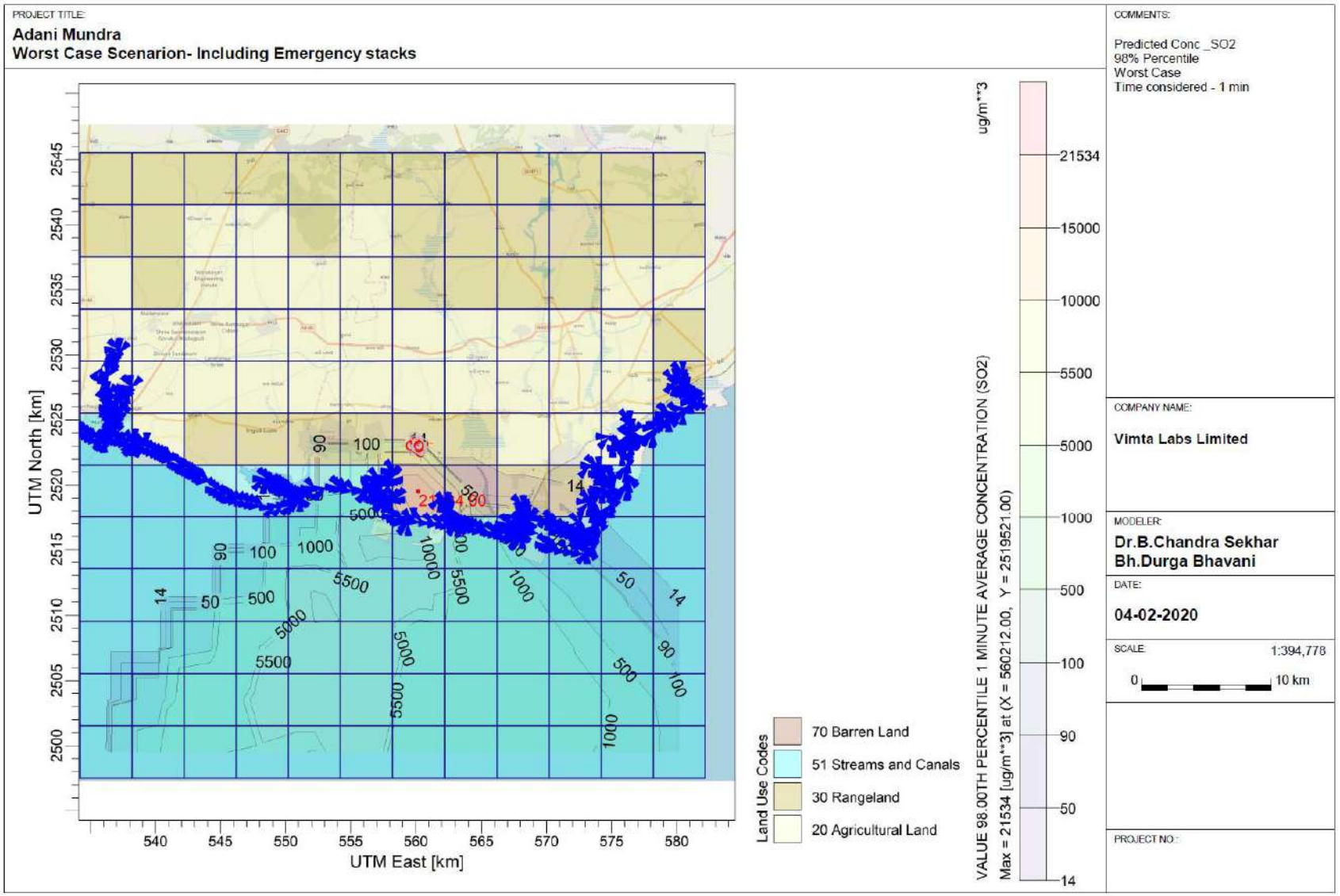


FIGURE-13
ISOPLETHS SHOWING THE INCREMENTAL CONCENTRATIONS - SO_2
(WORST CASE SCENARIO-1 MIN)

EAC OBSERVATION NO.-12

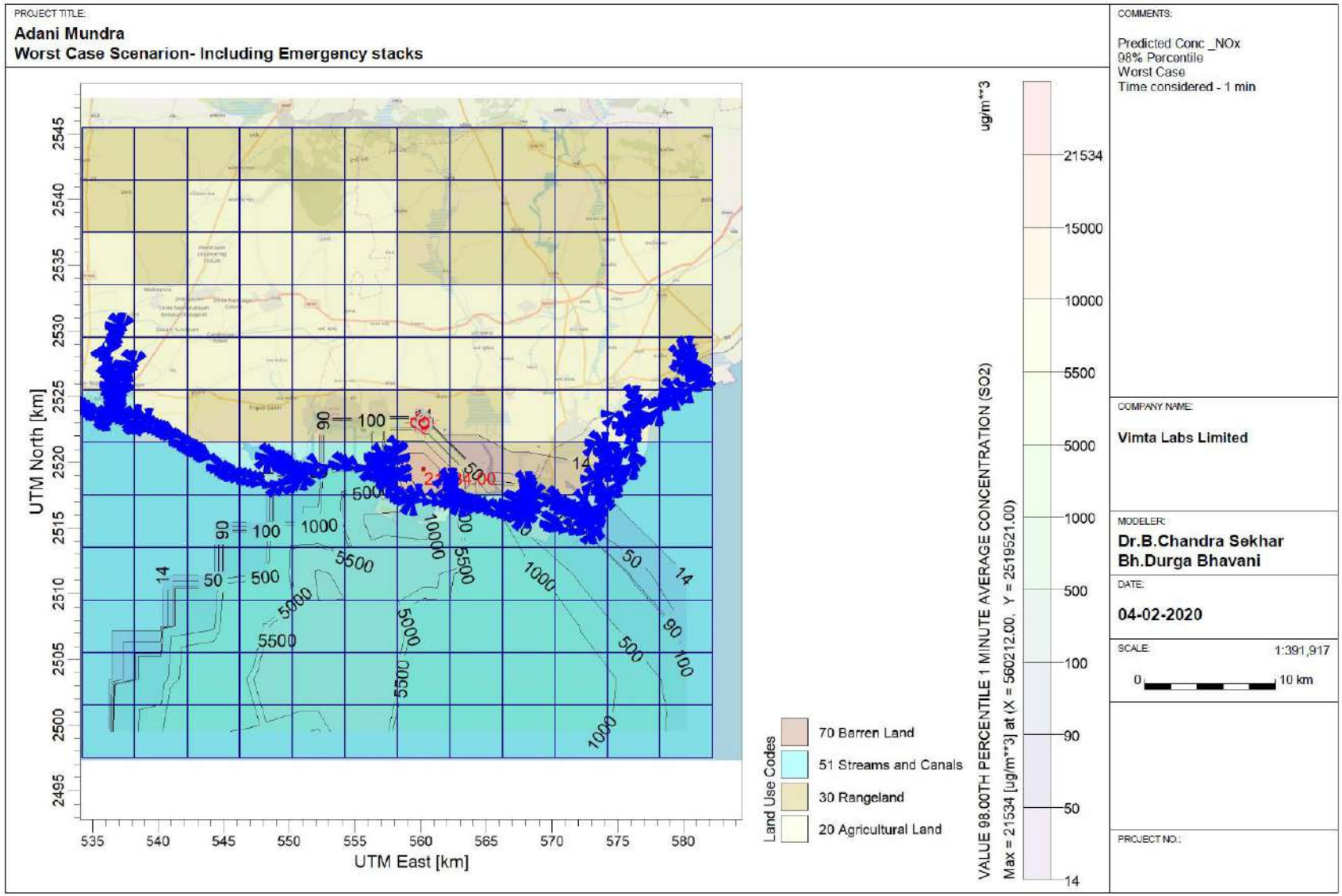


FIGURE-14
ISOPLETHS SHOWING THE INCREMENTAL CONCENTRATIONS – Nox (WORST CASE SCENARIO-1 MIN)

EAC OBSERVATION NO.-12

Impact on Habitation:

The release of air pollutant attributes from the emission sources of the proposed project and its impact on nearby habitations have been assessed for two scenarios i.e.; normal scenario and worst case scenario. The resultant concentrations are given below in **Table-5** to **Table-10**.

TABLE-5
IMPACT ON NEAREST HABITATION – PM -NORMAL SCENARIO

(Expressed in µg/m³)

AAQ	Village Name	Distance/ Direction	Baseline Concentration (PM_{10}) – 98th %ole	Predicted GLCs	Resultant Concentrations	NAAQ Norms
AAQ1	Project Site	-	54.2	1.00	55.2	100
AAQ2	Navinal	1.7 km, ENE	60.6	0.90	61.5	
AAQ3	Bhujpar Mota	6.2 km, NE	74.1	0.90	75.0	
AAQ4	Jarpara	6.8 km, ENE	63.7	1.00	64.7	
AAQ5	Wandh	1.8 km, SW	76.6	0.80	77.4	
AAQ6	Siracha	4.4 km, NW	82.2	0.40	82.6	
AAQ7	Siravha	1.7 km, NNW	64.8	0.90	65.7	
AAQ8	Moti Khakhar	5.9 km, NNW	84.1	0.20	84.3	

TABLE-6
IMPACT ON NEAREST HABITATION – SO_2 - NORMAL SCENARIO

(***Expressed in µg/m³)***

AAQ	Village Name	Distance/ Direction	Baseline Concentration (PM_{10}) – 98th %ole	Predicted GLCs	Resultant Concentrations	NAAQS 2009
AAQ1	Project Site	-	24.6	8.0	32.6	80
AAQ2	Navinal	1.7 km, ENE	32.1	7.0	7.1	
AAQ3	Bhujpar Mota	6.2 km, NE	30.7	7.0	37.7	
AAQ4	Jarpara	6.8 km, ENE	20.4	9.0	29.4	
AAQ5	Wandh	1.8 km, SW	29.8	8.0	37.8	
AAQ6	Siracha	4.4 km, NW	30.6	3.0	33.6	
AAQ7	Siravha	1.7 km, NNW	30.8	8.0	38.8	
AAQ8	Moti Khakhar	5.9 km, NNW	42.0	2.0	44.2	

TABLE-7
IMPACT ON NEAREST HABITATION – NOx -NORMAL SCENARIO

(***Expressed in µg/m³)***

AAQ	Village Name	Distance/ Direction	Baseline Concentration (PM_{10}) – 98th %ole	Predicted GLCs	Resultant Concentrations	NAAQS 2009
AAQ1	Project Site	-	19.9	0.08	19.98	80
AAQ2	Navinal	1.7 km, ENE	23.1	0.007	23.11	
AAQ3	Bhujpar Mota	6.2 km, NE	28.5	0.04	28.54	
AAQ4	Jarpara	6.8 km, ENE	27.5	0.05	27.55	
AAQ5	Wandh	1.8 km, SW	27.7	0.02	27.72	
AAQ6	Siracha	4.4 km, NW	27.3	0.008	27.31	
AAQ7	Siravha	1.7 km, NNW	28.5	0.007	28.51	
AAQ8	Moti Khakhar	5.9 km, NNW	31.7	0.0047	31.71	

EAC OBSERVATION NO.-12

TABLE-8
IMPACT ON NEAREST HABITATION – PM -WORST CASE SCENARIO

(***Expressed in µg/m³)***

AAQ	Village Name	Distance/ Direction	Baseline Concentration (PM_{10}) – 98th %ole	Predicted GLCs	Resultant Concentrations
AAQ1	Project Site	-	54.2	0.7	54.9
AAQ2	Navinal	1.7 km, ENE	60.6	0.3	60.9
AAQ3	Bhujpar Mota	6.2 km, NE	74.1	0.3	74.4
AAQ4	Jarpara	6.8 km, ENE	63.7	0.3	64.0
AAQ5	Wandh	1.8 km, SW	76.6	0.5	77.1
AAQ6	Siracha	4.4 km, NW	82.2	0.3	82.5
AAQ7	Siravha	1.7 km, NNW	64.8	0.3	65.1
AAQ8	Moti Khakhar	5.9 km, NNW	84.1	0.3	84.4

TABLE-9
IMPACT ON NEAREST HABITATION – SO_2 -WORST CASE SCENARIO

(***Expressed in µg/m³)***

AAQ	Village Name	Distance/ Direction	Baseline Concentration (PM_{10}) – 98th %ole	Predicted GLCs	Resultant Concentrations
AAQ1	Project Site	-	24.6	50.0	74.6
AAQ2	Navinal	1.7 km, ENE	32.1	14.0	46.1
AAQ3	Bhujpar Mota	6.2 km, NE	30.7	14.0	44.7
AAQ4	Jarpara	6.8 km, ENE	20.4	14.0	34.4
AAQ5	Wandh	1.8 km, SW	29.8	100.0	129.8
AAQ6	Siracha	4.4 km, NW	30.6	90.0	120.6
AAQ7	Siravha	1.7 km, NNW	30.8	50.0	80.8
AAQ8	Moti Khakhar	5.9 km, NNW	42.0	14.0	56.0

Incase of tripping of the system the worst case scenario will take place. The residual gases in the system will escape within less than 90 sec. Calpuff modelling has been done for releases gases incase of trip as worst case scenario and the resultant peak GLC has been predicted, which will be temporary in the ambient air and will get normalize instantaneously.

TABLE-10
IMPACT ON NEAREST HABITATION – NOx -WORST CASE SCENARIO

(***Expressed in µg/m³)***

AAQ	Village Name	Distance/ Direction	Baseline Concentration (PM_{10}) – 98th %ole	Predicted GLCs	Resultant Concentrations
AAQ1	Project Site	-	19.9	0.10	20.00
AAQ2	Navinal	1.7 km, ENE	23.1	0.40	23.50
AAQ3	Bhujpar Mota	6.2 km, NE	28.5	0.10	28.60
AAQ4	Jarpara	6.8 km, ENE	27.5	0.10	27.60
AAQ5	Wandh	1.8 km, SW	27.7	0.40	28.10
AAQ6	Siracha	4.4 km, NW	27.3	0.50	27.80
AAQ7	Siravha	1.7 km, NNW	28.5	0.10	28.60
AAQ8	Moti Khakhar	5.9 km, NNW	31.7	0.10	31.80

EAC OBSERVATION NO.-12

Mitigation measures at Receptor locations:

- Greenbelt/green cover shall be developed in the surrounding villages
- Provision of CER funds to develop greenbelt/green cover out side the plant premises
- Sulphur absorbing species shall be planted the villages in consultation with forest department
- Continuous Ambient Air Quality Monitoring Systems (CAAQMS) shall be installed to perform real time checks in nearby villages

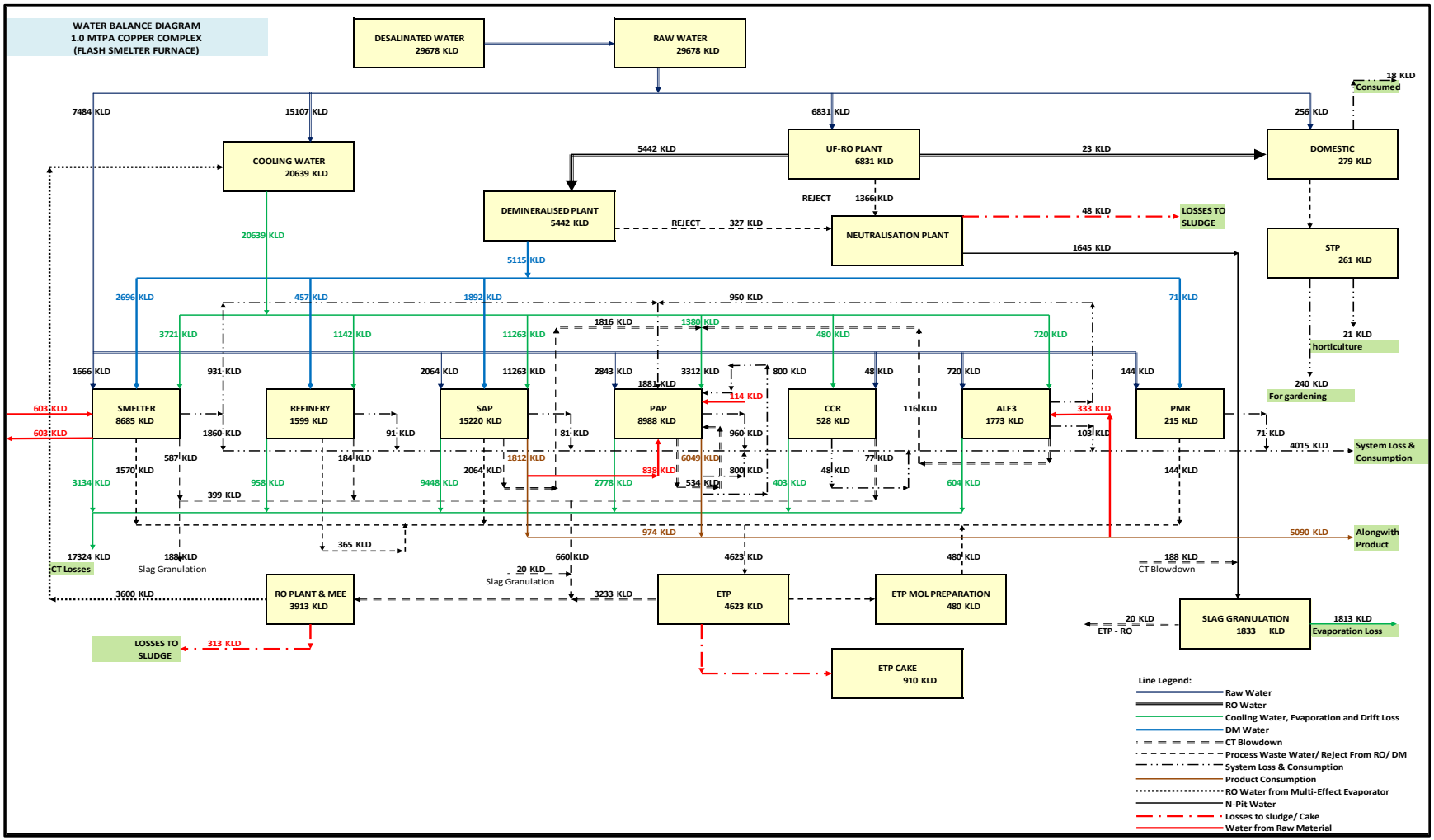
EAC OBSERVATION NO.-13

EAC OBSERVATION:

Unit wise water balance to be submitted in tabular form

REPLY:

Water Balance for the proposed Copper refinery project has been reworked and water requirement has been **reduced from 32,800 KLD to 29,678 KLD**, by increased **reuse and recycling**.



EAC OBSERVATION NO.-13

The water requirements for each facility-wise are mentioned below.

WATER BALANCE | 1.0 MTPA COPPER REFINERY										
Sr. No.	Area	Input		Output						
		Fresh	Recycled	Product Acid	Evaporation Loss	ETP	ETP - RO	Recycled within the plant	Used in the Other Plant	System Loss & Consumption
1	Smelter	7,795	2,771		4,947	1,570	419	188		3,443
2	Refinery	1,599			958	365	184			91
3	Sulphuric Acid Plant (SAP)	13,600	1,620	974	9,448	2,064			2,654	81
4	Phosphoric Acid Plant (PAP)	4,223	6,098	4,449	2,778			1,334		1,760
5	Continuous Cast Rod (CCR)	528			403		77			48
6	Aluminium Fluoride Plant (ALF3)	1,440	333		604				1,066	103
7	Precious Metal Recovery (PMR)	215				144				71
8	Domestic Consumption	279								279
Total		**29,678**	**10,823**	**5,423**	**19,138**	**4,143**	**680**	**1,522**	**3,720**	**5,876**

EAC OBSERVATION NO.-13

The specific water consumption (raw water) per ton of product and per ton of copper production is as follows, mentioned below for facility-wise.

Sr. No.	Plant Area	UOM	Installed Production Capacity	UOM	Specific Water Consumption (Raw Water)	
					Per Ton of Product	Per Ton of Cu Production
1	Smelter	t/day	3,030	m^3/t	2.57	2.57
2	Refinery	t/day	3,030	m^3/t	0.53	0.53
3	Sulphuric Acid Plant (SAP)	t/day	9,091	m^3/t	1.50	4.49
4	Phosphoric Acid Plant (PAP)	t/day	1,515	m^3/t	2.79	1.39
5	Continuous Cast Rod (CCR)	t/day	1,515	m^3/t	0.35	0.17
6	Aluminium Fluoride Plant (ALF_3)	t/day	91	m^3/t	15.84	0.48
7	Precious Metal Recovery (PMR)	Kg/day	1,667	m^3/kg	0.13	0.07

EAC OBSERVATION NO.-13

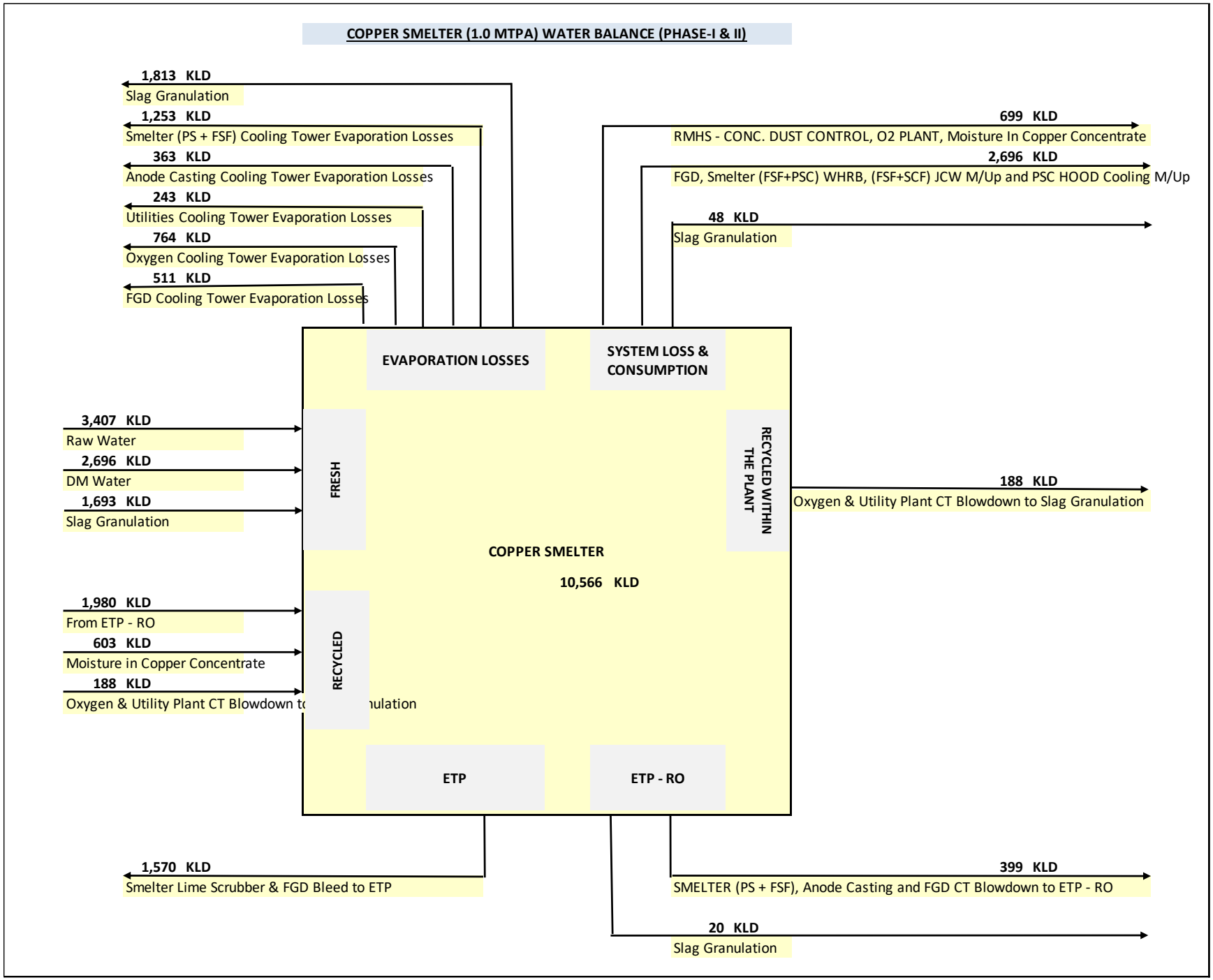
Unit wise water balance for Copper Refinery Project has been prepared facility-wise providing the details of fresh water, recycled water and waste water generated.

Smelter water balance (KLD).

Sr. No.	Area	Input		Output				
		Fresh	Recycled	Evaporation Loss	ETP	ETP - RO	Recycled within the plant	System Loss & Consumption
1	Raw Water	3,407						
2	DM Water	2,696						
3	Slag Granulation	1,693		1,813		20		48
4	From ETP - RO		1,980					
5	Moisture in Copper Concentrate		603					
6	Smelter (PS + FSF) Cooling Tower Evaporation Losses			1,253				
7	Anode Casting Cooling Tower Evaporation Losses			363				
8	Utilities Cooling Tower Evaporation Losses			243				
9	Oxygen Cooling Tower Evaporation Losses			764				
10	FGD Cooling Tower Evaporation Losses			511				
11	Smelter Lime Scrubber & FGD Bleed to ETP				1,570			
12	SMELTER (PS + FSF), Anode Casting and FGD CT Blowdown to ETP - RO					399		
13	Oxygen & Utility Plant CT Blowdown to Slag Granulation		188				188	
14	RMHS - CONC. DUST CONTROL, O2 PLANT, Moisture In Copper Concentrate							699
15	FGD, Smelter (FSF+PSC) WHRB, (FSF+SCF) JCW M/Up and PSC HOOD Cooling M/Up							2,696
Total		**7,795**	**2,771**	**4,947**	**1,570**	**419**	**188**	**3,443**

The total water requirement in the smelter is 10,566 KLD; of these, 7,795 KLD fresh water and 2,771 KLD recycling water from other the plant. A total of 1,570 KLD of wastewater from the smelter and the FGD is treated in the ETP plant.

EAC OBSERVATION NO.-13



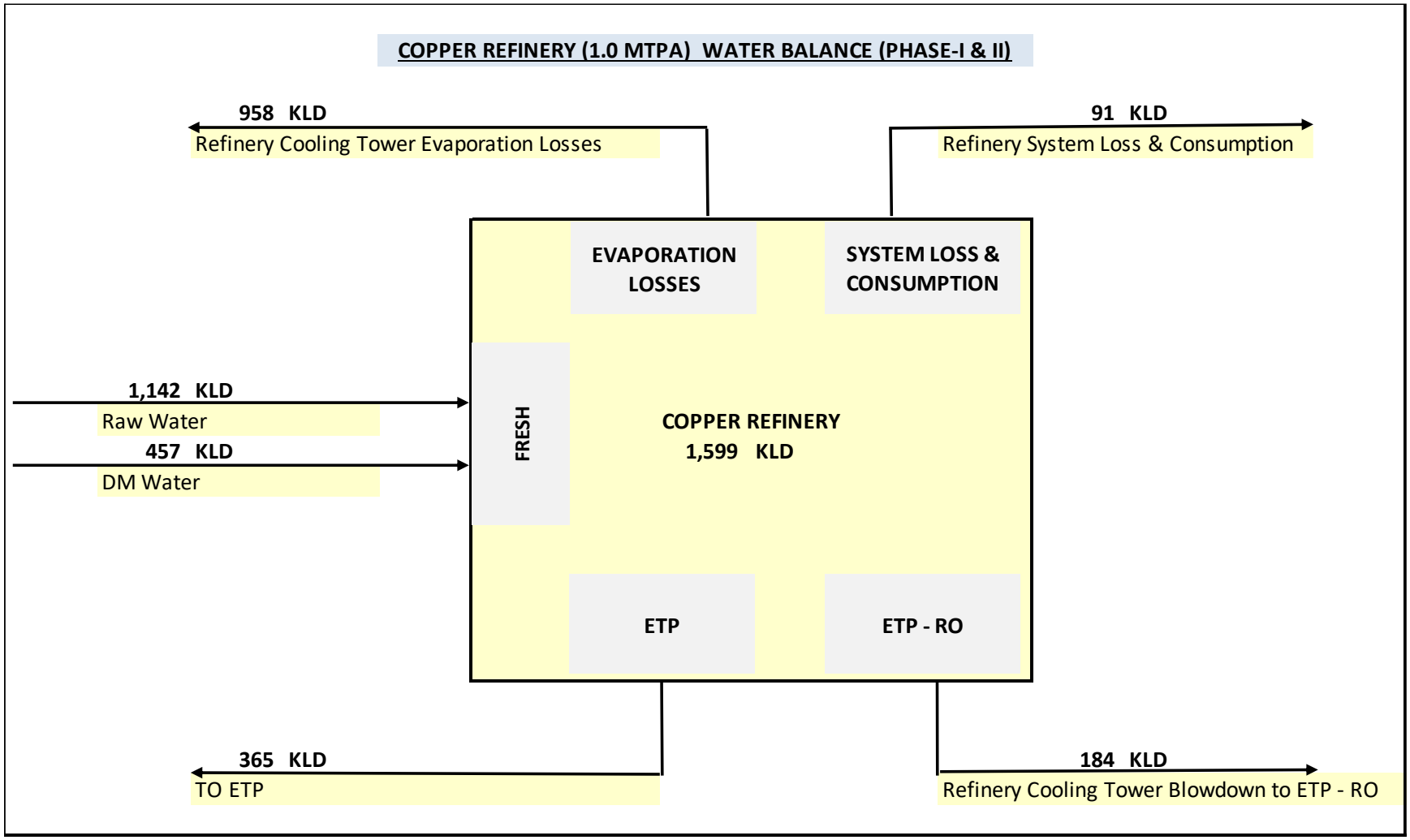
EAC OBSERVATION NO.-13

Refinery Water Balance (KLD):

Refinery Water Balance (KLD)						
Sr. No.	Area	INPUT	OUTPUT			
		Fresh	Evaporation losses	ETP	ETP - RO	System Loss & Consumption
1	Raw Water	1,142				
2	DM Water	457				
3	Refinery Cooling Tower Evaporation Losses		958			
4	TO ETP			365		
5	Refinery Cooling Tower Blowdown to ETP - RO				184	
6	Refinery System Loss & Consumption					91
Total		**1,599**	**958**	**365**	**184**	**91**

The total water requirement in the refinery is 1,599 KLD; Fresh water. A total of 365 KLD of wastewater from the refinery is treated in the ETP plant.

EAC OBSERVATION NO.-13



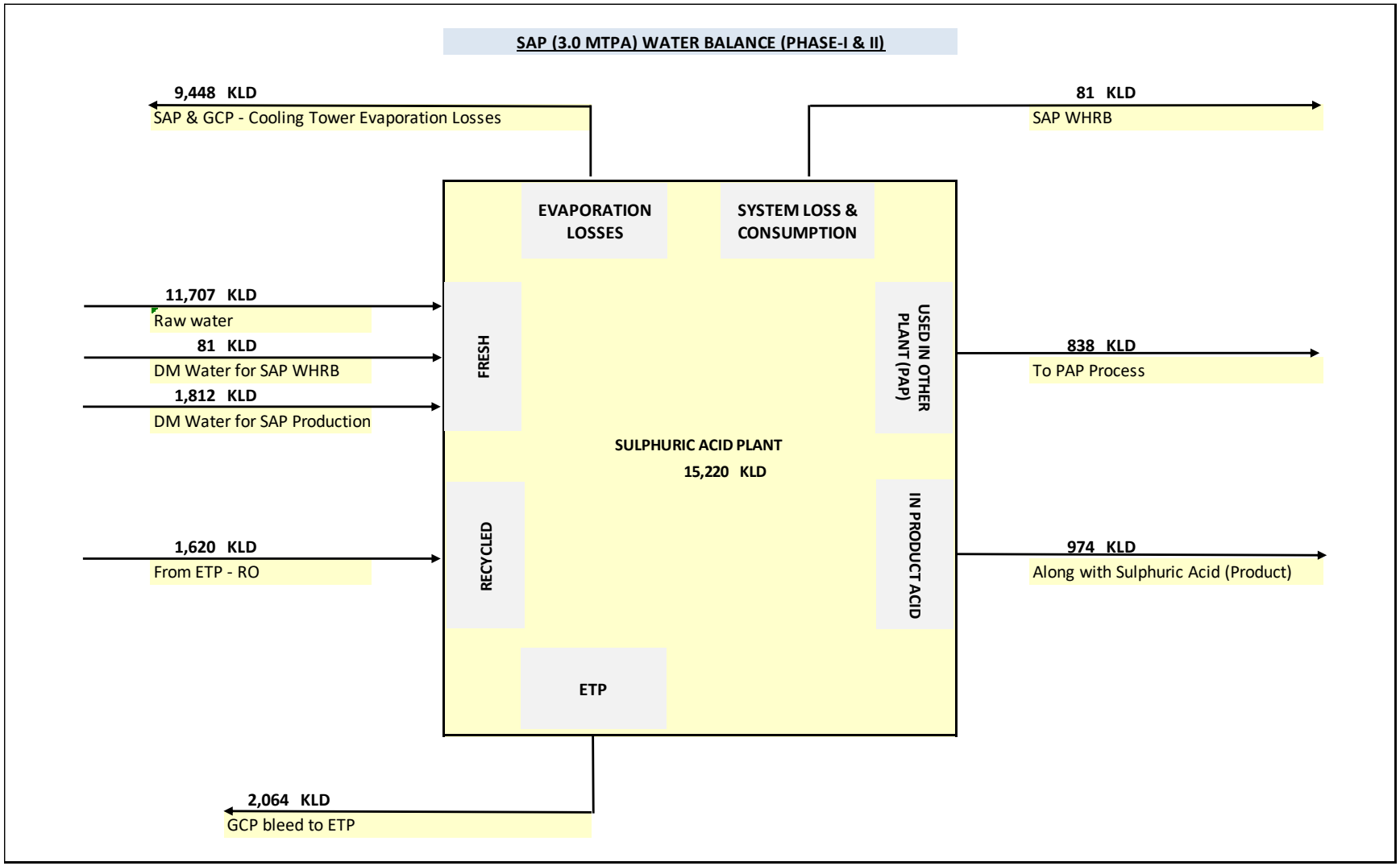
EAC OBSERVATION NO.-13

Sulphuric Acid Plant Water Balance (KLD):

SAP Water Balance (KLD)								
Sr. No.	Area	INPUT		OUTPUT				
		Fresh	Recycled	Product Acid	Evaporation losses	ETP	Used in other Plant (PAP)	System Loss & Consumption
1	Raw water	11,707						
2	From ETP - RO		1,620					
3	DM Water for SAP WHRB	81						
4	DM Water for SAP Production	1,812						
5	Along with Sulphuric Acid (Product)			974			838	
6	SAP & GCP - Cooling Tower Evaporation Losses				9,448			
7	GCP bleed to ETP					2,064		
8	SAP & GCP - Cooling Tower Blow Down						1,816	
9	SAP WHRB							81
Total		**13,600**	**1,620**	**974**	**9,448**	**2,064**	**2,654**	**81**

The total water requirement in the Sulphuric Acid Plant is 15,220 KLD; of these, 13,600 KLD fresh water and 1,620 KLD recycling water from the other plant. A total of 2,064 KLD of wastewater from the Gas Cleaning Plant is treated in the ETP plant.

EAC OBSERVATION NO.-13



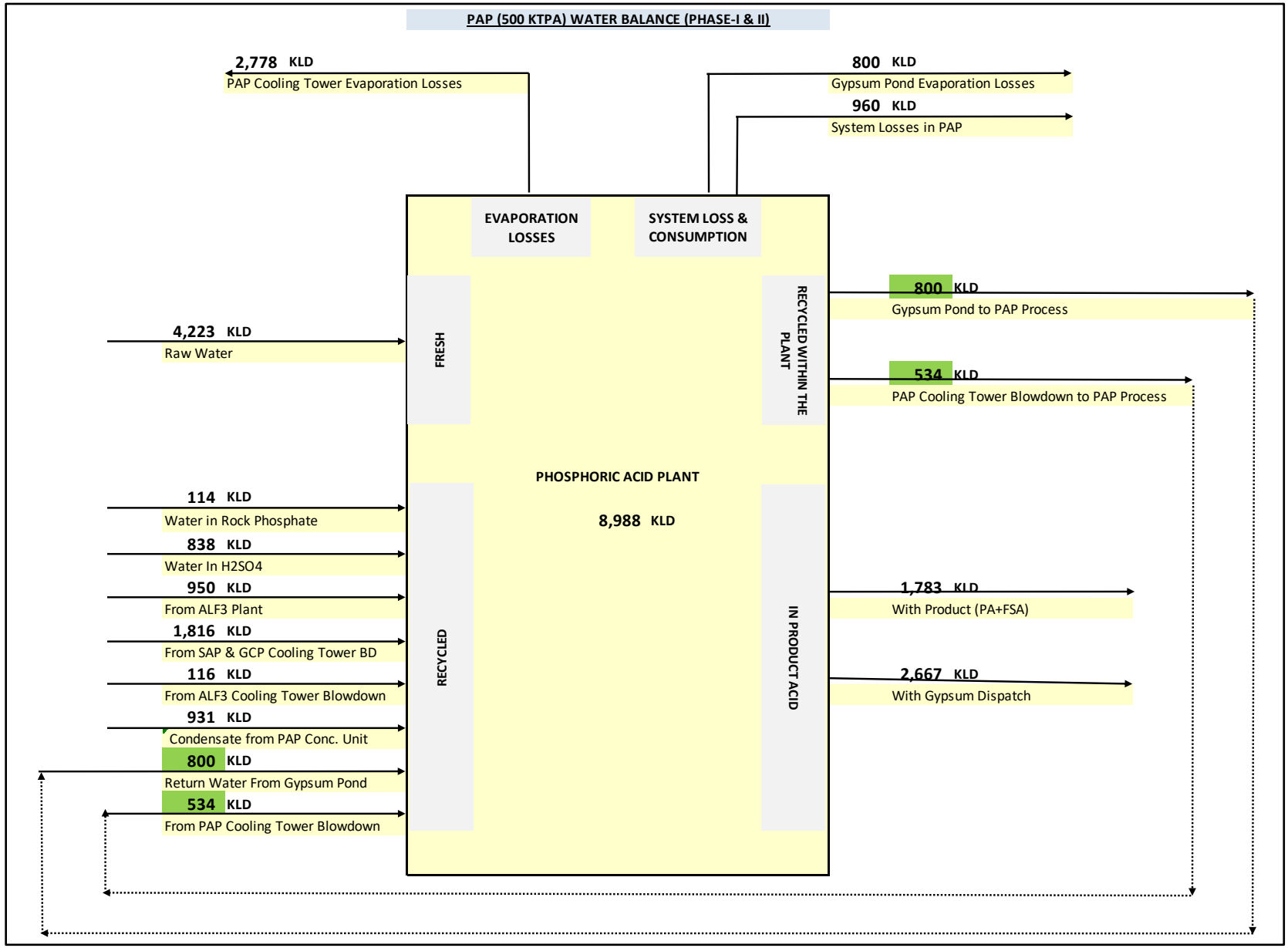
EAC OBSERVATION NO.-13

Phosphoric Acid Plant Water Balance (KLD):

PAP Water Balance (KLD)							
Sr. No.	Area	INPUT		OUTPUT			
		Fresh	Recycled	In Product	Evaporation Loss	System Loss & Consumption	Recycled Within the Plant
1	Raw Water	4,223					
2	Water in Rock Phosphate		114				
3	Water In H2SO4		838				
4	From ALF3 Plant		950				
5	From SAP & GCP Cooling Tower BD		1,816				
6	From ALF3 Cooling Tower Blowdown		116				
7	Condensate from PAP Conc. Unit		931				
8	From PAP Cooling Tower Blowdown		534				
9	Return Water From Gypsum Pond		800				
10	With Product (PA+FSA)			1,783			
11	With Gypsum Dispatch			2,667			
12	PAP Cooling Tower Evaporation Losses				2,778		
13	Gypsum Pond Evaporation Losses					800	
14	System Losses in PAP					960	
15	Gypsum Pond to PAP Process						800
16	PAP Cooling Tower Blowdown to PAP Process						534
Total		**4,223**	**6,098**	**4,449**	**2,778**	**1,760**	**1,334**

The total water requirement in the Phosphoric Acid Plant is 10,322 KLD; of these, 4,223 KLD fresh water and 6,098 KLD recycling water from the other plant.

EAC OBSERVATION NO.-13

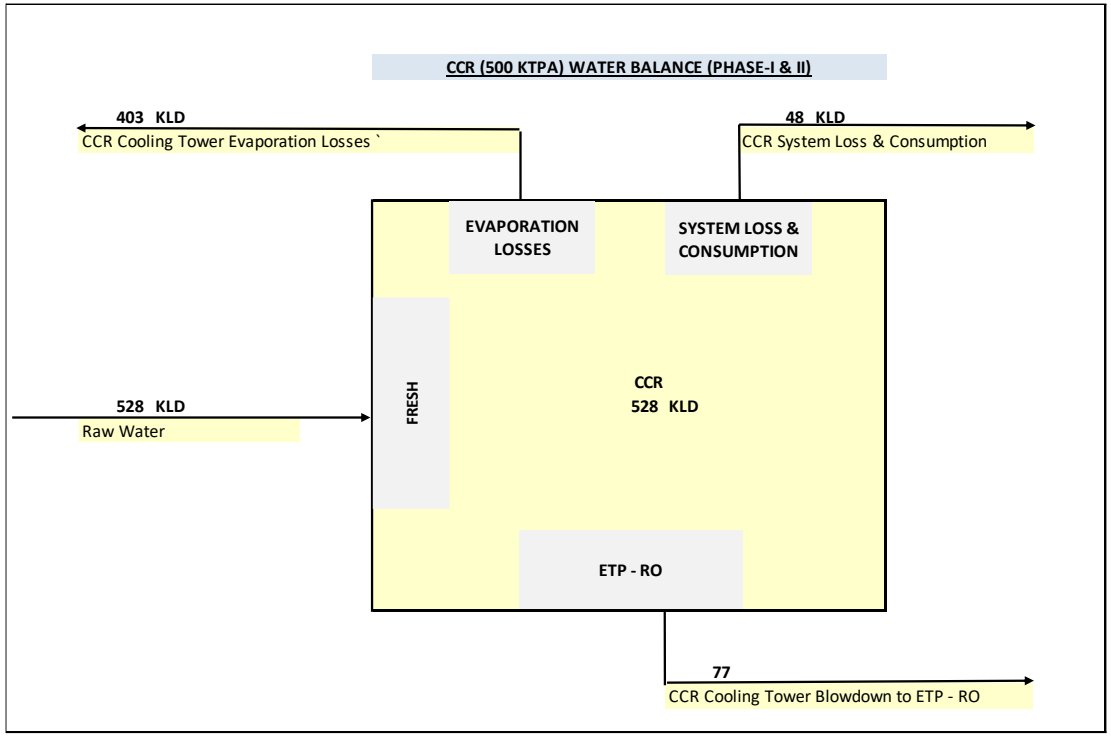


EAC OBSERVATION NO.-13

CCR Water Balance (KLD):

CCR Water Balance (KLD)					
Sr. No.	Area	INPUT	OUTPUT		
		Fresh Water	Evaporation losses	ETP - RO	System Loss & Consumption
1	Raw Water	528			
2	CCR Cooling Tower Evaporation Losses		403		
3	CCR Cooling Tower Blowdown to ETP - RO			77	
4	CCR System Loss & Consumption				48
Total		**528**	**403**	**77**	**48**

The total water requirement in the CCR is 528 KLD; Fresh water.

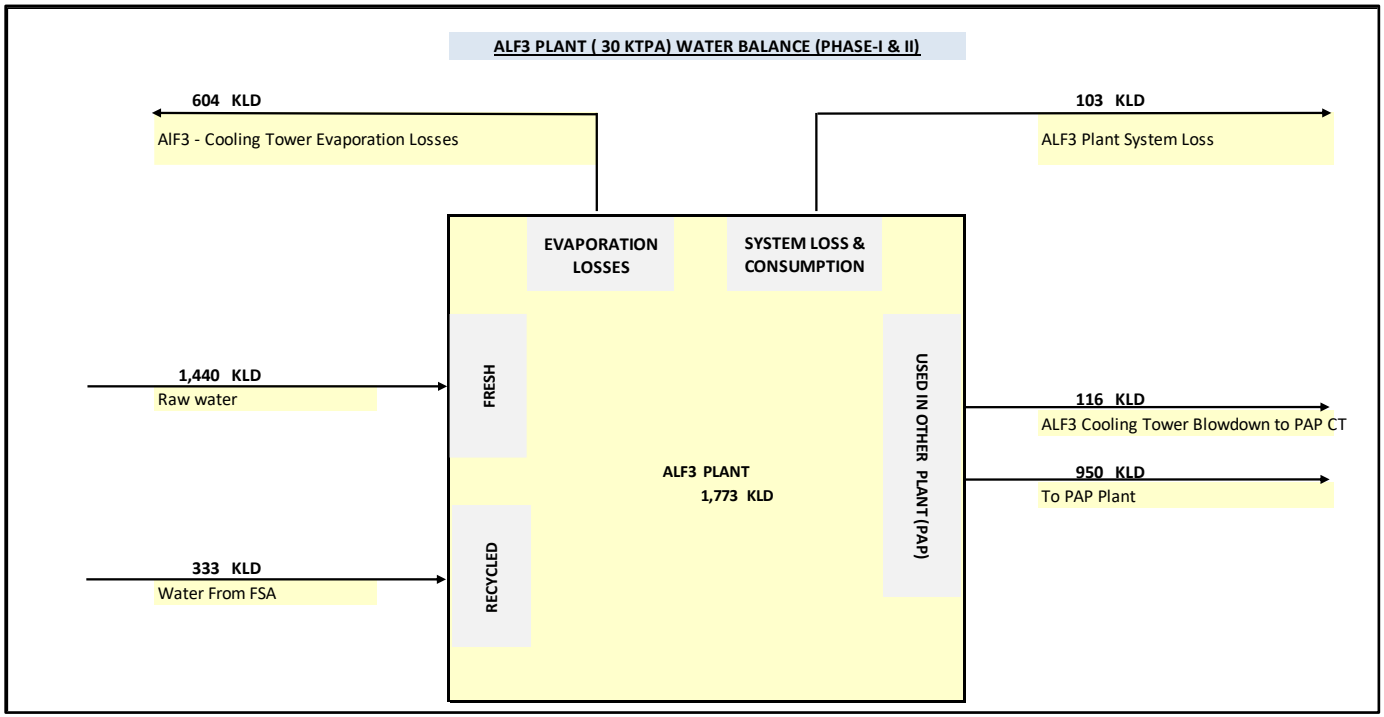


EAC OBSERVATION NO.-13

ALF_3 Water Balance (KLD):

Sr. No.	Area	INPUT		OUTPUT		
		Fresh	Recycled	Evaporation losses	Used in other Plant (PAP)	System Loss & Consumption
1	Raw water	1,440				
2	Water From FSA		333			
3	AlF3 - Cooling Tower Evaporation Losses			604		
4	To PAP Plant				950	
5	ALF3 Cooling Tower Blowdown to PAP CT				116	
6	ALF3 Plant System Loss					103
Total		**1,440**	**333**	**604**	**1,066**	**103**

The total water requirement in the ALF3 Plant is 1,773 KLD; of these, 1,440 KLD fresh water and 333 KLD recycling water from the other plant.

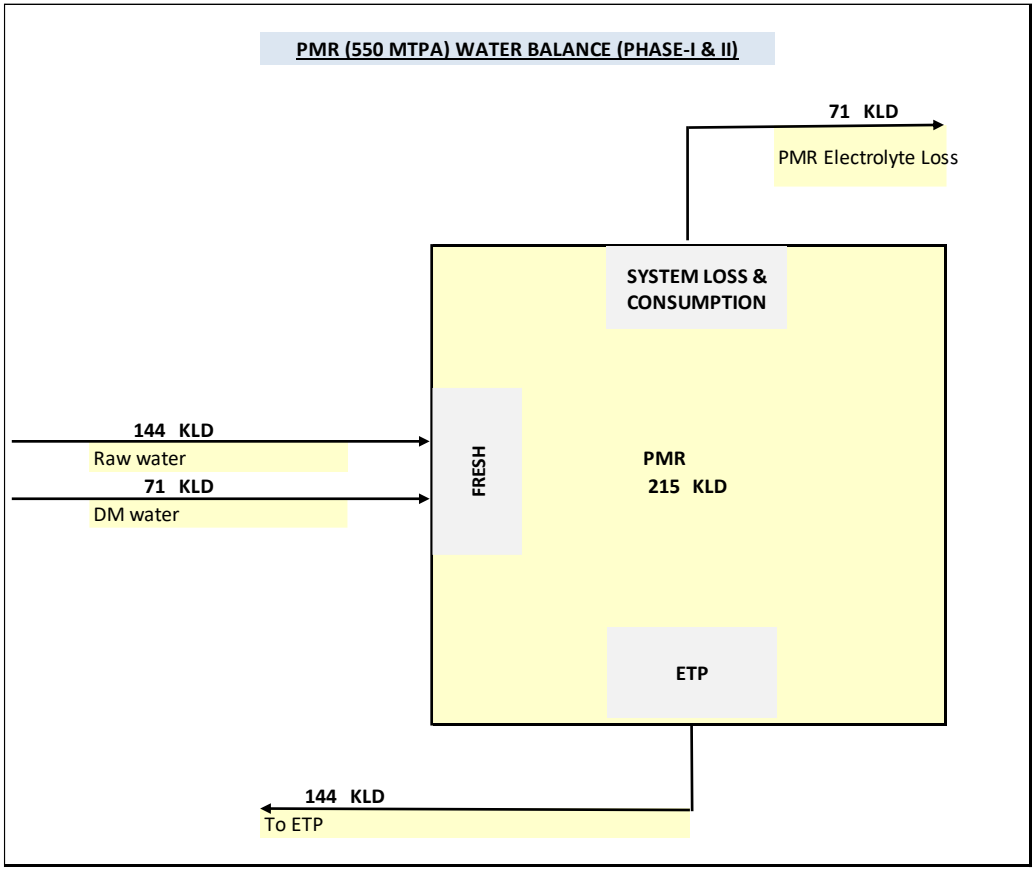


EAC OBSERVATION NO.-13

PMR Water Balance (KLD):

Sr. No.	Area	INPUT	OUTPUT	
		Fresh Water	ETP	System Loss & Consumption
1	Raw water	144		
2	DM water	71		
3	To ETP		144	
4	PMR Electrolyte Loss			71
Total		**215**	**144**	**71**

The total water requirement in the PMR is 215 KLD; Fresh water.



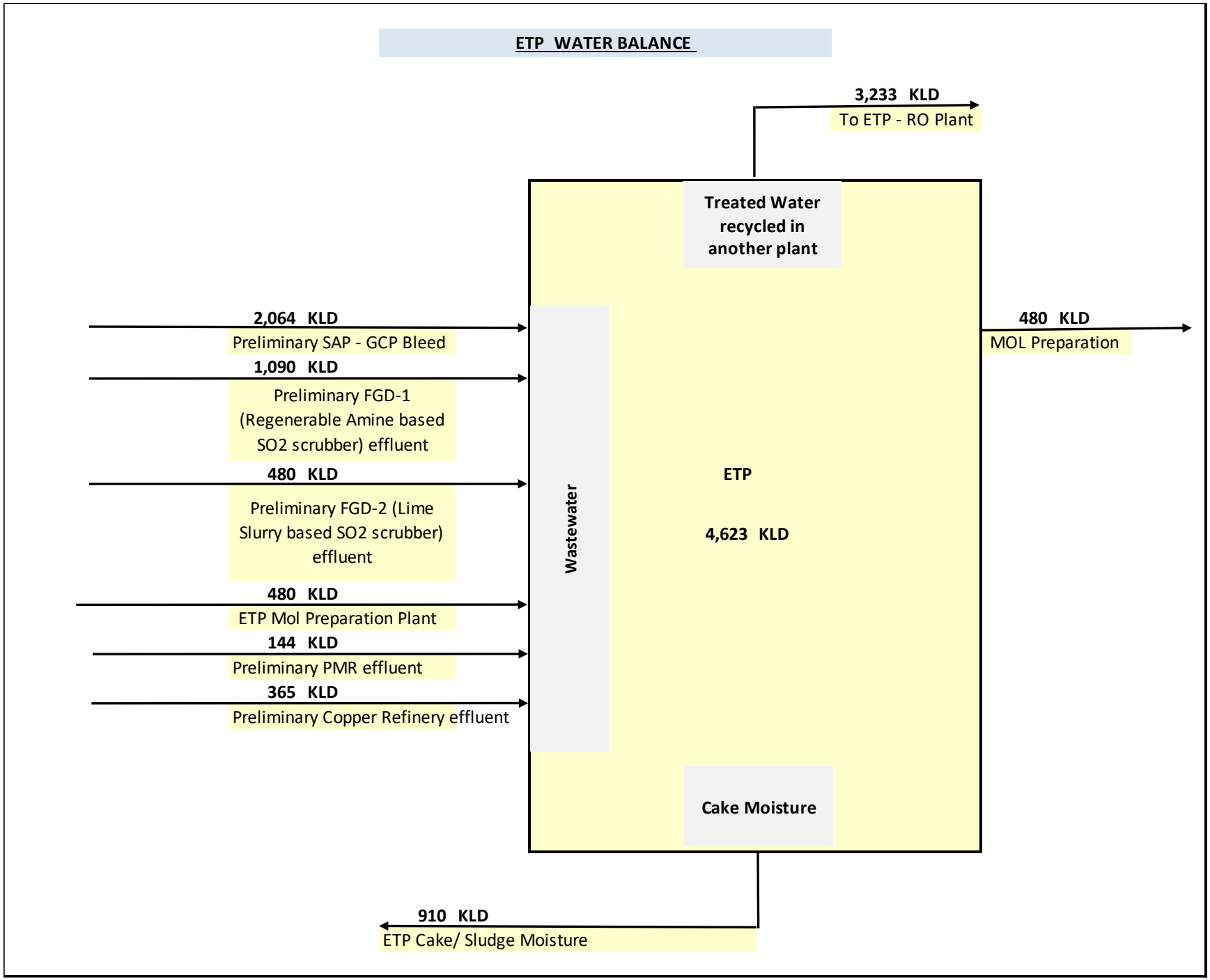
EAC OBSERVATION NO.-13

ETP Water Balance (KLD):

ETP Water Balance (KLD)				
Sr. No.	Area	INPUT	OUTPUT	
		Effluent Generated	Water Lost in Cake/ Sludge Moisture	Treated water generated
1	Preliminary SAP - GCP Bleed	2,064		
2	Preliminary FGD-1 (Regenerable Amine based SO2 scrubber) effluent	1,090		
3	Preliminary FGD-2 (Lime Slurry based SO2 scrubber) effluent	480		
4	ETP Mol Preparation Plant	480		
5	Preliminary PMR effluent	144		
6	Preliminary Copper Refinery effluent	365		
7	ETP Cake/ Sludge Moisture		910	
8	MOL Preparation			480
9	To ETP - RO Plant			3,233
Total		**4,623**	**910**	**3,713**

The total effluent generated by the plant is 4,623 KLD; of these, 3,713 KLD of treated water from the ETP plant were recycled in another plant and 910 KLD of water lost in the moisture of the cakes / sludge.

EAC OBSERVATION NO.-13

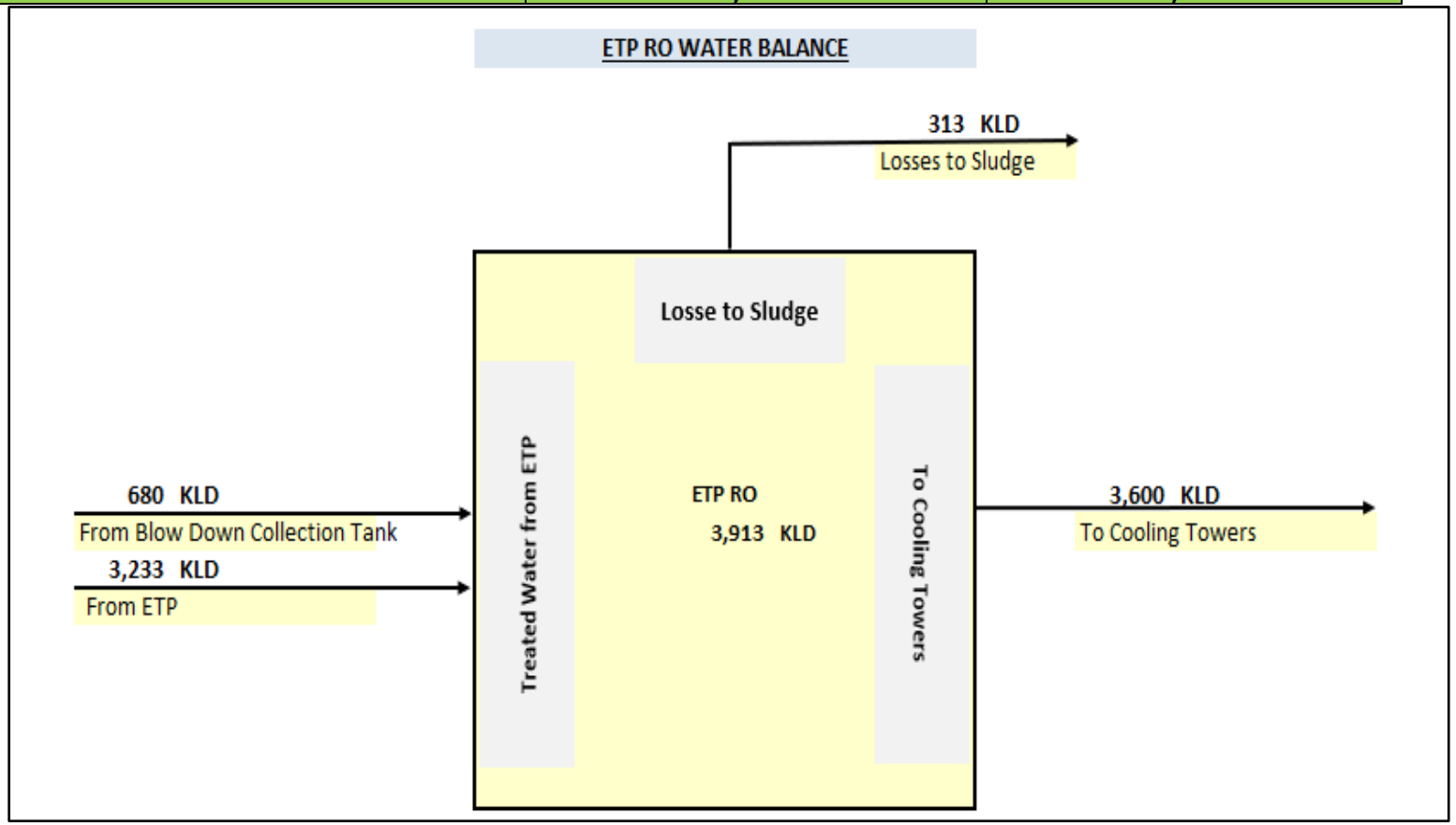


EAC OBSERVATION NO.-13

ETP RO water balance (KLD).

- ***ETP RO plant is a part of ZLD system.***
- ***ETP RO system will consists of 2 stage RO plant followed by MEE/MVR system.***
- ***The sludge coming out of MEE/MVR system will be disposed in SLF and water recovered will be utilized for the plant operation.***

Sr. No.	Area	Treated Water from ETP	RO Water Generated
1	From Blow Down Collection Tank	680	
2	From ETP	3,233	
3	To Cooling Towers		3,600
4	Losses to Sludge		313
Total		**3,913**	**3,913**



EAC OBSERVATION NO.-14

EAC OBSERVATION:

Stack and process vents to be noted separately and all stack heights to be as per standards.

REPLY:

Details of the preliminary process vents and stacks for the proposed copper project are as below:

Sr. No.	Stacks	Stack/ Vent	H m	Dia m	Temp ^0C	Velocity m/s	Volume Nm^3/hr	Emission	Material of Construction
	Unit –I & II								
	Flue Emission Through Stack attached to Boiler/Furnace/Heater								
1	Waste Heat Recovery Super heater - I & II	Stack	70	1	150	18	35,000	SO_2	Carbon Steel
2	Sulphuric Acid Pre-Heater-I (Only for plant startup)	Stack	45	1.5	250	17	60,000	SO_2	Carbon Steel
3	Sulphuric Acid Pre-Heater-II (Only for plant startup)	Stack	45	1.5	250	17	60,000	SO_2	Carbon Steel
4	DG Set – I, II, III & IV (4 MVA Standby)	Stack	30	-	-	-	-	SO_2	Carbon Steel
5	Boiler – II (operational only when steam is not available from smelter)	Stack	70	1	150	15	30,000	SO_2	Carbon Steel
6	Shaft Furnace of CCR Plant-I	Stack	36	1.5	200	9	37,000	Dust	Carbon Steel
7	Anode Casting – I, II, III & IV	Vent	20	0.75	100	17	21,000	Water Vapour	Carbon Steel
8	Main Stack Secondary Gas Scrubber- I, II, III & IV (Bi flue) (Convertor Secondary and Anode & scrap melting furnace combustion gases)	Stack	150	2.8	60	17	345,900	SO_2	Carbon Steel with glass Flake/FRP/Rubber Lining
				2.0	60	17	171,823		
	Flue Emission Through Stack attached to Boiler/Furnace/Heater								
9	Electric Furnace and Secondary gases from Smelting – I & II (Bi-Flue)	Stack	150	2.0	150	17	135,000	SO_2	Carbon Steel
				2.2	150	18	168,796		
10	Main Stack Sulphuric Acid Plant-I, II, III & IV (Bi-flue)	Stack	150	2	75	16	150,760	SO_2	Carbon Steel
				2	75	16	150,760		
11	Cathode Stripping MC – I, II, III & IV	Vent	30	0.2	50	14	1,500	Water Vapour	FRP
12	Anode Scrap Washing MC– I & II	Vent	30	0.2	40	14	1,500	Water Vapour	FRP
13	Electro winning Stack – I & II	Stack	45	0.3	40	19	4,500	Mist	FRP
14	Slag Granulation – I & II	Vent	45	1.4	100	18	80,000	Water Vapour	Carbon Steel
15	Steam Dryer for Copper concentrate – I & II	Stack	60	1.4	120	15	62,150	Dust	Carbon Steel
16	Smelting Furnace Area (Emergency Stack-I & II only during process tripping)	Stack	150	2.0	300	18	86,000	SO_2	Carbon Steel
17	PS Convertor Area (Emergency Stack-I & II (only during process tripping)	Stack	150	2.4	300	18	130,000	SO_2	Carbon Steel
18	Dust Extraction – I & II (Rock Phosphate Handling Area)	Stack	45	0.6	40	15	15,000	Dust	Carbon Steel
19	Precious Metal Recovery Plant – I & II	Stack	60	0.6	60	16	15,000	SO_2	Carbon Steel with glass Flake/FRP Lining
20	Phosphoric Acid Plant – I & II	Stack	120	2.1	50	18	206,000	HF	Carbon Steel with glass Flake/FRP/Rubber Lining

EAC OBSERVATION NO.-15

EAC OBSERVATION:

HIRA shall be prepared for worst case scenario of Hydro Fluro Silicic acid storage tank failure. Quantitative Risk Analysis (QRA) leading to FN Curve for storage related risk to be submitted.

REPLY:

The HIRA Study has been prepared for worst case scenario of hydro fluro silicic acid based on the methodology using a comprehensive checklist of hazards guidelines provided by the ISO 17776:2002.

Quantitative Risk Analysis (QRA) leading to FN Curve for acid storage (Sulphuric acid, Phosphoric acid and Hydro fluro silicic acid) has been carried out as enclosed as **Annexure-15(A).**

The findings that emerges from this HIRA study for the same as that mentioned below:

Failure of the Hydro fluro silicic Acid Tank

Handling of Hydro fluro silicic Acid

I. Hydro fluro silicic Acid is mild and less hazardous.

II. There are 2 tanks of the Hydro fluro silicic Acid with a capacity of ~ 1100 m^3 each for both plant 1 and plant 2.

III. Tanks will be with natural Rubber lined Carbon steel material of construction with additionally carbon brick lining at the bottom of the tank as well as 1 meter height along the circumference.

IV. Relevant BIS standard will be used for civil construction as plant is coming in seismic zone – V.

V. Rubber-lined carbon steel pipes are used for handling Hydro Fluro Silicic Acid.

VI. Signage Boards along with DANGER signs with safety measures to be followed are displayed at Acid storage and handling facility.

VII. Storage Tanks are built-in with Dyke, Sump and Pump for collection of acid leakage and transfer the same to other storage tanks.

VIII. Dyke is provided with impervious HDPE liner followed by acid resistant tiles to prevent seepage of the acid into the ground.

IX. Dyke will have capacity of 110% of the largest tank within the dyke.

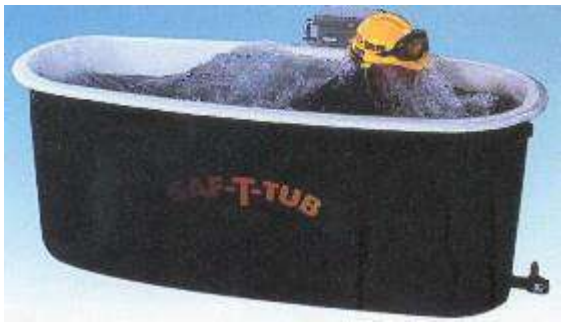
X. Tanks will be filled with maximum of 80% of the capacity; so that in case of any emergency spilled or leaked acid can be accommodated in the rest of the tanks.

XI. Usage of PPE such as PVC gloves, PVC suit, Face Shield, and Gum boots is ensured while handling Hydro fluro silicic Acid.

XII. Safety showers and Eye Wash Fountains are provided at easily accessible positions near the proposed Acid storage facility and used if persons are affected with acid spray.

EAC OBSERVATION NO.-15

Dunk Tanks (large bath tub in which a person can be completely immersed) will be provided



xvii. In case of major leaks from failure of storage tanks,

a) Cordon off the area with suitable signage boards.

b) Evacuate the people from affected areas.

c) Check whether the dyke area drain valve is closed or not

d) Allow Hydro fluro silicic Acid flow towards sump line and transfer acid into other storage tanks.

e) Use PVC suit, PVC gloves, and gum boots to handle the Hydro fluro silicic Acid and Airline respirator and PVC hood if acid fumes are pungent.

f) Use portable SS pump to transfer the residual pool of acid into a suitable container

g) Send collected drums / acid containers to the designated area for further action

h) Neutralize residual acid with lime powder/ soda ash.

i) Collect the contaminants and transfer the same to effluent treatment plant.

In case of injury:

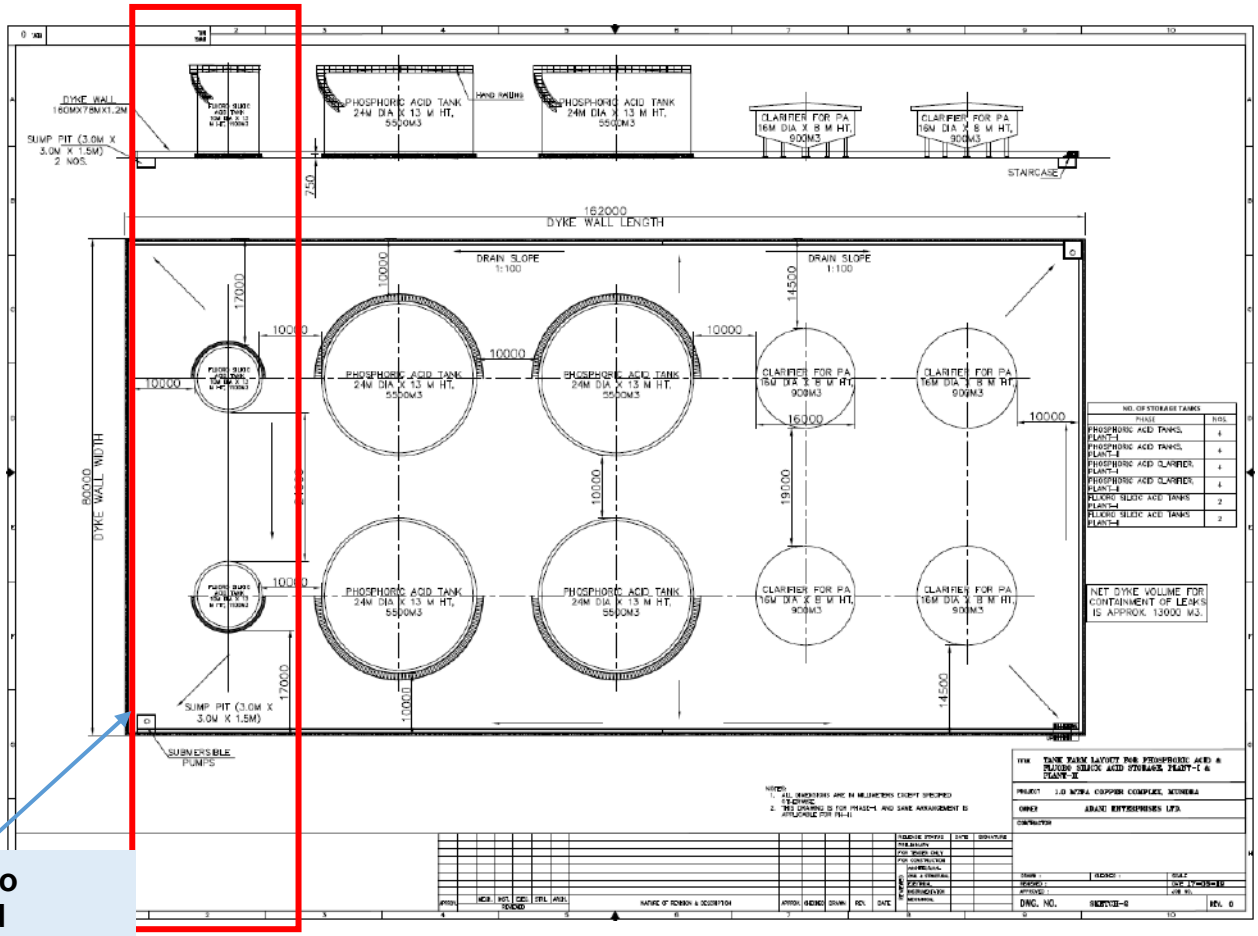
I. First aid will be provided at the Occupational health center

II. Further treatment will be provided at District Hospital.

III. Burn injuries will be treated at burn care unit, Bhuj District Hospital. The budget for the burn care unit is proposed in CER.

EAC OBSERVATION NO.-15

HYDRO FLURO SILICIC ACID & PHOSPHORIC ACID TANK STORAGE DETAILS



Hydro Fluro Silicic Acid Storage Tank, 2 X 1100 M^3

Tank Inspection Protocol

Tank inspection is required to ensure that tanks containing concentrated Hydro fluro silicic Acid are maintained in a safe condition.

Documentation and Records

Proper documentation and records for each tank will be maintained. These records should include the following:

a) Tank design and construction details including shell thickness, weld details, dimensions, etc.

b) Materials of construction

c) Corrosion allowance

d) History of tank contents including acid concentration and temperature

e) Civil engineering details for foundations and supports

f) Record of all maintenance performed on the tank

g) Record of all previous inspections

h) Details of any incidents the may have occurred to the tank (i.e. leaks)

Routine Inspections

A regular visual inspection of a tank ensures that there has been no obvious damage to the tank due to deterioration of accident. This is accomplished by walking around and on top of the tank. This type of inspection is limited to the exterior of the tank.

Some of the things to look for during an inspection are:

a) Signs of acid leaks

b) Damage to foundation and supports

c) Exterior corrosion

d) Damage to the shell or roof

e) Examination of piping systems for leaks

f) Evidence of sulphate build-up causing deformation of bottom plates and reinforcing pads

g) Damage to insulation and cladding

Frequency of Inspection:

Tanks will be inspected with a minimum frequency of once a week.

In-Service Inspections

In-service inspection of the tank involves both a detailed visual examination of the exterior of the tank as well as ultrasonic thickness measurement of the shell. The in-service inspection should include all the inspection points of the routine inspection as well as ultrasonic thickness measurements of the tank shell and roof as per the procedure.

The readings obtained should be compared to previous data to determine the extent of corrosion on the tank shell, roof and bottom. Where higher than anticipated metal losses are found, more extensive testing is required to confirm and establish the severity and extent of corrosion.

Internal Inspections

Internal inspections are required since there are areas of the tank where corrosion can only be detected by an internal inspection.

Internal inspections should be done at least once every five (5) years.

MSDS for sulphuric acid, phosphoric acid and hydro fluro silicic acid are enclosed as **Annexure-15(B).**

ANNEXURE-15(A)

ADANI ENTERPRISES LIMITED (AEL)

1 MTPA COPPER REFINERY - MUNDRA

RISK ASSESSMENT STUDY
FOR
ACIDS STORAGE

ANNEXURE-15(A)

1. INTRODUCTION

Adani Enterprises Limited (AEL) have taken up a project for installation of Copper Refinery with 10,00,000 TPA capacity at Mundra in Gujarat State.

The project includes storage of large inventories of sulphuric acid, phosphoric acid and hydro fluoro silicic acid.

In the process of granting Environmental Clearance for the Project, the Expert Appraisal Committee advised to carry out a risk assessment including FN curve for the acid storage systems.

Accordingly, this document presents the risk assessment study for the storage systems of sulphuric acid, phosphoric acid and hydro fluro silicic acid in the Copper Refinery facility.

2. FACILITY DESCRIPTION

The following major storage tanks for acids are provided in the Copper Refinery facility.

Sr. No.	Chemical Stored	No. of Tanks	Capacity of Each Tank	Total Capacity	Type of tank
1	Sulphuric acid (~98%)	12	5,500 m^3	66,000 m^3	Cone roof tanks. Carbon steel (CS)
2	Phosphoric acid (~54% P_2O_5)	8	5,500 m^3	44,000 m^3	Cone roof tanks. CS with rubber lining, Carbon brick lining at bottom and 1 m height in circumference
3	Hydrofluoro silicic acid (~22% H_2SiF_6)	4	1,100 m^3	4,400 m^3	Cone roof tanks. CS with rubber lining, Carbon brick lining at bottom and 1 m height in circumference

3. OBJECTIVE & METHODOLOGY

The objective of this study is to assess the risk involved in the storage of sulphuric acid, phosphoric acid and hydrofluoro silicic acid in the Copper refinery facility including FN curve for societal risk, with a view to minimizing the risk to as low as reasonably practicable.

The methodology for risk assessment is as follows.

Scenarios for storage tank failures are formulated considering the hazardous properties of acid, type of construction, safeguards provided and likelihood of exposure of people to the hazard.

Frequency of occurrence of the failure is estimated using the data available in generic database published by the International Association of Oil & Gas Producers (OGP) applying suitable adjustment factor for acid storage tanks.

Risk assessment is carried out by evaluating the Societal Risk in the form of FN curve.

ANNEXURE-15(A)

Societal Risk parameter considers the number of people who might be affected by hazardous incidents. Societal risk is represented as an F-N (frequency-number) curve, which is a logarithmic plot of cumulative frequency (F) at which events with N or more fatalities may occur, against N.

The tolerability criteria for societal risk as defined by UK-HSE are shown in the following **Figure-1**.

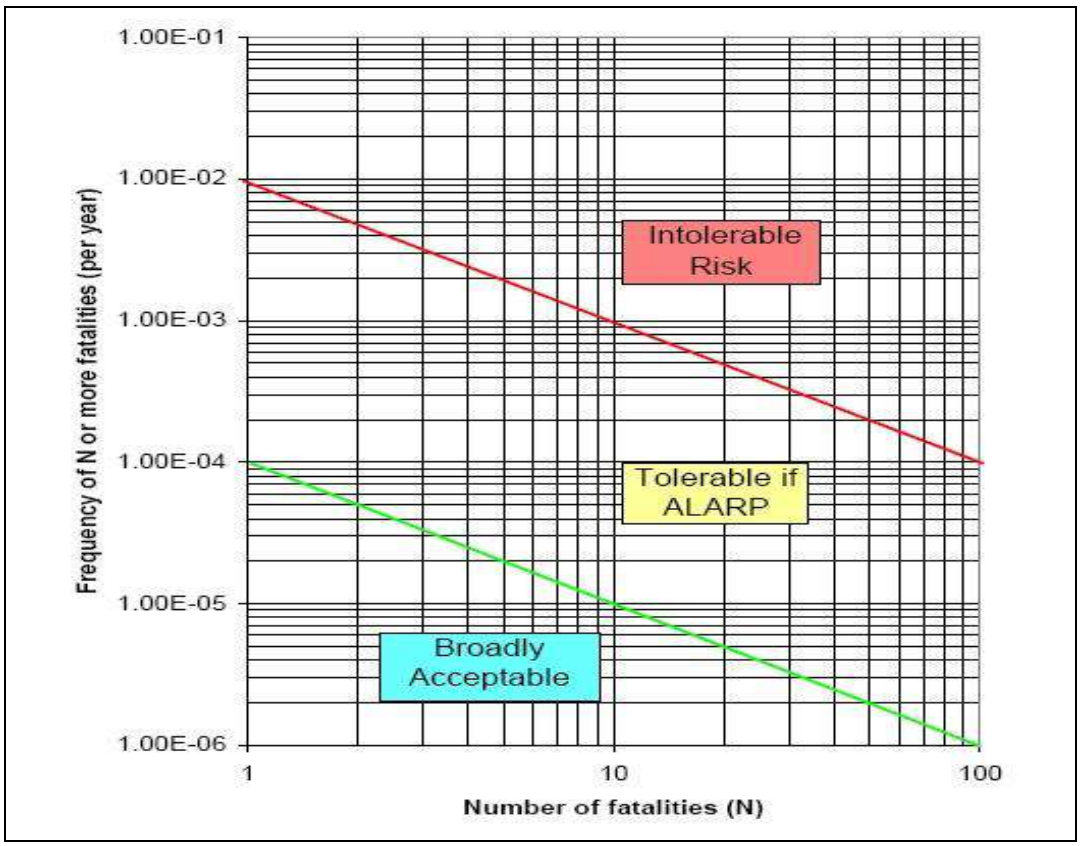


FIGURE-1:
TOLERABILITY CRITERIA FOR SOCIETAL RISK BY UK-HSE

4. RISK ASSESSMENT FOR DAMAGE EFFECTS OF STORAGE TANK FAILURE

a) Sulphuric Acid Tanks:

There are 6 tanks for storage of concentrated Sulphuric Acid with a capacity of 5,500 M^3 each for Plant #1 and Plant #2.

Sulphuric acid is stored as ~98% acid. Contact with concentrated sulphuric acid causes severe acid burn injury.

Concentrated sulphuric acid of ~98% concentration has vapour pressure of only 0.001 mm Hg and does not emit fumes. As such, spillage of large quantity of sulphuric acid is not expected to produce toxic vapour cloud which may cause injury to persons outside the spill area.

The following safeguards are provided:

- RCC dyke containment with internal acid-resistant tile lining and sump pump for transfer of collected acid
- The acid storage tanks, their foundations and RCC dyke structures shall be designed for seismic zone – V representing the highest seismic activity.
- Sizing of foundations and dyke (length, width & height) will ensure adequate space inside the dyke to prevent spillage of acid outside.

b) Phosphoric Acid Tanks:

There are 4 tanks to store Phosphoric Acid with a capacity of about 5,500 m^3 each and 4 clarifiers with a capacity of about 1800 m^3 each for plant 1 and plant 2.

Tanks and clarifier will be made of carbon steel with natural Rubber lining for the shell, carbon steel material of construction with additionally carbon brick lining at the bottom of the tank as well as 1 meter height along the circumference.

Phosphoric acid is stored as aqueous solution with ~54% P_2O_5 concentration. Contact with phosphoric acid causes acid burn injury but the effects are much less severe compared to concentrated sulphuric acid. The safeguards are similar to those provided for sulphuric acid storage tanks.

Phosphoric acid does not emit any fumes. As such, spillage of large quantity of phosphoric acid is not expected to produce toxic vapour cloud which may cause injury to persons outside the area.

c) Hydrofluoro Silicic Acid Tanks:

There are 2 tanks to store Hydrofluoro Silicic Acid with a capacity of about 1,100 m^3 each for Plant#1 & Plant#2.

Tanks will be made of carbon steel with natural Rubber lining for the shell, carbon steel material of construction with additionally carbon brick lining at the bottom of the tank as well as 1 meter height along the circumference.

Hydrofluoro silicic acid is stored as aqueous solution with ~22% H_2SiF_6 concentration. Contact with hydrofluoro silicicacid causes acid burn injury but the effects are much less severe compared to concentrated sulphuric acid. The safeguards are similar to those provided for sulphuric acid storage tanks.

Hydrofluoro silicic acid does not emit any fumes. It is also not expected to contain any significant concentration of hydrofluoric (HF) acid. As such, spillage of large quantity of phosphoric acid is not expected to produce toxic vapour cloud which may cause injury to persons outside the area.

Risk Assessment for Acid Storage Tanks:

The major failure of sulphuric acid storage tanks is considered in this risk assessment study. The following two scenarios are considered:

1. Acid released from the storage tank is contained inside the dyke; and
2. Acid released from the storage tank flows breaches the dyke and flows outside. In case of tank failure, the acid released from the tank is expected to be contained within the dyke.

ANNEXURE-15(A)

Scenario-1: Acid released from storage tank is contained in the dyke area:

a) Estimation of damage severity:

Normally no person is required to be present inside the dyke. However, operation and maintenance personnel may be required to work in the dyke area for a few hours. Considering the presence of maximum of 2 persons in the dyke area during acid release due to tank failure and assuming 50% lethality factor, the event is estimated to result in a **single fatality**.

b) Frequency estimation:

As per the storage incident frequency data published by the International Association of Oil & Gas Producers (OGP), the frequency of catastrophic failure of atmospheric tank is 3.0E-06 per year. For acid storage tanks, the failure rate is taken as double that of oil tanks, that is 6.0E-06 per year.

The six tanks will be operated with 75%-80% acid level. Therefore, the frequency of acid tank failure is estimated as 6 x 6.0E-06 = **3.6E-05 per year**.

Scenario-2: Acid released from storage tank flows outside due to breach in the dyke:

a) Estimation of damage severity:

If the dyke is also breached during tank failure, the acid may flow outside the dyke area and cause serious damage. However, the quantity flowing outside the dyke will be limited by the mitigation measures such as storm water drains and other emergency actions taken by the plant personnel. Release of about 100 MT of acid outside the dyke may be considered for risk assessment.

Considering the presence of maximum of 20 persons in the surrounding dyke area during acid release due to tank failure and assuming 10% lethality factor, the event is estimated to cause **2 fatalities**.

b) Frequency estimation:

The dyke containment made of RCC construction and suitable lining is expected to provide risk reduction factor of 100. On a conservative basis, considering risk reduction factor of only 80% for the dyke, the frequency of release outside the dyke is estimated as **4.5E-07 per year.**

Risk Assessment for Acid Storage:

Based on the estimation of damage severity and frequency for the failure scenarios involving failure of storage tanks, the data for risk analysis are as follows:

Sr. No.	Description	Severity (No. of Fatalities)	Failure Frequency (per year)
1	Tank failure with acid contained in the dyke	1	3.6E-05
2	Tank failure with breach of dyke leading to acid release outside	2	4.5E-07

The FN curve for societal risk for the case of acid tank failure in comparison with the UK-HSE criteria is shown in the following **Figure-2**.

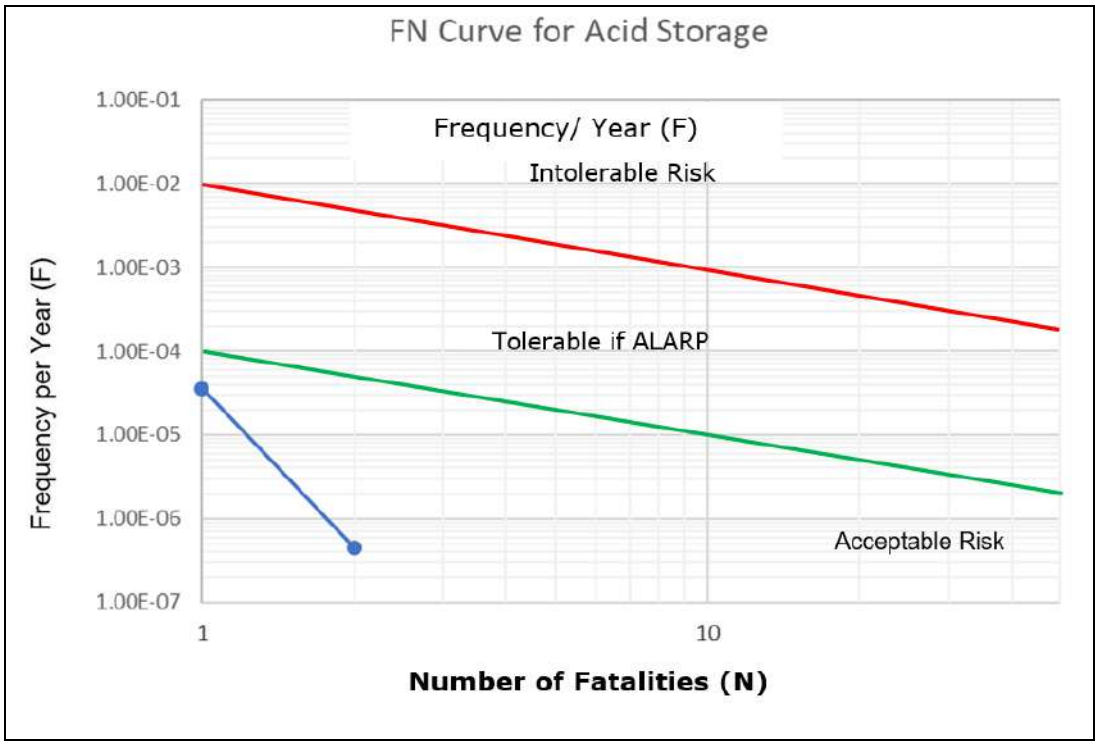


FIGURE-2:
FN CURVE FOR SOCIETAL RISK FOR THE CASE OF ACID TANK FAILURE IN COMPARISON WITH THE UK-HSE CRITERIA

5. CONCLUSION

Based on the risk assessment including FN curve for societal risk for the acid storage systems at Mundra Copper Smelter, it is concluded that the risk is in **Acceptable** level.

- - - x - - -

Sulfuric Acid, ACS

Safety Data Sheet

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Date of issue: 10/01/1998 Revision date: 02/28/2018 Supersedes: 01/23/2018 Version: 1.3

SECTION 1: Identification

1.1. Identification

Product form	:	Substance
Substance name	:	Sulfuric Acid, ACS
CAS-No.	:	7664-93-9
Product code	:	LC25550
Formula	:	H2SO4
Synonyms	:	battery acid / brown acid / brown oil of vitriol / dihydrogen sulfate / dipping acid / electrolyte acid / nordhausen acid / oil of vitriol / sulphuric acid

1.2. Recommended use and restrictions on use

Use of the substance/mixture	:	Industrial use Laboratory chemical Battery: component
Recommended use	:	Laboratory chemicals
Restrictions on use	:	Not for food, drug or household use

1.3. Supplier

LabChem Inc
Jackson's Pointe Commerce Park Building 1000, 1010 Jackson's Pointe Court
Zelienople, PA 16063 - USA
T 412-826-5230 - F 724-473-0647
info@labchem.com - www.labchem.com

1.4. Emergency telephone number

Emergency number	:	CHEMTREC: 1-800-424-9300 or 011-703-527-3887

SECTION 2: Hazard(s) identification

2.1. Classification of the substance or mixture

GHS-US classification

Skin corrosion/irritation, Category 1A	H314	Causes severe skin burns and eye damage.
Serious eye damage/eye irritation, Category 1	H318	Causes serious eye damage.

Full text of H statements : see section 16

2.2. GHS Label elements, including precautionary statements

GHS-US labelling

Hazard pictograms (GHS-US) :

GHS05

Signal word (GHS-US) : Danger

Hazard statements (GHS-US) : H314 - Causes severe skin burns and eye damage.

Precautionary statements (GHS-US) : P260 - Do not breathe mist, vapours, spray.
P264 - Wash exposed skin thoroughly after handling.
P280 - Wear protective gloves, protective clothing, eye protection, face protection.
P301+P330+P331 - IF SWALLOWED: rinse mouth. Do NOT induce vomiting.
P303+P361+P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340 - IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P305+P351+P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310 - Immediately call a POISON CENTER/doctor
P363 - Wash contaminated clothing before reuse.
P405 - Store locked up.
P501 - Dispose of contents/container to comply with local, state and federal regulations

Sulfuric Acid, ACS

Safety Data Sheet

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

2.3. Other hazards which do not result in classification

Other hazards not contributing to the classification : None.

2.4. Unknown acute toxicity (GHS US)

Not applicable

SECTION 3: Composition/information on ingredients

3.1. Substances

Substance type : Mono-constituent

Name	Product identifier	%	GHS-US classification
Sulfuric Acid, ACS (Main constituent)	(CAS-No.) 7664-93-9	96	Skin Corr. 1A, H314 Eye Dam. 1, H318

Full text of hazard classes and H-statements : see section 16

3.2. Mixtures

Not applicable

SECTION 4: First-aid measures

4.1. Description of first aid measures

First-aid measures general : Check the vital functions. Unconscious: maintain adequate airway and respiration. Respiratory arrest: artificial respiration or oxygen. Cardiac arrest: perform resuscitation. Victim conscious with laboured breathing: half-seated. Victim in shock: on his back with legs slightly raised. Vomiting: prevent asphyxia/aspiration pneumonia. Prevent cooling by covering the victim (no warming up). Keep watching the victim. Give psychological aid. Keep the victim calm, avoid physical strain. Depending on the victim's condition: doctor/hospital.

First-aid measures after inhalation : Remove the victim into fresh air. Immediately consult a doctor/medical service.

First-aid measures after skin contact : Wash immediately with lots of water (15 minutes)/shower. Do not apply (chemical) neutralizing agents. Remove clothing while washing. Do not remove clothing if it sticks to the skin. Cover wounds with sterile bandage. Consult a doctor/medical service. If burned surface > 10%: take victim to hospital.

First-aid measures after eye contact : Rinse immediately with plenty of water for 15 minutes. Take victim to an ophthalmologist. Do not apply neutralizing agents. Remove contact lenses, if present and easy to do. Continue rinsing.

First-aid measures after ingestion : Rinse mouth with water. Do not induce vomiting. Do not give activated charcoal. Immediately consult a doctor/medical service. Call Poison Information Centre (www.big.be/antigif.htm). Take the container/vomit to the doctor/hospital. Ingestion of large quantities: immediately to hospital. Do not give chemical antidote.

4.2. Most important symptoms and effects (acute and delayed)

Symptoms/effects after inhalation : Dry/sore throat. Coughing. Irritation of the respiratory tract. Irritation of the nasal mucous membranes. ON CONTINUOUS EXPOSURE/CONTACT: Corrosion of the upper respiratory tract. FOLLOWING SYMPTOMS MAY APPEAR LATER: Possible laryngeal spasm/oedema. Risk of pneumonia. Risk of lung oedema. Respiratory difficulties.

Symptoms/effects after skin contact : Caustic burns/corrosion of the skin.

Symptoms/effects after eye contact : Corrosion of the eye tissue. Permanent eye damage.

Symptoms/effects after ingestion : Nausea. Abdominal pain. Blood in stool. Blood in vomit. Burns to the gastric/intestinal mucosa. AFTER INGESTION OF HIGH QUANTITIES: Shock.

Chronic symptoms : ON CONTINUOUS/REPEATED EXPOSURE/CONTACT: Red skin. Dry skin. Itching. Skin rash/inflammation. Affection/discolouration of the teeth. Inflammation/damage of the eye tissue.

4.3. Immediate medical attention and special treatment, if necessary

Obtain medical assistance.

SECTION 5: Fire-fighting measures

5.1. Suitable (and unsuitable) extinguishing media

Suitable extinguishing media : Quick-acting ABC powder extinguisher. Quick-acting BC powder extinguisher. Quick-acting CO2 extinguisher. Class B foam (alcohol-resistant); after consulting specialist.

Unsuitable extinguishing media : Water (quick-acting extinguisher, reel); risk of puddle expansion. Quick-acting class B foam extinguisher. Water.

5.2. Specific hazards arising from the chemical

Fire hazard : DIRECT FIRE HAZARD: Non combustible. INDIRECT FIRE HAZARD: Reactions involving a fire hazard: see "Reactivity Hazard".

Explosion hazard : INDIRECT EXPLOSION HAZARD: Reactions with explosion hazards: see "Reactivity Hazard".

Reactivity	:	Reacts violently with (some) bases: heat release resulting in increased fire or explosion risk. Reacts with many compounds e.g.: with (strong) reducers, with organic material and with combustible materials: (increased) risk of fire/explosion. Violent exothermic reaction with water (moisture): release of corrosive gases/vapours.

5.3. Special protective equipment and precautions for fire-fighters

Precautionary measures fire	:	Exposure to fire/heat: keep upwind. Exposure to fire/heat: consider evacuation. Exposure to fire/heat: seal off low-lying areas. Exposure to fire/heat: have neighbourhood close doors and windows.
Firefighting instructions	:	Cool tanks/drums with water spray/remove them into safety. When cooling/extinguishing: no water in the substance. Dilute toxic gases with water spray.
Protection during firefighting	:	Heat/fire exposure: compressed air/oxygen apparatus.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

6.1.1. For non-emergency personnel

Protective equipment	:	Gloves. Face-shield. Corrosion-proof suit. Large spills/in enclosed spaces: compressed air apparatus. Large spills/in enclosed spaces: gas-tight suit.
Emergency procedures	:	Mark the danger area. No naked flames. Keep containers closed. Avoid ingress of water in the containers. Wash contaminated clothes. Large spills/in confined spaces: consider evacuation. In case of hazardous reactions: keep upwind. In case of reactivity hazard: consider evacuation.

6.1.2. For emergency responders

Protective equipment	:	Equip cleanup crew with proper protection.
Emergency procedures	:	Stop leak if safe to do so. Ventilate area.

6.2. Environmental precautions

Prevent soil and water pollution. Prevent spreading in sewers.

6.3. Methods and material for containment and cleaning up

For containment	:	Contain released product, pump into suitable containers. Plug the leak, cut off the supply. Dam up the liquid spill. Hazardous reaction: measure explosive gas-air mixture. Reaction: dilute combustible gas/vapour with water curtain. Take account of toxic/corrosive precipitation water. Heat exposure: dilute toxic gas/vapour with water spray.
Methods for cleaning up	:	Take up liquid spill into inert absorbent material, e.g.: dry sand/earth/vermiculite. Scoop absorbed substance into closing containers. Carefully collect the spill/leftovers. Damaged/cooled tanks must be emptied. Clean contaminated surfaces with an excess of water. Take collected spill to manufacturer/competent authority. Wash clothing and equipment after handling.

6.4. Reference to other sections

No additional information available

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling	:	Keep away from naked flames/heat. Measure the concentration in the air regularly. Carry operations in the open/under local exhaust/ventilation or with respiratory protection. Comply with the legal requirements. Remove contaminated clothing immediately. Clean contaminated clothing. Keep the substance free from contamination. Thoroughly clean/dry the installation before use. Do not discharge the waste into the drain. Never add water to this product. Never dilute by pouring water to the acid. Always add the acid to the water.
Hygiene measures	:	Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Wash contaminated clothing before reuse. Do not eat, drink or smoke when using this product.

7.2. Conditions for safe storage, including any incompatibilities

Incompatible products	:	Strong bases. metals. combustible materials.
Heat and ignition sources	:	KEEP SUBSTANCE AWAY FROM: heat sources.
Prohibitions on mixed storage	:	KEEP SUBSTANCE AWAY FROM: combustible materials. reducing agents. (strong) bases. highly flammable materials. metals. cellulosic materials. organic materials. alcohols. amines. water/moisture.
Storage area	:	Store in a dry area. Ventilation at floor level. Keep locked up. Provide for a tub to collect spills. Unauthorized persons are not admitted. Meet the legal requirements.
Special rules on packaging	:	SPECIAL REQUIREMENTS: closing. dry. clean. correctly labelled. meet the legal requirements. Secure fragile packagings in solid containers.

Packaging materials : SUITABLE MATERIAL: stainless steel. carbon steel. polyethylene. polypropylene. glass. stoneware/porcelain. MATERIAL TO AVOID: monel steel. lead. copper. zinc.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Sulfuric Acid, ACS (7664-93-9)		
ACGIH	ACGIH TWA (mg/m³)	0.2 mg/m³ (Thoracic fraction)
OSHA	OSHA PEL (TWA) (mg/m³)	1 mg/m³
IDLH	US IDLH (mg/m³)	15 mg/m³
NIOSH	NIOSH REL (TWA) (mg/m³)	1 mg/m³

8.2. Appropriate engineering controls

Appropriate engineering controls : Emergency eye wash fountains should be available in the immediate vicinity of any potential exposure. Provide adequate general and local exhaust ventilation.

8.3. Individual protection measures/Personal protective equipment

Personal protective equipment:

Gloves. Face shield. Chemical resistant apron. Safety glasses. Protective goggles. Gas mask with filter type E.

Materials for protective clothing:

GIVE EXCELLENT RESISTANCE: butyl rubber. polyethylene. tetrafluoroethylene. GIVE LESS RESISTANCE: neoprene. PVC. viton. GIVE POOR RESISTANCE: natural rubber. nitrile rubber. PVA

Hand protection:

Gloves

Eye protection:

Face shield

Skin and body protection:

Corrosion-proof clothing

Respiratory protection:

Full face mask with filter type E at conc. in air > exposure limit

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state : Liquid
Appearance : Liquid.
Colour : Pure substance: colourless Unpurified: yellow to brown
Odour : Almost odourless
Odour threshold : > 1 mg/m³
pH : < 1
Melting point : 10 °C
Freezing point : No data available
Boiling point : 288 °C
Flash point : Not applicable
Relative evaporation rate (butylacetate=1) : No data available
Flammability (solid, gas) : No data available

Vapour pressure	:	< 1 hPa (20 °C)
Relative vapour density at 20 °C	:	3.4
Relative density	:	1.8
Density	:	1840 kg/m³
Molecular mass	:	98.08 g/mol
Solubility	:	Exothermically soluble in water. Soluble in ethanol. Water: complete
Log Pow	:	-2.2 (Estimated value)
Auto-ignition temperature	:	No data available
Decomposition temperature	:	> 340 °C
Viscosity, kinematic	:	No data available
Viscosity, dynamic	:	No data available
Explosive limits	:	No data available
Explosive properties	:	No data available.
Oxidising properties	:	No data available.

9.2. Other information

VOC content	:	0 %
Other properties	:	Gas/vapour heavier than air at 20°C. Clear. Hygroscopic. Slightly volatile. Substance has acid reaction.

SECTION 10: Stability and reactivity

10.1. Reactivity

Reacts violently with (some) bases: heat release resulting in increased fire or explosion risk. Reacts with many compounds e.g.: with (strong) reducers, with organic material and with combustible materials: (increased) risk of fire/explosion. Violent exothermic reaction with water (moisture): release of corrosive gases/vapours.

10.2. Chemical stability

Unstable on exposure to moisture.

10.3. Possibility of hazardous reactions

Reacts violently with water. Reacts violently with (some) bases: release of heat.

10.4. Conditions to avoid

Incompatible materials. Moisture.

10.5. Incompatible materials

Water. Strong bases. Organic compounds. metals. Halogens. cyanides. combustible materials.

10.6. Hazardous decomposition products

Sulfur compounds.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Likely routes of exposure	:	Skin and eyes contact
Acute toxicity	:	Not classified

Sulfuric Acid, ACS (7664-93-9)	
LD50 oral rat	2140 mg/kg bodyweight (Rat, Experimental value)
ATE US (oral)	2140 mg/kg bodyweight

Skin corrosion/irritation	:	Causes severe skin burns and eye damage. pH: < 1
Serious eye damage/irritation	:	Causes serious eye damage. pH: < 1
Respiratory or skin sensitisation	:	Not classified
Germ cell mutagenicity	:	Not classified
Carcinogenicity	:	Not classified

Sulfuric Acid, ACS (7664-93-9)	
Additional information	Strong inorganic acid mists containing sulfuric acid are carcinogenic to humans
National Toxicology Program (NTP) Status	2 - Known Human Carcinogens

Reproductive toxicity : Not classified

Specific target organ toxicity (single exposure) : Not classified

Specific target organ toxicity (repeated exposure) : Not classified

Aspiration hazard : Not classified

Potential adverse human health effects and symptoms : Odour threshold is well above the exposure limit. Causes severe skin burns. Irritant to the respiratory organs. Causes serious eye damage.

Symptoms/effects after inhalation : Dry/sore throat. Coughing. Irritation of the respiratory tract. Irritation of the nasal mucous membranes. ON CONTINUOUS EXPOSURE/CONTACT: Corrosion of the upper respiratory tract. FOLLOWING SYMPTOMS MAY APPEAR LATER: Possible laryngeal spasm/oedema. Risk of pneumonia. Risk of lung oedema. Respiratory difficulties.

Symptoms/effects after skin contact : Caustic burns/corrosion of the skin.

Symptoms/effects after eye contact : Corrosion of the eye tissue. Permanent eye damage.

Symptoms/effects after ingestion : Nausea. Abdominal pain. Blood in stool. Blood in vomit. Burns to the gastric/intestinal mucosa. AFTER INGESTION OF HIGH QUANTITIES: Shock.

Chronic symptoms : ON CONTINUOUS/REPEATED EXPOSURE/CONTACT: Red skin. Dry skin. Itching. Skin rash/inflammation. Affection/discolouration of the teeth. Inflammation/damage of the eye tissue.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : Not classified as dangerous for the environment according to the criteria of Regulation (EC) No 1272/2008.

Ecology - air : Not classified as dangerous for the ozone layer (Regulation (EC) No 1005/2009).

Ecology - water : Harmful to crustacea. Harmful to fishes. Groundwater pollutant. Mild water pollutant (surface water). Inhibition of activated sludge. pH shift. Toxic to plankton.

Sulfuric Acid, ACS (7664-93-9)	
LC50 fish 1	42 mg/l (96 h, Gambusia affinis)
EC50 Daphnia 1	29 mg/l (24 h, Daphnia magna)

12.2. Persistence and degradability

Sulfuric Acid, ACS (7664-93-9)	
Persistence and degradability	Biodegradability: not applicable.
Biochemical oxygen demand (BOD)	Not applicable
Chemical oxygen demand (COD)	Not applicable
ThOD	Not applicable
BOD (% of ThOD)	Not applicable

12.3. Bioaccumulative potential

Sulfuric Acid, ACS (7664-93-9)	
Log Pow	-2.2 (Estimated value)
Bioaccumulative potential	Not bioaccumulative.

12.4. Mobility in soil

No additional information available

12.5. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Disposal methods

Regional legislation (waste) : LWCA (the Netherlands): KGA category 01.

Waste disposal recommendations	:	Treat using the best available techniques before discharge into drains or the aquatic environment. Use appropriate containment to avoid environmental contamination. Remove waste in accordance with local and/or national regulations. Hazardous waste shall not be mixed together with other waste. Different types of hazardous waste shall not be mixed together if this may entail a risk of pollution or create problems for the further management of the waste. Hazardous waste shall be managed responsibly. All entities that store, transport or handle hazardous waste shall take the necessary measures to prevent risks of pollution or damage to people or animals. Recycle/reuse. Remove to an authorized dump (Class I). Remove for physico-chemical/biological treatment.
Additional information	:	Hazardous waste according to Directive 2008/98/EC, as amended by Regulation (EU) No 1357/2014 and Regulation (EU) No 2017/997.
Ecology - waste materials	:	Avoid release to the environment.

SECTION 14: Transport information

Department of Transportation (DOT)

In accordance with DOT

Transport document description	:	UN1830 Sulfuric acid (with more than 51 percent acid), 8, II
UN-No.(DOT)	:	UN1830
Proper Shipping Name (DOT)	:	Sulfuric acid with more than 51 percent acid
Transport hazard class(es) (DOT)	:	8 - Class 8 - Corrosive material 49 CFR 173.136
Packing group (DOT)	:	II - Medium Danger
Hazard labels (DOT)	:	8 - Corrosive

DOT Packaging Non Bulk (49 CFR 173.xxx)	:	202
DOT Packaging Bulk (49 CFR 173.xxx)	:	242
DOT Special Provisions (49 CFR 172.102)	:	A3 - For combination packagings, if glass inner packagings (including ampoules) are used, they must be packed with absorbent material in tightly closed metal receptacles before packing in outer packagings. A7 - Steel packagings must be corrosion-resistant or have protection against corrosion. B3 - MC 300, MC 301, MC 302, MC 303, MC 305, and MC 306 and DOT 406 cargo tanks and DOT 57 portable tanks are not authorized. B83 - Bottom outlets are prohibited on tank car tanks transporting sulfuric acid in concentrations over 65.25 percent. B84 - Packagings must be protected with non-metallic linings impervious to the lading or have a suitable corrosion allowance for sulfuric acid or spent sulfuric acid in concentration up to 65.25 percent. IB2 - Authorized IBCs: Metal (31A, 31B and 31N); Rigid plastics (31H1 and 31H2); Composite (31HZ1). Additional Requirement: Only liquids with a vapor pressure less than or equal to 110 kPa at 50 C (1.1 bar at 122 F), or 130 kPa at 55 C (1.3 bar at 131 F) are authorized. N34 - Aluminum construction materials are not authorized for any part of a packaging which is normally in contact with the hazardous material. T8 - 4 178.274(d)(2) Normal..... Prohibited TP2 - a. The maximum degree of filling must not exceed the degree of filling determined by the following: (image) Where: tr is the maximum mean bulk temperature during transport, tf is the temperature in degrees celsius of the liquid during filling, and a is the mean coefficient of cubical expansion of the liquid between the mean temperature of the liquid during filling (tf) and the maximum mean bulk temperature during transportation (tr) both in degrees celsius. b. For liquids transported under ambient conditions may be calculated using the formula: (image) Where: d15 and d50 are the densities (in units of mass per unit volume) of the liquid at 15 C (59 F) and 50 C (122 F), respectively. TP12 - This material is considered highly corrosive to steel.
DOT Packaging Exceptions (49 CFR 173.xxx)	:	154
DOT Quantity Limitations Passenger aircraft/rail (49 CFR 173.27)	:	1 L
DOT Quantity Limitations Cargo aircraft only (49 CFR 175.75)	:	30 L
DOT Vessel Stowage Location	:	C - The material must be stowed ‘‘on deck only’’ on a cargo vessel and on a passenger vessel.

DOT Vessel Stowage Other : 14 - For metal drums, stowage permitted under deck on cargo vessels

Other information : No supplementary information available.

SECTION 15: Regulatory information

15.1. US Federal regulations

Sulfuric Acid, ACS (7664-93-9)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory Not subject to reporting requirements of the United States SARA Section 313 Subject to reporting requirements of United States SARA Section 313	
RQ (Reportable quantity, section 304 of EPA's List of Lists)	1000 lb
SARA Section 302 Threshold Planning Quantity (TPQ)	1000 lb
SARA Section 311/312 Hazard Classes	Health hazard - Skin corrosion or Irritation Health hazard - Serious eye damage or eye irritation

All components of this product are listed, or excluded from listing, on the United States Environmental Protection Agency Toxic Substances Control Act (TSCA) inventory

Chemical(s) subject to the reporting requirements of Section 313 or Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 and 40 CFR Part 372.

Sulfuric Acid, ACS	CAS-No. 7664-93-9	100%

15.2. International regulations

CANADA

No additional information available

EU-Regulations

No additional information available

National regulations

Sulfuric Acid, ACS (7664-93-9)
Listed on IARC (International Agency for Research on Cancer) Listed as carcinogen on NTP (National Toxicology Program)

15.3. US State regulations

California Proposition 65 - This product does not contain any substances known to the state of California to cause cancer, developmental and/or reproductive harm

SECTION 16: Other information

Revision date : 02/28/2018

Full text of H-statements: see section 16:

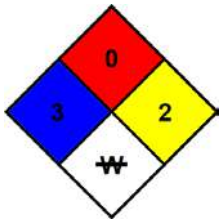
H314	Causes severe skin burns and eye damage.
H318	Causes serious eye damage.

NFPA health hazard : 3 - Materials that, under emergency conditions, can cause serious or permanent injury.

NFPA fire hazard : 0 - Materials that will not burn under typical dire conditions, including intrinsically noncombustible materials such as concrete, stone, and sand.

NFPA reactivity : 2 - Materials that readily undergo violent chemical change at elevated temperatures and pressures.

NFPA specific hazard : W - Materials that react violently or explosively with water.



Hazard Rating		
Health	:	3 Serious Hazard - Major injury likely unless prompt action is taken and medical treatment is given
Flammability	:	0 Minimal Hazard - Materials that will not burn
Physical	:	2 Moderate Hazard - Materials that are unstable and may undergo violent chemical changes at normal temperature and pressure with low risk for explosion. Materials may react violently with water or form peroxides upon exposure to air.
Personal protection	:	H H - Splash goggles, Gloves, Synthetic apron, Vapor respirator

SDS US LabChem

Information in this SDS is from available published sources and is believed to be accurate. No warranty, express or implied, is made and LabChem Inc assumes no liability resulting from the use of this SDS. The user must determine suitability of this information for his application.

0-52-0 Merchant Grade Phosphoric Acid

Safety Data Sheet

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

SECTION 1: Identification

1.1. Identification

Product form : Mixture

Product name : 0-52-0 Merchant Grade Phosphoric Acid

Product code : M12010

1.2. Recommended use and restrictions on use

No additional information available

1.3. Supplier

JR Simplot Company

P.O. Box 70013

Boise, ID 83707

T 1-208-336-2110

1.4. Emergency telephone number

Emergency number : CHEMTREC 1-800-424-9300

SECTION 2: Hazard(s) identification

2.1. Classification of the substance or mixture

GHS-US classification

Corrosive to metals, Category 1	H290	May be corrosive to metals
Acute toxicity (oral), Category 4	H302	Harmful if swallowed
Acute toxicity (dermal), Category 4	H312	Harmful in contact with skin
Skin corrosion/irritation, Category 1A	H314	Causes severe skin burns and eye damage

Full text of H statements : see section 16

2.2. GHS Label elements, including precautionary statements

GHS-US labelling

Hazard pictograms (GHS-US) :

Signal word (GHS-US) : Danger

Hazard statements (GHS-US) :
H290 - May be corrosive to metals
H302+H312 - Harmful if swallowed or in contact with skin
H314 - Causes severe skin burns and eye damage

Precautionary statements (GHS-US) :
P234 - Keep only in original container
P260 - Do not breathe dust/fume/gas/mist/vapours/spray
P264 - Wash hands, forearms and face thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P280 - Wear protective gloves/protective clothing/eye protection/face protection
P301+P312 - If swallowed: Call a poison center/doctor/… if you feel unwell
P301+P330+P331 - If swallowed: rinse mouth. Do NOT induce vomiting
P302+P352 - If on skin: Wash with plenty of water/…
P303+P361+P353 - If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
P304+P340 - If inhaled: Remove person to fresh air and keep comfortable for breathing
P305+P351+P338 - If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a poison center/doctor/…
P312 - Call a poison center/doctor/… if you feel unwell
P321 - Specific treatment (see supplemental first aid instruction on this label)
P322 - Specific treatment (see ... on this label)
P330 - Rinse mouth
P362+P364 - Take off contaminated clothing and wash it before reuse

P363 - Wash contaminated clothing before reuse
P390 - Absorb spillage to prevent material damage
P405 - Store locked up
P406 - Store in a corrosion resistant container with a resistant inner liner
P501 - Dispose of contents/container to ...

2.3. Other hazards which do not result in classification

No additional information available

2.4. Unknown acute toxicity (GHS US)

Not applicable

SECTION 3: Composition/information on ingredients

3.1. Substance

Not applicable

3.2. Mixture

Name	Product identifier	%	GHS-US classification
phosphoric acid (7664-38-2)	(CAS No) 7664-38-2		Met. Corr. 1, H290 Acute Tox. 4 (Oral), H302 Acute Tox. 4 (Dermal), H312 Skin Corr. 1B, H314
Proprietary			Not classified

Full text of hazard classes and H-statements : see section 16

SECTION 4: First-aid measures

4.1. Description of first aid measures

First-aid measures general : Never give anything by mouth to an unconscious person. If you feel unwell, seek medical advice (show the label where possible).

First-aid measures after inhalation : Remove person to fresh air and keep comfortable for breathing. Remove victim to fresh air and keep at rest in a position comfortable for breathing. Immediately call a POISON CENTER or doctor/physician.

First-aid measures after skin contact : Immediately call a POISON CENTER or doctor/physician. Specific measures (see ... on this label). Wash with plenty of soap and water. Wash contaminated clothing before reuse. Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.

First-aid measures after eye contact : Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or doctor/physician.

First-aid measures after ingestion : Rinse mouth. Do NOT induce vomiting. Call a POISON CENTER or doctor/physician if you feel unwell. Immediately call a POISON CENTER or doctor/physician. Call a poison center or a doctor if you feel unwell.

4.2. Most important symptoms and effects (acute and delayed)

Potential adverse human health effects and symptoms : Based on available data, the classification criteria are not met. Harmful if swallowed. Harmful in contact with skin.

Symptoms/injuries : Causes severe skin burns and eye damage.

Symptoms/injuries after skin contact : Repeated exposure to this material can result in absorption through skin causing significant health hazard. Harmful in contact with skin.

Symptoms/injuries after ingestion : Swallowing a small quantity of this material will result in serious health hazard.

4.3. Immediate medical attention and special treatment, if necessary

Treat symptomatically.

SECTION 5: Fire-fighting measures

5.1. Suitable (and unsuitable) extinguishing media

Suitable extinguishing media : Foam. Dry powder. Carbon dioxide. Water spray. Sand.

Unsuitable extinguishing media : Do not use a heavy water stream.

5.2. Specific hazards arising from the chemical

Reactivity : Thermal decomposition generates : Corrosive vapours.

5.3. Special protective equipment and precautions for fire-fighters

Firefighting instructions : Use water spray or fog for cooling exposed containers. Exercise caution when fighting any chemical fire. Prevent fire-fighting water from entering environment.

Protection during firefighting : Do not enter fire area without proper protective equipment, including respiratory protection. Do not attempt to take action without suitable protective equipment. Self-contained breathing apparatus. Complete protective clothing.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

6.1.1. For non-emergency personnel

Emergency procedures : Ventilate spillage area. Evacuate unnecessary personnel.

6.1.2. For emergency responders

Protective equipment : Do not attempt to take action without suitable protective equipment. Equip cleanup crew with proper protection. For further information refer to section 8: "Exposure controls/personal protection".

Emergency procedures : Ventilate area.

6.2. Environmental precautions

Avoid release to the environment. Prevent entry to sewers and public waters. Notify authorities if liquid enters sewers or public waters.

6.3. Methods and material for containment and cleaning up

Methods for cleaning up : Take up liquid spill into absorbent material. Soak up spills with inert solids, such as clay or diatomaceous earth as soon as possible. Collect spillage. Store away from other materials. Absorb spillage to prevent material damage.

Other information : Dispose of materials or solid residues at an authorized site.

6.4. Reference to other sections

See Heading 8. Exposure controls and personal protection. For further information refer to section 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Additional hazards when processed : May be corrosive to metals.

Precautions for safe handling : Ensure good ventilation of the work station. Wear personal protective equipment. Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Provide good ventilation in process area to prevent formation of vapour. Do not breathe dust/fume/gas/mist/vapours/spray. Avoid contact during pregnancy/while nursing.

Hygiene measures : Do not eat, drink or smoke when using this product. Wash hands, forearms and face thoroughly after handling. Always wash hands after handling the product.

7.2. Conditions for safe storage, including any incompatibilities

Technical measures : Comply with applicable regulations.

Storage conditions : Keep only in the original container in a cool, well ventilated place away from : Keep container closed when not in use. Store in a well-ventilated place. Keep cool.

Incompatible products : Strong bases. Strong acids.

Incompatible materials : Sources of ignition. Direct sunlight.

Packaging materials : Store in a corrosion resistant container with a resistant inner liner.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Proprietary
Not applicable

phosphoric acid (7664-38-2) (7664-38-2)		
ACGIH	ACGIH TWA (mg/m³)	1 mg/m³
ACGIH	ACGIH STEL (mg/m³)	3 mg/m³

8.2. Appropriate engineering controls

Appropriate engineering controls : Ensure good ventilation of the work station.

Environmental exposure controls : Avoid release to the environment.

8.3. Individual protection measures/Personal protective equipment

Personal protective equipment:

Avoid all unnecessary exposure.

Hand protection:

Wear protective gloves

Eye protection:

Chemical goggles or face shield. Safety glasses

Skin and body protection:

Wear suitable protective clothing

Respiratory protection:

Wear appropriate mask

Other information:

Do not eat, drink or smoke during use.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	:	Liquid
Appearance	:	Green, viscous liquid.
Colour	:	Green
Odour	:	Odorless when cold; pungent when hot.
Odour threshold	:	No data available
pH	:	< 1
Melting point	:	≈ °C
Freezing point	:	No data available
Boiling point	:	No data available
Flash point	:	123 °C
Relative evaporation rate (butylacetate=1)	:	No data available
Flammability (solid, gas)	:	Non flammable.
Vapour pressure	:	No data available
Relative vapour density at 20 °C	:	No data available
Relative density	:	No data available
Solubility	:	No data available
Log Pow	:	No data available
Auto-ignition temperature	:	No data available
Decomposition temperature	:	No data available
Viscosity, kinematic	:	No data available
Viscosity, dynamic	:	No data available
Explosive limits	:	No data available
Explosive properties	:	No data available
Oxidising properties	:	No data available

9.2. Other information

No additional information available

SECTION 10: Stability and reactivity

10.1. Reactivity

Thermal decomposition generates : Corrosive vapours.

10.2. Chemical stability

Stable.

10.3. Possibility of hazardous reactions

Not established.

10.4. Conditions to avoid

Strong Alkalies. Metals other than stainless steel. Direct sunlight. Extremely high or low temperatures.

10.5. Incompatible materials

Reacts violently with strong alkalies producing heat. Contact with many metals may result in severe corrosion attack of the metal and liberation of hydrogen gas. Strong acids. Strong bases. metals. May be corrosive to metals.

10.6. Hazardous decomposition products

High temperatures will liberate phosphorus oxides. fume. Carbon monoxide. Carbon dioxide. Thermal decomposition generates : Corrosive vapours.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Oral: Harmful if swallowed. Dermal: Harmful in contact with skin.

0-52-0 Merchant Grade Phosphoric Acid	
LD50 oral rat	1530 mg/kg
LD50 dermal rabbit	1260 mg/kg
ATE US (oral)	1530 mg/kg bodyweight
ATE US (dermal)	1260 mg/kg bodyweight

phosphoric acid (7664-38-2) (7664-38-2)	
LD50 oral rat	1530 mg/kg (Rat)
LD50 dermal rat	>= 1260 mg/kg bodyweight
LC50 inhalation rat (mg/l)	>= mg/l/4h
ATE US (oral)	1530 mg/kg bodyweight
ATE US (dermal)	1100 mg/kg bodyweight

Skin corrosion/irritation : Causes severe skin burns and eye damage.
pH: < 1

Serious eye damage/irritation : Not classified
pH: < 1

Respiratory or skin sensitisation : Not classified

Germ cell mutagenicity : Not classified
Based on available data, the classification criteria are not met

Carcinogenicity : Not classified

Reproductive toxicity : Not classified
Based on available data, the classification criteria are not met

Specific target organ toxicity (single exposure) : Not classified

Specific target organ toxicity (repeated exposure) : Not classified

Aspiration hazard : Not classified

Potential adverse human health effects and symptoms : Based on available data, the classification criteria are not met. Harmful if swallowed. Harmful in contact with skin.

Symptoms/injuries : Causes severe skin burns and eye damage.

Symptoms/injuries after skin contact : Repeated exposure to this material can result in absorption through skin causing significant health hazard. Harmful in contact with skin.

Symptoms/injuries after ingestion : Swallowing a small quantity of this material will result in serious health hazard.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : The product is not considered harmful to aquatic organisms or to cause long-term adverse effects in the environment.

0-52-0 Merchant Grade Phosphoric Acid	
LC50 fish 1	3 - 3.5 ppm

phosphoric acid (7664-38-2) (7664-38-2)	
LC50 fish 1	138 mg/l (96 h; Pisces; Pure substance)
LC50 other aquatic organisms 1	240 mg/l (96 h; Protozoa; Pure substance)
LC50 fish 2	100 - 1000 mg/l (Pisces; Pure substance)
LC50 other aquatic organisms 2	100 - 1000 mg/l (Pure substance)
TLM fish 1	138 ppm (24 h; Gambusia affinis; Pure substance)
Threshold limit other aquatic organisms 1	240 mg/l (96 h; Protozoa; Pure substance)
Threshold limit other aquatic organisms 2	100 - 1000,Pure substance

12.2. Persistence and degradability

0-52-0 Merchant Grade Phosphoric Acid	
Persistence and degradability	Not established.

Proprietary	
Persistence and degradability	Not established.

phosphoric acid (7664-38-2) (7664-38-2)	
Persistence and degradability	Biodegradability: not applicable. No (test)data on mobility of the components available. Not established.
Biochemical oxygen demand (BOD)	Not applicable
Chemical oxygen demand (COD)	Not applicable
ThOD	Not applicable
BOD (% of ThOD)	Not applicable

12.3. Bioaccumulative potential

0-52-0 Merchant Grade Phosphoric Acid	
Bioaccumulative potential	Not established.

Proprietary	
Bioaccumulative potential	Not established.

phosphoric acid (7664-38-2) (7664-38-2)	
Log Pow	-0.77 (Estimated value)
Bioaccumulative potential	Bioaccumulation: not applicable. Not established.

12.4. Mobility in soil

No additional information available

12.5. Other adverse effects

Effect on the global warming : No known effects from this product.

GWPmix comment : No known effects from this product.

Other information : Avoid release to the environment.

SECTION 13: Disposal considerations

13.1. Disposal methods

Waste treatment methods : Dispose of contents/container in accordance with licensed collector's sorting instructions.

Product/Packaging disposal recommendations : Dispose in a safe manner in accordance with local/national regulations. Dispose of contents/container to ...

Ecology - waste materials : Avoid release to the environment.

SECTION 14: Transport information

Department of Transportation (DOT)

In accordance with DOT

Transport document description : UN1805 Phosphoric acid solution, 8, III

UN-No.(DOT) : UN1805

Proper Shipping Name (DOT) : Phosphoric acid solution

Class (DOT)	:	8 - Class 8 - Corrosive material 49 CFR 173.136
Packing group (DOT)	:	III - Minor Danger
Hazard labels (DOT)	:	8 - Corrosive

DOT Packaging Non Bulk (49 CFR 173.xxx)	:	203
DOT Packaging Bulk (49 CFR 173.xxx)	:	241
DOT Special Provisions (49 CFR 172.102)	:	A7 - Steel packagings must be corrosion-resistant or have protection against corrosion. IB3 - Authorized IBCs: Metal (31A, 31B and 31N); Rigid plastics (31H1 and 31H2); Composite (31HZ1 and 31HA2, 31HB2, 31HN2, 31HD2 and 31HH2). Additional Requirement: Only liquids with a vapor pressure less than or equal to 110 kPa at 50 C (1.1 bar at 122 F), or 130 kPa at 55 C (1.3 bar at 131 F) are authorized, except for UN2672 (also see Special Provision IP8 in Table 2 for UN2672). N34 - Aluminum construction materials are not authorized for any part of a packaging which is normally in contact with the hazardous material. T4 - 2.65 178.274(d)(2) Normal..... 178.275(d)(3) TP1 - The maximum degree of filling must not exceed the degree of filling determined by the following: Degree of filling = 97 / (1 + a (tr - tf)) Where: tr is the maximum mean bulk temperature during transport, and tf is the temperature in degrees celsius of the liquid during filling.
DOT Packaging Exceptions (49 CFR 173.xxx)	:	154
DOT Quantity Limitations Passenger aircraft/rail (49 CFR 173.27)	:	5 L
DOT Quantity Limitations Cargo aircraft only (49 CFR 175.75)	:	60 L
DOT Vessel Stowage Location	:	A - The material may be stowed ‘‘on deck’’ or ‘‘under deck’’ on a cargo vessel and on a passenger vessel.
Other information	:	No supplementary information available.

TDG

Transport by sea

Transport document description (IMDG)	:	UN 1805 PHOSPHORIC ACID SOLUTION, 8, III
UN-No. (IMDG)	:	1805
Proper Shipping Name (IMDG)	:	PHOSPHORIC ACID SOLUTION
Class (IMDG)	:	8 - Corrosive substances
Packing group (IMDG)	:	III - substances presenting low danger
Limited quantities (IMDG)	:	5 L

Air transport

Transport document description (IATA)	:	UN 1805 Phosphoric acid, solution, 8, III
UN-No. (IATA)	:	1805
Proper Shipping Name (IATA)	:	Phosphoric acid, solution
Class (IATA)	:	8 - Corrosives
Packing group (IATA)	:	III - Minor Danger

SECTION 15: Regulatory information

15.1. US Federal regulations

0-52-0 Merchant Grade Phosphoric Acid	
Not listed on the United States TSCA (Toxic Substances Control Act) inventory Not subject to reporing requirements of the United States SARA Section 313	
CERCLA RQ	5000 lb

All components of this product are listed, or excluded from listing, on the United States Environmental Protection Agency Toxic Substances Control Act (TSCA) inventory except for:

Proprietary	CAS No	%

phosphoric acid (7664-38-2) (7664-38-2)	
CERCLA RQ	5000 lb

15.2. International regulations

CANADA
No additional information available

EU-Regulations
No additional information available

National regulations
No additional information available

15.3. US State regulations

California Proposition 65 - This product does not contain any substances known to the state of California to cause cancer, developmental and/or reproductive harm

phosphoric acid (7664-38-2) (7664-38-2)
U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

SECTION 16: Other information

Data sources : REGULATION (EC) No 1272/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.

Other information : None.

Full text of H-statements:

H290	May be corrosive to metals
H302	Harmful if swallowed
H312	Harmful in contact with skin
H314	Causes severe skin burns and eye damage

SDS US (GHS HazCom 2012)

Disclaimer: This information relates to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. Such information is to the best of our knowledge and belief, accurate and reliable as of the date compiled. However, no representation, warranty or guarantee is made as to its accuracy, reliability or completeness. NO WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED, IS MADE CONCERNING THE INFORMATION HEREIN PROVIDED. It is the user's responsibility to satisfy himself as to the suitability and completeness of such information for his own particular use. We do not accept liability for any loss or damage that may occur from the use of this information nor do we offer warranty against patent infringement.

FLUOROSILICIC ACID, 23-25%

Revision Date 10/15/2018

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

- Trade name: FLUOROSILICIC ACID, 23-25%
- Synonyms: Hydrofluorosilicic acid, Fluorosilicic acid, Hydrofluosilicic acid, Flousilicic acid, HFS, FSA

1.2 Relevant identified uses of the substance or mixture and uses advised against

Uses of the Substance / Mixture

- Chemical intermediate
- Water treatment

1.3 Details of the supplier of the safety data sheet

Company

SOLVAY FLUORIDES, LLC
3737 Buffalo Speedway,
Suite 800,
Houston, TX 77098
USA
Tel: 800-515-6065

1.4 Emergency telephone

FOR EMERGENCIES INVOLVING A SPILL, LEAK, FIRE, EXPOSURE OR ACCIDENT, CONTACT CHEMTREC (24-Hour Number): 800-424-9300 within the United States and Canada, or 703-527-3887 for international collect calls.

SECTION 2: Hazards identification

Although WHMIS has not adopted the environmental portion of the GHS regulations, this document may include information on environmental effects

2.1 Classification of the substance or mixture

Hazardous Products Regulations (WHMIS 2015)

Acute toxicity, Category 4	H302: Harmful if swallowed.
Acute toxicity, Category 4	H332: Harmful if inhaled.
Acute toxicity, Category 3	H311: Toxic in contact with skin.
Skin corrosion, Category 1B	H314: Causes severe skin burns and eye damage.
Serious eye damage, Category 1	H318: Causes serious eye damage.

2.2 Label elements

Hazardous Products Regulations (WHMIS 2015)

Pictogram

Signal Word

- Danger

Hazard Statements

- H302 + H332	Harmful if swallowed or if inhaled.
- H311	Toxic in contact with skin.
- H314	Causes severe skin burns and eye damage.

Precautionary Statements

Prevention

- P261	Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray.
- P264	Wash skin thoroughly after handling.
- P270	Do not eat, drink or smoke when using this product.
- P271	Use only outdoors or in a well-ventilated area.
- P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.

Response

- P301 + P312 + P330	IF SWALLOWED: Call a POISON CENTER/doctor if you feel unwell. Rinse mouth.
- P301 + P330 + P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
- P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water.
- P304 + P340 + P310	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER/doctor.
- P305 + P351 + P338 + P310	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER/doctor.
- P361 + P364	Take off immediately all contaminated clothing and wash it before reuse.

Storage

- P405	Store locked up.

Disposal

- P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Other hazards which do not result in classification

None identified

SECTION 3: Composition/information on ingredients

3.1 Substance

- Not applicable, this product is a mixture.

3.2 Mixture

- Synonyms: Hydrofluorosilicic acid, Fluorosilicic acid, Hydrofluosilicic acid, Flousilicic acid, HFS, FSA

WHMIS Hazardous Ingredients and Impurities

Chemical name	Identification number CAS-No.	Concentration [% wt/wt or V/V]
Silicate(2-), hexafluoro-, hydrogen (1:2)	16961-83-4	>= 23 - <= 25
Hydrofluoric acid	7664-39-3	<= 1

SECTION 4: First aid measures

4.1 Description of first-aid measures

General advice

- HF exposures are unique. Serious and potentially life threatening effects can occur immediately or up to 24 hours after exposure.
- Always decontaminate exposure victims before applying first aid or medical treatment.
- Rescuers should wear PPE during rescue and decontamination of victims.
- First aid providers should wear gloves when touching exposed areas or applying calcium gluconate gel to victims.
- In case of splashes to eyes and face, treat eyes first.
- Always seek medical attention if exposed to HF.

In case of inhalation

- Move to fresh air.
- Get immediate medical advice/ attention.
- Administer oxygen by mask at a rate of 12 liters/minute.
- Nebulize 2.5% calcium gluconate solution for 15 to 20 minutes minimum or until the victim reaches medical attention.
- If calcium gluconate is not available, administer oxygen as above until the victim reaches medical attention.
- If respiratory assistance is needed, use indirect methods such as “microshilds” or “AMBU” bag. Do not give mouth to mouth resuscitation.
-
- If exposed to HF vapor, expect to see skin and eye exposure. Follow the decontamination and first aid procedures for skin and eye exposure.
- Be aware to maintain life support if necessary.

In case of skin contact

- In case of HF exposure to skin, go to the nearest source of water or safety shower. Turn water on.
- While washing, remove all clothing, shoes and jewelry.
- Finally, while closing eyes and facing the water flow, remove goggles or respirator face mask.
- HF-resistant gloves should be worn while touching contaminated skin.
- Wash the exposed areas for 5 minutes maximum if first aid treatments are immediately available. Otherwise continue to wash until first aid treatments are available.
- Immediately apply calcium gluconate gel 2.5% and massage into the affected area; continue to massage while repeatedly applying gel until 15 minutes after pain is relieved.
- If fingers/finger nails are touched, even if there is no pain, dip them in a bath of 2.5% calcium gluconate for 15 to 20 minutes.
- Seek medical attention as soon as possible. During transportation to a medical facility or while waiting for a physician to see victim, it is extremely important to continue messaging calcium gluconate gel.
- Be aware to maintain life support if necessary.

In case of eye contact

- Decontamination: Go to the nearest eye wash or clean source of water, open the water valve. Have a trained person remove contact lenses if present (contact lenses should be prohibited), put your eye(s) in the water flow and hold eyelids open while flushing.
- After flushing, irrigate eyes with 1% calcium gluconate solution using a nasal cannula cinched over the bridge of the nose. Dispense 1000 cc of calcium gluconate solution in a continuous flush for a minimum period of 15 minutes, or if necessary until medical aid is available.
-
- During transportation to a medical facility or while waiting for a physician to see the victim, it is extremely important to continue the calcium gluconate irrigation.
-
- Always obtain specialized medical evaluation & treatment as soon as possible.
- Be aware to maintain life support if necessary.

In case of ingestion

- If HF has been ingested, the victim should be immediately transported to a medical facility.
- Do NOT induce vomiting.
- If the victim is able to swallow, give oral calcium containing antacids or solution. The recommended antidote is

calcium gluconate. However, if no calcium gluconate is at hand, the oral administration of small and limited amount of milk or water might be considered if it's consistent with local practice.
- Be aware to maintain life support if necessary.

4.2 Most important symptoms and effects, both acute and delayed

In case of skin contact

Symptoms
- Causes severe burns.
- metabolic imbalances
- Life threatening cardiac arrhythmia

Effects
- HF penetrate very fast any tissue It comes in contact with, and do not remain on its surface.
- Initially, the substances will be locally burning, and afterwards they will penetrate into deeper tissues and might cause the following significant complications:
- In case of lower concentrations, symptoms can be delayed and might appear even 48h after the exposure.
- It is completely absorbed into the body, where it causes acute and severe toxic systemic effects, mainly attributable to a rapid development of serum hypocalcaemia and hypomagnesaemia and to enzymes blocking.

In case of eye contact

Symptoms
- Causes severe burns.
- Blindness

Effects
- HF penetrate very fast any tissue It comes in contact with, and do not remain on its surface.
- Initially, the substances will be locally burning, and afterwards they will penetrate into deeper tissues and might cause the following significant complications:
- In case of lower concentrations, symptoms can be delayed and might appear even 48h after the exposure.
- It is completely absorbed into the body, where it causes acute and severe toxic systemic effects, mainly attributable to a rapid development of serum hypocalcaemia and hypomagnesaemia and to enzymes blocking.

In case of inhalation

Symptoms
- Causes severe burns.
- metabolic imbalances
- pulmonary edema
- Life threatening cardiac arrhythmia

Effects
- Initially, the substances will be locally burning, and afterwards they will penetrate into deeper tissues and might cause the following significant complications:
- In case of lower concentrations, symptoms can be delayed and might appear even 48h after the exposure.
- It is completely absorbed into the body, where it causes acute and severe toxic systemic effects, mainly attributable to a rapid development of serum hypocalcaemia and hypomagnesaemia and to enzymes blocking.

In case of ingestion

Effects
- In case of lower concentrations, symptoms can be delayed and might appear even 48h after the exposure.
- It is completely absorbed into the body, where it causes acute and severe toxic systemic effects, mainly attributable to a rapid development of serum hypocalcaemia and hypomagnesaemia and to enzymes blocking.

4.3 Indication of any immediate medical attention and special treatment needed

- no data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media

- Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media

- None.

5.2 Special hazards arising from the substance or mixture

Specific hazards during fire fighting

- The product is not flammable.
- Not combustible.
- Heating can release hazardous gases.
- Gives off hydrogen by reaction with metals.

Hazardous combustion products:

- Hydrogen
- Hydrogen fluoride

5.3 Advice for firefighters

Special protective equipment for fire-fighters

- Wear self-contained breathing apparatus and protective suit.
- Fire fighters must wear fire resistant personnel protective equipment.
- Wear chemical resistant oversuit
- Protect intervention team with a water spray as they approach the fire.

Further information

- Cool containers/tanks with water spray.
- Approach from upwind.
- Suppress (knock down) gases/vapors/mists with a water spray jet.
- After the fire, proceed rapidly with cleaning of surfaces exposed to the fumes in order to limit equipment damage.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Advice for non-emergency personnel

- Prevent further leakage or spillage if safe to do so.
- Keep away from incompatible products

Advice for emergency responders

- Approach from upwind.
- Isolate the area.
- Wear self-contained breathing apparatus in confined spaces, in cases where the oxygen level is depleted, or in case of significant emissions.
- Suppress (knock down) gases/vapors/mists with a water spray jet.
- Avoid spraying the leak source.
- Ventilate the area.

6.2 Environmental precautions

- Should not be released into the environment.
- If the product contaminates rivers and lakes or drains inform respective authorities.

6.3 Methods and materials for containment and cleaning up

- Dam up.
- Soak up with inert absorbent material.
- Prevent product from entering sewage system.
- Dilute with water.
- Contact with water may produce heat release and presents risks of splashing.
- When diluting, always add the product to water. Never add water to the product.
- Neutralize with the following product(s):
- soda ash
- lime
- Keep in properly labeled containers.
- Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

- Refer to protective measures listed in sections 7 and 8.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

- Used in closed system
- Handle small quantities under a lab hood.
- Use only in well-ventilated areas.
- Use only equipment and materials which are compatible with the product.
- Preferably transfer by pump or gravity.
- For further information, please contact:
- Manufacturer, importer, supplier
- Keep away from incompatible products

Hygiene measures

- Ensure that eyewash stations and safety showers are close to the workstation location.
- Take off contaminated clothing and shoes immediately.
- Wash contaminated clothing before re-use.
- May not get in touch with:
- Leather
- Handle in accordance with good industrial hygiene and safety practice.

7.2 Conditions for safe storage, including any incompatibilities

Technical measures/Storage conditions

- Do not freeze.

- Keep container tightly closed.
- Keep in a cool, well-ventilated place.
- Keep away from heat.
- Keep in a contained area
- Information about special precautions needed for bulk handling is available on request.

- Provide tight electrical equipment well protected against corrosion.
- For personal protection see section 8.

- Keep away from:
- Incompatible products

Packaging material

Suitable material
- Plastic materials.
- Coated steels.

Unsuitable material
- glass

7.3 Specific end use(s)

- Contact your supplier for additional information

SECTION 8: Exposure controls/personal protection

Introductory Remarks: These recommendations provide general guidance for handling this product. Because specific work environments and material handling practices vary, safety procedures should be developed for each intended application. Assistance with selection, use and maintenance of worker protection equipment is generally available from equipment manufacturers.

8.1 Control parameters

Components with workplace occupational exposure limits

Consult local authorities for acceptable exposure limits.

Components	Value type	Value	Basis
Silicate(2-), hexafluoro-, hydrogen (1:2)	TWA	2.5 mg/m3	American Conference of Governmental Industrial Hygienists
	Bone damage, Fluorosis, Substances for which there is a Biological Exposure Index or Indices (see BEI® section), Not classifiable as a human carcinogen, varies Expressed as :Fluorine		
Hydrofluoric acid	TWA	0.5 ppm	American Conference of Governmental Industrial Hygienists
	Upper Respiratory Tract irritation, Lower Respiratory Tract irritation, Eye irritation, Skin irritation, Fluorosis, Substances for which there is a Biological Exposure Index or Indices (see BEI® section), Danger of cutaneous absorption Expressed as :Fluorine		
Hydrofluoric acid	C	2 ppm	American Conference of Governmental Industrial Hygienists
	Upper Respiratory Tract irritation, Lower Respiratory Tract irritation, Eye irritation, Skin irritation, Fluorosis, Substances for which there is a Biological Exposure Index or Indices (see BEI® section), Danger of cutaneous absorption Expressed as :Fluorine		

Biological Exposure Indices

Components	Value type	Value	Basis
Silicate(2-), hexafluoro-, hydrogen (1:2)	BEI	2 mg/l Fluoride Urine Prior to shift (16 hours after exposure ceases)	American Conference of Governmental Industrial Hygienists
Silicate(2-), hexafluoro-, hydrogen (1:2)	BEI	3 mg/l Fluoride Urine End of shift (As soon as possible after exposure ceases)	American Conference of Governmental Industrial Hygienists
Hydrofluoric acid	BEI	2 mg/l Fluoride Urine Prior to shift (16 hours after exposure ceases)	American Conference of Governmental Industrial Hygienists
Hydrofluoric acid	BEI	3 mg/l Fluoride Urine End of shift (As soon as possible after exposure ceases)	American Conference of Governmental Industrial Hygienists

8.2 Exposure controls

Control measures

Engineering measures

- Provide adequate ventilation.
- Apply technical measures to comply with the occupational exposure limits.

Individual protection measures

Respiratory protection

- Use respirator when performing operations involving potential exposure to vapor of the product.
- Respirator with a full face mask.
- Respirator with combination filter for vapor/particulate (EN 141)
- In case of decomposition (see section 10), face mask with combined type B-P3 cartridge.
- In the case of dust or aerosol formation use respirator with an approved filter.
- Self-contained breathing apparatus in confined spaces/insufficient oxygen/in case of large uncontrolled emissions/in all circumstances when the mask and cartridge do not give adequate protection.
- Use only respiratory protection that conforms to international/ national standards.
- Use NIOSH approved respiratory protection.
- Self-contained breathing apparatus in case of: 1) large uncontrolled emissions, 2) insufficient oxygen, 3) the mask and cartridge do not give adequate protection.

Hand protection

- Take note of the information given by the producer concerning permeability and break through times, and of special workplace conditions (mechanical strain, duration of contact).
- Protective gloves - impervious chemical resistant:

Suitable material
- Copolymer VF2-HFP (fluoroelastomer)

Eye protection
- Chemical resistant goggles must be worn.
- Face-shield

Skin and body protection
- Impervious clothing
- Do not wear leather shoes.

- If splashes are likely to occur, wear:
- butyl-rubber
- Boots

Hygiene measures
- Ensure that eyewash stations and safety showers are close to the workstation location.
- Take off contaminated clothing and shoes immediately.
- Wash contaminated clothing before re-use.
- May not get in touch with:
- Leather
- Handle in accordance with good industrial hygiene and safety practice.

SECTION 9: Physical and chemical properties

Physical and Chemical properties here represent typical properties of this product. Contact the business area using the Product information phone number in Section 1 for its exact specifications.

9.1 Information on basic physical and chemical properties

Appearance	Physical state: liquid Color: colorless
Odor	pungent
Odor Threshold	No data available
pH	1.0 (100 g/l)
Melting point/freezing point	Freezing point: < 4.1 °F (< -15.5 °C)
Initial boiling point and boiling range	Boiling point/boiling range: Thermal decomposition: yes Not applicable
Flash point	Not applicable
Evaporation rate (Butylacetate = 1)	No data available
Flammability (solid, gas)	Not applicable
Flammability (liquids)	The product is not flammable.

Flammability / Explosive limit	Explosiveness: With certain materials (see section 10).
Autoignition temperature	Not applicable
Vapor pressure	22.50 mmHg (30 hPa) (68 °F (20 °C))
Vapor density	> 1 (68 °F (20 °C))
Density	Bulk density: Not applicable
Relative density	1.27 (68 °F (20 °C)) 30 % solution
Solubility	Water solubility: soluble
Partition coefficient: n-octanol/water	Not applicable
Decomposition temperature	No data available
Viscosity	Viscosity, dynamic : 6.5 mPa.s (68 °F (20 °C)) 30 % solution
Explosive properties	No data available
Oxidizing properties	Not considered as oxidizing.

9.2 Other information

No data available

SECTION 10: Stability and reactivity

10.1 Reactivity

- Risk of violent reaction.
- Risk of explosion.

10.2 Chemical stability

- Stable under recommended storage conditions.
- Corrosive in contact with metals
- Gives off hydrogen by reaction with metals.
- Risk of violent reaction.
- Risk of explosion.

10.3 Possibility of hazardous reactions

- Reacts violently with water., Corrosive in contact with metals, Gives off hydrogen by reaction with metals.

10.4 Conditions to avoid

- To avoid thermal decomposition, do not overheat.

10.5 Incompatible materials

- glass
- Strong oxidizing agents
- Metals

10.6 Hazardous decomposition products

- Hydrogen
- Hydrogen fluoride

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Acute oral toxicity

Silicate(2-), hexafluoro-, hydrogen (1:2)	study scientifically unjustified Corrosive
Hydrofluoric acid	study scientifically unjustified

Acute inhalation toxicity

Silicate(2-), hexafluoro-, hydrogen (1:2)	study scientifically unjustified Corrosive
Hydrofluoric acid	LC50 - 1 h (gas) : 2,240 - 2,340 ppm - Rat , male dry air Humid air

Acute dermal toxicity

Silicate(2-), hexafluoro-, hydrogen (1:2)	study scientifically unjustified Corrosive
Hydrofluoric acid	NOEC : 2 %(m) - Rabbit Test substance: solution Exposure time 1 min NOEC : 0.01 %(m) - Rabbit Test substance: solution Exposure time 30 min
Acute toxicity (other routes of administration)	No data available

Skin corrosion/irritation

Silicate(2-), hexafluoro-, hydrogen (1:2)	Corrosive
Hydrofluoric acid	Corrosive

Serious eye damage/eye irritation

Silicate(2-), hexafluoro-, hydrogen (1:2)	Corrosive
Hydrofluoric acid	Risk of serious damage to eyes.

Respiratory or skin sensitization

Silicate(2-), hexafluoro-, hydrogen (1:2)	study scientifically unjustified Corrosive
Hydrofluoric acid	By analogy Does not cause skin sensitization. Test substance: Sodium fluoride

Mutagenicity

Genotoxicity in vitro

Silicate(2-), hexafluoro-, hydrogen (1:2)	Ames test Strain: Salmonella typhimurium with and without metabolic activation negative Method: OECD Test Guideline 471
Hydrofluoric acid	By analogy Test substance: Sodium fluoride In vitro tests did not show mutagenic effects

Genotoxicity in vivo

Silicate(2-), hexafluoro-, hydrogen (1:2)	Test substance: Sodium fluoride By analogy In vivo tests did not show mutagenic effects
Hydrofluoric acid	By analogy Test substance: Sodium fluoride In vivo tests did not show mutagenic effects

Carcinogenicity

Silicate(2-), hexafluoro-, hydrogen (1:2)	By analogy Rat Mouse Oral Exposure time: Prolonged exposure NOAEL: 175ppm Test substance: Sodium fluoride drinking water No carcinogenic effects have been observed
Hydrofluoric acid	By analogy Rat Oral NOAEL: 175ppm Test substance: Sodium fluoride drinking water Mouse Oral NOAEL: 175ppm Test substance: Sodium fluoride drinking water No carcinogenic effects have been observed

This product does not contain any ingredient designated as probable or suspected human carcinogens by:
ACGIH

Toxicity for reproduction and development

Toxicity to reproduction / fertility

Silicate(2-), hexafluoro-, hydrogen (1:2)	By analogy Two-generation study - Rat, male and female, Oral Fertility NOAEL Parent: 10 mg/kg Fertility NOAEL F1: 10 mg/kg Test substance, Sodium fluoride, drinking water, The product is not considered to affect fertility.
Hydrofluoric acid	By analogy Two-generation study - Rat, male and female, Oral Fertility NOAEL Parent: 10 mg/kg Fertility NOAEL F1: 10 mg/kg Test substance, Sodium fluoride, drinking water, The product is not considered to affect fertility.

Developmental Toxicity/Teratogenicity

Silicate(2-), hexafluoro-, hydrogen (1:2)	By analogy Rat Rabbit , Oral Teratogenicity NOAEL:14mg/kg Test substance, Sodium fluoride, drinking water, The product is not considered to be toxic for development.
Hydrofluoric acid	By analogy Rat Rabbit , Oral Teratogenicity NOAEL:14mg/kg Test substance, Sodium fluoride, drinking water, The product is not considered to be toxic for development.

STOT

STOT-single exposure

Silicate(2-), hexafluoro-, hydrogen (1:2)	The substance or mixture is not classified as specific target organ toxicant, single exposure according to GHS criteria.
Hydrofluoric acid	The substance or mixture is not classified as specific target organ toxicant, single exposure according to GHS criteria.

STOT-repeated exposure

Silicate(2-), hexafluoro-, hydrogen (1:2)	The substance or mixture is not classified as specific target organ toxicant, repeated exposure according to GHS criteria.
Hydrofluoric acid	The substance or mixture is not classified as specific target organ toxicant, repeated exposure according to GHS criteria.
Silicate(2-), hexafluoro-, hydrogen (1:2)	By analogy Oral - Mouse , male and female LOAEL: 50 ppm Test substance: Sodium fluoride Target Organs: Skeleton By analogy Inhalation 90-day - Rat , male and female NOAEC: 0.72 mg/m3 Test substance: Hydrogen fluoride Target Organs: Respiratory Tract, Bone, Teeth, Kidney
Hydrofluoric acid	By analogy

Oral - Mouse , male and female
LOAEL: 50 ppm
Test substance: Sodium fluoride
Target Organs: Skeleton

Inhalation 90-day - Rat , male and female
NOAEC: 0.72 mg/m3
Test substance: Hydrogen fluoride
Target Organs: Respiratory Tract, Bone, Teeth, Kidney

Experience with human exposure No data available

Aspiration toxicity No data available

Further information

Hydrofluoric acid — corrosive effects
Liver and kidney injuries may occur.

SECTION 12: Ecological information

12.1 Toxicity

Aquatic Compartment

Acute toxicity to fish

Silicate(2-), hexafluoro-, hydrogen (1:2)	LC50 - 96 h : 50 mg/l - Lepomis macrochirus (Bluegill sunfish) static test Fresh water
Hydrofluoric acid	By analogy LC50 - 96 h : 51 mg/l - Fishes, Salmo gairdneri static test Test substance: Sodium fluoride Fresh water

Acute toxicity to daphnia and other aquatic invertebrates

Silicate(2-), hexafluoro-, hydrogen (1:2)	By analogy EC50 - 48 h : 26 mg/l - Daphnia magna (Water flea) static test Test substance: Sodium fluoride Fresh water By analogy EC50 - 96 h : 10.5 mg/l static test Test substance: Sodium fluoride Marine species salt water
Hydrofluoric acid	By analogy EC50 - 48 h : 26 mg/l - Daphnia magna (Water flea) static test Test substance: Sodium fluoride Fresh water EC50 - 96 h : 10.5 mg/l static test Test substance: Sodium fluoride Marine species salt water

Toxicity to aquatic plants

Silicate(2-), hexafluoro-, hydrogen (1:2)	By analogy EC50 - 96 h : 43 mg/l - algae static test Test substance: Sodium fluoride Fresh water Sea water By analogy EC50 - 96 h : 81 mg/l - algae static test Test substance: Sodium fluoride Fresh water Sea water By analogy NOEC - 7 Days : 50 mg/l - algae static test Test substance: Sodium fluoride Fresh water Sea water
Hydrofluoric acid	By analogy EC50 - 96 h : 43 mg/l - Algae

static test
Test substance: Sodium fluoride
Fresh water

By analogy

EC50 - 96 h : 81 mg/l - Algae
static test
Test substance: Sodium fluoride
Sea water

By analogy

NOEC - 7 Days : 50 mg/l - Algae
static test
Test substance: Sodium fluoride
Fresh water
Sea water

Toxicity to microorganisms No data available

Chronic toxicity to fish

Silicate(2-), hexafluoro-, hydrogen (1:2) By analogy

NOEC: 4 mg/l - 21 Days - Oncorhynchus mykiss (rainbow trout)
static test
Test substance: Sodium fluoride
Fresh water

Hydrofluoric acid By analogy

NOEC: 4 mg/l - 21 Days - Oncorhynchus mykiss (rainbow trout)
static test
Test substance: Sodium fluoride
Fresh water

Chronic toxicity to daphnia and other aquatic invertebrates

Silicate(2-), hexafluoro-, hydrogen (1:2) By analogy

NOEC: 8.9 mg/l - 21 Days - Daphnia magna (Water flea)
static test
Test substance: Sodium fluoride
Fresh water

Hydrofluoric acid By analogy

NOEC: 8.9 mg/l - 21 Days - Daphnia magna (Water flea)
static test
Test substance: Sodium fluoride
Fresh water

12.2 Persistence and degradability

Abiotic degradation

Stability in water

Silicate(2-), hexafluoro-, hydrogen (1:2)	Water/soil ionization/neutralization, Water/soil complexation/precipitation of inorganic materials,

Photodegradation

Hydrofluoric acid	Air neutralization by natural alkalinity

Physical- and photo-chemical elimination	No data available

Biodegradation

Biodegradability

Silicate(2-), hexafluoro-, hydrogen (1:2)	The methods for determining biodegradability are not applicable to inorganic substances.
Hydrofluoric acid	The methods for determining the biological degradability are not applicable to inorganic substances.

12.3 Bioaccumulative potential

Partition coefficient: n-octanol/water

Silicate(2-), hexafluoro-, hydrogen (1:2)	Not applicable, inorganic substance
Hydrofluoric acid	Not applicable, inorganic substance

Bioconcentration factor (BCF)

Silicate(2-), hexafluoro-, hydrogen (1:2)	Does not bioaccumulate.
Hydrofluoric acid	Does not bioaccumulate.

12.4 Mobility in soil

Adsorption potential (Koc)

Silicate(2-), hexafluoro-, hydrogen (1:2)	Air mobility as solid aerosols Solubility(ies) Water Mobility Soil/sediments potential adsorption pH Test substance fluoride
Hydrofluoric acid	Air mobility as solid aerosols Water Solubility(ies) Mobility Soil/sediments potential adsorption pH Test substance fluoride

Known distribution to environmental compartments No data available

12.5 Results of PBT and vPvB assessment

Silicate(2-), hexafluoro-, hydrogen (1:2)	According to Annex XIII of regulation (EC) 1907/2006 a PBT and vPvB assessment shall not be conducted for inorganic substances. Not applicable, inorganic substance
Hydrofluoric acid	Not applicable, inorganic substance According to Annex XIII of regulation (EC) 1907/2006 a PBT and vPvB assessment shall not be conducted for inorganic substances.

12.6 Other adverse effects

Ecotoxicity assessment

Short-term (acute) aquatic hazard

Hydrofluoric acid	Harmful to aquatic organisms.

Long-term (chronic) aquatic hazard

Hydrofluoric acid	. low chronic toxicity.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product Disposal

- In accordance with local and national regulations.
- Refer to manufacturer/supplier for information on recovery/recycling.

Advice on cleaning and disposal of packaging

- Clean container with water.
- The empty and clean containers are to be reused in conformity with regulations.
- To avoid treatments, as far as possible, use dedicated containers.

SECTION 14: Transport information

Transportation status: IMPORTANT! Statements below provide additional data on listed transport classification.
The listed Transportation Classification does not address regulatory variations due to changes in package size, mode of shipment or other regulatory descriptors.

TDG

14.1 UN number	UN 1778
14.2 Proper shipping name	FLUOROSILICIC ACID
14.3 Transport hazard class Label(s)	8 8
14.4 Packing group Packing group ERG No	 II 154
14.5 Environmental hazards **Marine pollutant**	NO

DOT

14.1 UN number	UN 1778
14.2 Proper shipping name	FLUOROSILICIC ACID
14.3 Transport hazard class Label(s)	8 8
14.4 Packing group Packing group ERG No	 II 154
14.5 Environmental hazards **Marine pollutant**	NO

NOM

14.1 UN number	UN 1778
14.2 Proper shipping name	FLUOROSILICIC ACID
14.3 Transport hazard class	8
Label(s)	8
14.4 Packing group	
Packing group	II
ERG No	154
14.5 Environmental hazards	NO
Marine pollutant	

IMDG

14.1 UN number	UN 1778
14.2 Proper shipping name	FLUOROSILICIC ACID
14.3 Transport hazard class	8
Label(s)	8
14.4 Packing group	
Packing group	II
14.5 Environmental hazards	NO
Marine pollutant	
14.6 Special precautions for user	
EmS	F-A , S-B

For personal protection see section 8.

IATA

14.1 UN number	UN 1778
14.2 Proper shipping name	FLUOROSILICIC ACID
14.3 Transport hazard class	8
Label(s):	8
14.4 Packing group	
Packing group	II
Packing instruction (cargo aircraft)	855
Max net qty / pkg	30.00 L
Packing instruction (passenger aircraft)	851
Max net qty / pkg	1.00 L
14.5 Environmental hazards	NO
14.6 Special precautions for user	

For personal protection see section 8.

Note: The above regulatory prescriptions are those valid on the date of publication of this sheet. Given the possible evolution of transportation regulations for hazardous materials, it would be advisable to check their validity with your sales office.

SECTION 15: Regulatory information

15.1Notification status

Inventory Information	Status
United States TSCA Inventory	- Listed on Inventory
Canadian Domestic Substances List (DSL)	- Listed on Inventory
Australia Inventory of Chemical Substances (AICS)	- Listed on Inventory
Japan. CSCL - Inventory of Existing and New Chemical Substances	- Listed on Inventory
Korea. Korean Existing Chemicals Inventory (KECI)	- Listed on Inventory
China. Inventory of Existing Chemical Substances in China (IECSC)	- Listed on Inventory
Philippines Inventory of Chemicals and Chemical Substances (PICCS)	- Listed on Inventory
Taiwan Chemical Substance Inventory (TCSI)	- Listed on Inventory
EU. European Registration, Evaluation, Authorisation and Restriction of Chemical (REACH)	- When purchased from a European Solvay legal entity, this product is compliant with the registration provisions of the REACH Regulation (EC) No. 1907/2006 as all its components are either excluded, exempt, and/or registered. When purchased from a legal entity outside of Europe, please contact your local representative for additional information.

15.2 National Regulations

Canada. CEPA 1999 Significant New Activity (SNAc) List:

- No substances are subject to a Significant New Activity Notification.

SECTION 16: Other information

Revision Date:

10/15/2018

Key or legend to abbreviations and acronyms used in the safety data sheet

- C Ceiling limit

-	PEL	Permissible exposure limit
-	STEL	Short term exposure limit
-	TWA	8-hour, time-weighted average
-	ACGIH	American Conference of Governmental Industrial Hygienists
-	OSHA	Occupational Safety and Health Administration
-	NTP	National Toxicology Program
-	IARC	International Agency for Research on Cancer
-	NIOSH	National Institute for Occupational Safety and Health

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information, and belief at the date of its publication. Such information is only given as a guidance to help the user handle, use, process, store, transport, dispose, and release the product in satisfactory safety conditions and is not to be considered as a warranty or quality specification. It should be used in conjunction with technical sheets but do not replace them. Thus, the information only relates to the designated specific product and may not be applicable if such product is used in combination with other materials or in any other manufacturing process, unless otherwise specifically indicated. It does not release the user from ensuring he is in conformity with all regulations linked to its activity.

EAC OBSERVATION NO.-16

EAC OBSERVATION:

Reporting system of non-compliances/ violations to be submitted as per TOR 9(iii) and (iv).

9(iii) What is the hierarchical system or Administrative order of the company to deal with the environmental issues and for ensuring compliance with the environmental clearance conditions? Details for this system may be given.

REPLY:

The hierarchical system or Administrative order of the company to deal with the environmental issues and for ensuring compliance with the environmental clearance conditions has defined as below

Role & Responsibility for Reporting mechanism of Environmental Non-compliance and Emergencies:

Site Environmental Head:

- Developing effective Environment Management System;
- To monitor the Environmental Compliance Conditions;
- To monitor the progress of the Environmental Targets set for the year; and
- To report all the environmental non-compliance as and when it happens to the Location Head.

Location Head:

- Effective implementation of the Environment Management System;
- Monthly review of the Environmental Compliance Conditions;
- Monthly review of the progress of the Environmental Targets set for the year;
- To report all the environmental non-compliance to the Business CEO within 24 hrs; and
- To report any environmental emergencies to the Business CEO on immediate basis.

Business CEO:

- Quarterly review of the Environment Management System;
- Quarterly review of the Environmental Compliance Conditions;
- Quarterly review of the progress of the Environmental Targets set for the year;
- To report all the environmental non-compliance to the Board of Directors on Quarterly Basis; and
- To report any environmental emergencies to the board of Directors on immediate basis.

Risk Management Committee:

- Quarterly review of the Environmental Compliance Conditions.
- Compliance of escalation and review system on environment non-compliance as per Environment Management System.
- Provide a summary of the Annual Environmental Performance Statement to concerned Stakeholders.
- Reporting to board on quarterly basis and providing the compliances and non-compliances with respect to environmental clearance condition

EAC OBSERVATION NO.-16

adani

CERTIFIED TRUE COPY OF THE RESOLUTION PASSED AT THE MEETING OF THE BOARD OF DIRECTORS ("BOARD") OF ADANI ENTERPRISES LIMITED ("COMPANY") HELD ON 12TH NOVEMBER, 2019.

"**RESOLVED THAT** in continuation to the earlier resolution passed by the Board of Directors, existing terms of reference of Risk Management Committee be and is hereby modified to include the process of monitoring & reporting mechanism of non-compliance of any environmental laws pertaining to Copper Refinery Plant at Mundra, Gujarat, as per the following details:

Reporting mechanism of Environmental Non Compliance and Emergencies:

Site Environmental Head is responsible for:
- Developing effective Environment Management System.
- To monitor the Environmental Compliance Conditions.
- To monitor the progress of the Environmental Targets set for the year.
- To report all the environmental non-compliance as and when it happens to the Location Head.

Location Head is responsible for:
- Effective implementation of the Environment Management System.
- Monthly review of the Environmental Compliance Conditions.
- Monthly review of the progress of the Environmental Targets set for the year.
- To report all the environmental non-compliance to the Business CEO within 24 hrs.
- To report any environmental emergencies to the Business CEO on immediate basis.

Business CEO is responsible for:
- Quarterly review of the Environment Management System.
- Quarterly review of the Environmental Compliance Conditions.
- Quarterly review of the progress of the Environmental Targets set for the year.
- To report all the environmental non-compliance to the Chairman of Risk Management Committee on Quarterly basis.
- To report any environmental emergencies to the Chairman of Risk Management Committee and all the members of the board on immediate basis.

Risk Management Committee is responsible for:
- Quarterly review of the Environmental Compliance Conditions.
- Compliance of escalation and review system on environment non-compliance as per Environment Management System.
- Provide a summary of the Annual Environmental Performance Statement to concerned Stakeholders.
- Reporting to Board on quarterly basis and providing the compliance and non-compliances with respect to environmental clearance conditions.

Certified True Copy,
For Adani Enterprises Limited

J. R. Jalundhwala

Jatin Jalundhwala
Company Secretary &
Joint President (Legal)

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EAC OBSERVATION NO.-16

9(iv) Does the company have system of reporting of Non-compliances/ violations of environmental norms to Board of Directors of the Company and/ or shareholders or stakeholders at large? This Reporting mechanism shall be detailed in EIA Report.

REPLY:

Company will have system of reporting of Non-compliances/ violations of environmental norms to Board of Directors of the Company and/ or shareholders or stakeholders at large.
AEL Board has empowered "Risk Management Committee" to manage health, safety & environment risks and achieve compliance with sustainable development responsibilities. A board resolution in this regards is attached as **Annexure-16.**

The current scope of Risk Management Committee is as follows:
"The Committee is required to lay down the procedures to inform to the Board about the risk assessment and minimization procedures & the Board shall be responsible for framing, implementing & monitoring the risk management plan of the company."

Additional Scope of Risk Management Committee will be as follows:

"The Committee will also oversee management processes, standards and strategies designed to manage Health, Safety & Environment and Social risks and ensure maintaining the highest standards and compliance with applicable statutory provisions."

The risk management committee will review all the environmental compliance if any on quarterly basis along with its corrective and preventive measures. This will be the permanent agenda point for all board meetings.

EAC OBSERVATION NO.-17

EAC OBSERVATION:

Provide details about reduction in acid mist formation in Sulphuric acid plant.

REPLY:

Sulphuric Acid Mist Control Mechanisms:

Mist is the term used to describe a phenomenon of small finely divided liquid aerosol droplets suspended or dispersed in air or process gases.

Mist can be formed in the manufacturing processes in three different ways:

Ways	Nature of Generation
Mechanical	Mechanical forces may break up or "atomize" a liquid to form a mist with a mean size of ~ 2.5 Micron
Condensation	Cooling of a gas stream may result in the condensation of vapor to form a mist with a mean size of ~ 1.0 Micron.
Chemical Reaction	Chemical reaction of two or more gases may take place at temperatures and pressures where the reaction products are mists with a mean size of ~ 0.3 Micron.

Formation of the acid Mists in the Sulphuric acid plant:

Larger acid mist particles are created in sulfuric acid drying and absorbing towers. They generally form when acid is re-entrained due to localized high velocity gas tearing droplets away from a liquid film or from the splashing or spray generated from a liquid distribution device.

More difficult to collect small acid particles are formed by the reaction of sulfur trioxide with any water vapor present and by the condensation of acid from the gaseous or vapor phase.

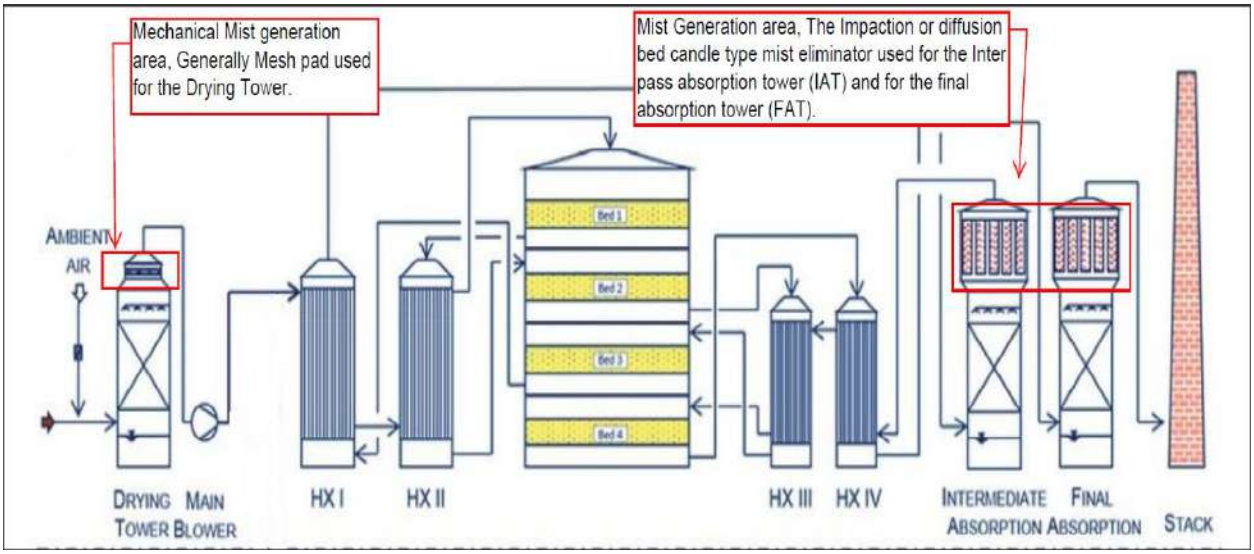

FIGURE-1:
THE ACID MISTS IN THE SULPHURIC ACID PLANT

EAC OBSERVATION NO.-17

Impact of the acid mist on the plant and environment:

These acid particles can corrode blowers, ductwork and heat exchangers, damage catalyst and cause atmospheric pollution.

Importance of Mist Removal in Critical Absorption Tower			
Safeguard	**Drying Tower**	**Intermediate Absorption Tower**	**Final Absorption Tower**
Prevents corrosion to heat exchange and economizer tubes; and avoids catastrophic and expensive damages to the downstream equipment.	✓	✓	N/A
Prevent instrumentation corrosion.	✓	✓	✓
Protects catalyst (Vn_2O_5) from Sulfuric acid poisoning.	✓	✓	N/A
Meets environmental stack emission regulations.	✓	✓	✓
Type of mist eliminator	Mesh pad	Candle filter	Candle filter

Mist Eliminators Selection Guide (Metallurgical Sulphuric Acid Plant):

The droplets produced by sulfuric acid plant operations are quite small.

Unit Operation	Mist Load (mg/m³)	Mist Mean Size	Mesh Pad	Impaction Candle Filters	Brownian Diffusion Candle Filters
Drying Tower	175 to 3,530	~ 2.5µm	✓	✓	
Interpass Absorption Tower (IAT)	500 to 700	~ 1.5µm		✓	✓
Final Absorption Tower (FAT)	500 to 700	~ 1 µm			✓

Collection Efficiency for the different mist eliminators:

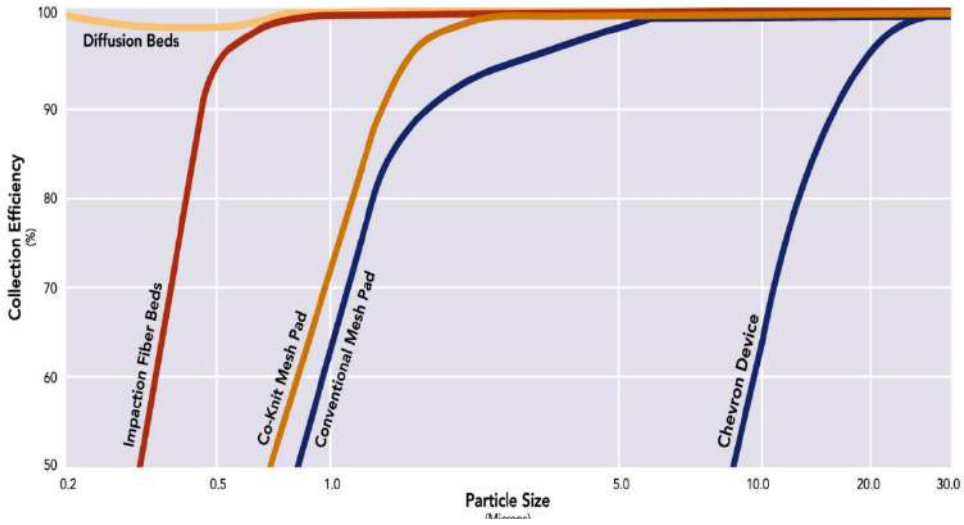

FIGURE-2:
COLLECTION EFFICIENCY FOR THE DIFFERENT MIST ELIMINATORS

EAC OBSERVATION NO.-17

In the sulfuric acid industry, for the drying tower, generally use co– knit mesh pads as they have an efficiency of almost 100% at ~ 3 µm for capturing, collecting and returning acid mist in the tower.

Whereas, in the Interpass and final absorption tower, generally use Impaction beds & Diffusion beds Mist Eliminators: 100% efficiency at > 1 µm and Diffusion beds: 99.95 % efficiency at < 1 µm

Mesh Pad for the Drying Tower:

Fine mist, created by mechanical shearing forces through tower packing, can pass through conventional mesh pads and cause downstream corrosion of valuable equipment. This above configuration mesh pads capture, collect and return the acid mist to the tower. This mesh pad made with co-knit fibers provide larger surface areas for the capture of slower and smaller droplets.

FIGURE-3:
CO KNIT MESH PAD

The Fiber Bed Candle Mist Eliminator for Interpass and final absorption tower:

1. **Standing Type**
2. **Hanging Type**

EAC OBSERVATION NO.-17

Standing Type:

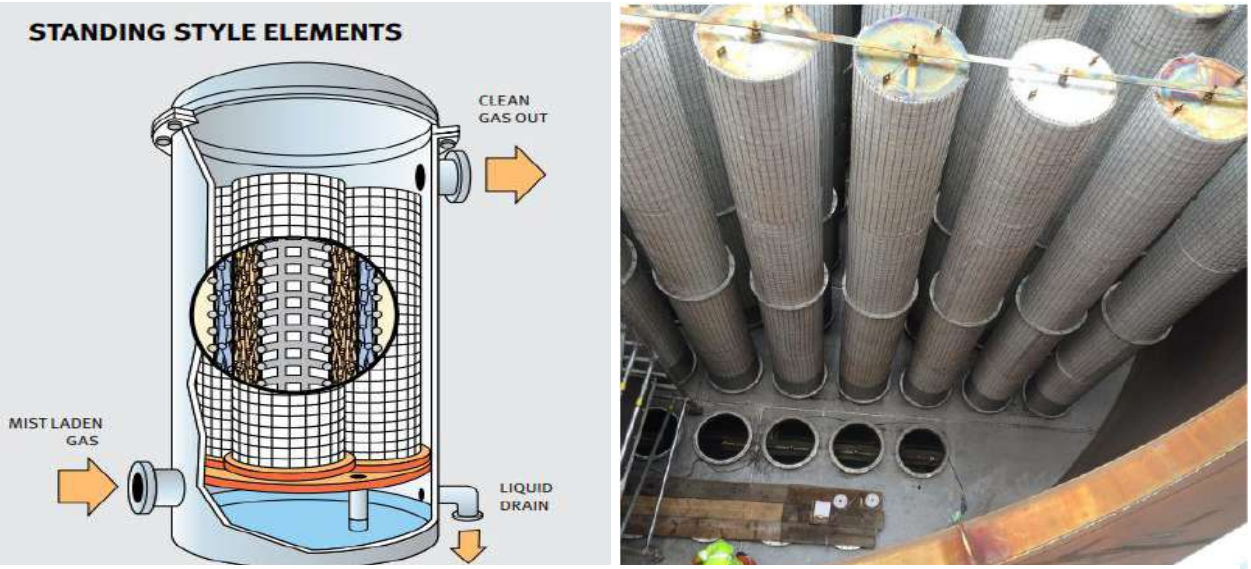

FIGURE-3:
STANDING TYPE CANDLE MIST ELIMINATORS

Reverse Flow, stand vertically on the tube sheet/vessel division plate. In this style, the dirty gas goes into the center core of the element and the clean gas exits through the outside. Acid mist Captured, collected and returned in the tower.

Hanging Type (With Seal Leg):

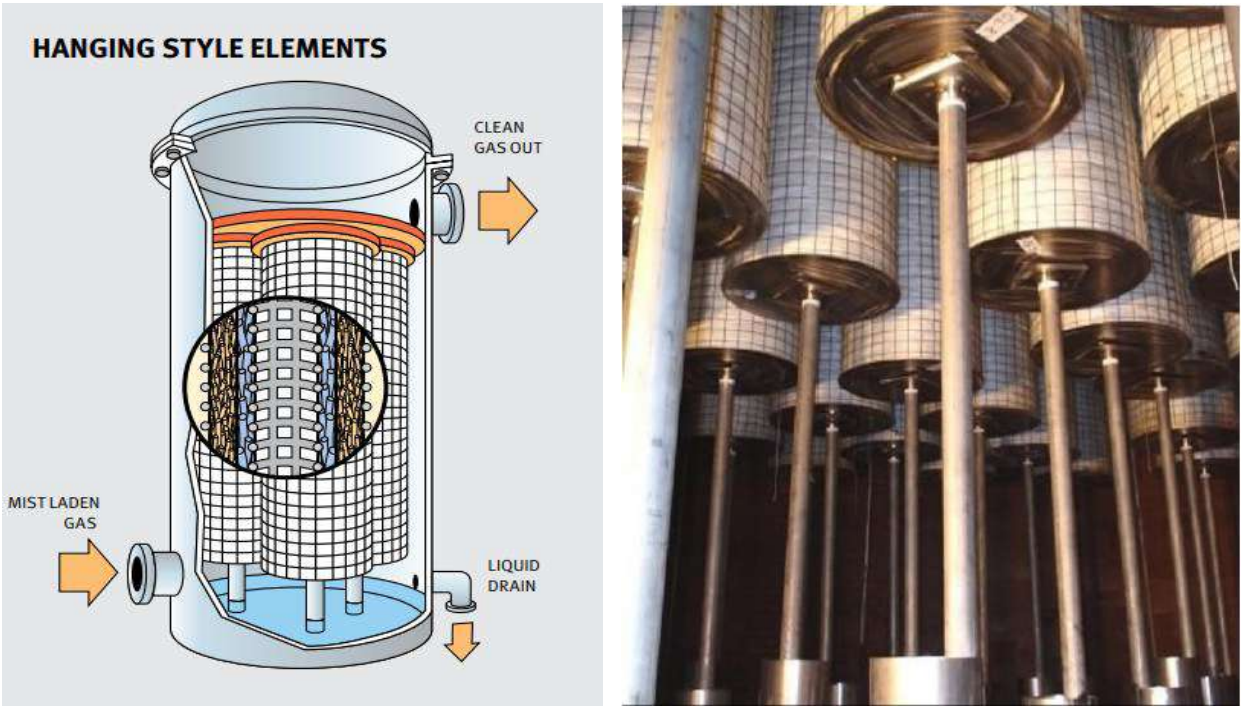

FIGURE-4:
HANGING TYPE CANDLE MIST ELIMINATORS

EAC OBSERVATION NO.-17

Forward Flow, hang from the tube sheet/vessel division plate and is configuration features ease of installation and maintenance. In this style, the dirty gas goes in the outside of the element and the clean gas exits through the center core. Acid mist Captured, collected and returned in the tower. Acid mist Captured, collected and returned in the tower.

Conclusion:

In the proposed sulfuric acid plant, for the removal of sulfuric acid mists, we will provide suitable acid mist eliminators as advised technology supplier, such as a mesh pad for the drying tower and the candle type mist eliminator for the Interpass absorption tower (IAT) and for the final absorption tower (FAT). The emission of acid mist **through the stack will be less than 25 mg/Nm^3, which is well within the limit stipulated as per CPCB.**

EAC OBSERVATION NO.-18

EAC OBSERVATION:

Provide details of interlocking system envisaged for copper smelter and Sulphuric acid

REPLY:

Procedures to Control SO_2 emissions:

a. Start Up:

To control SO_2 emissions during startup or following a shutdown during which converter bed temperatures have fallen below catalyst auto-ignition temperature, the converter beds need to be heated before the Smelter Off-Gases can be fed to Acid Plant, using Preheater.

The converter heat exchanger and preheater valves are set for converter preheating with gas circulating through the preheater to the converter heat exchangers. The valves are set to uniformly heat all five converter beds to catalyst ignition temperature and to minimize startup SO_2 emissions.

Continue preheating until all the bed temperatures are as near to 400°C as possible. The 1st, 4th, and 5th pass inlet temperatures should be over 390°C, while the 2^{nd} and 3^{rd} pass inlet temperatures should be at least 400°C as a minimum before accepting off gases from the smelter. After converter preheating is complete, prepare for normal operation on SO_2 feed gas from the furnaces.

The acid plant should be started at a reduced rate with the smelter furnaces at about 50% turndown. Starting the plant at the reduced rate will allow the following:

- Provide time for the middle converter passes to gain additional heat prior to reaching full gas flow (full load), which should limit any fugitive SO_2 emissions due to low catalyst temperature.
- Allow the plant time to stabilize.

The final Interlocks will be decided during overall HAZOP of the plant (Smelter + Acid Plant) as the operating conditions of Smelter and Sulphuric Acid plant need to be looked into before deciding on the interlocks. Process technology licensers will advice necessary interlocks to operate the plant within the prescribed environmental limits for SO_2 emission.

Following preliminary interlocks will be put in place to avoid SO_2 emission to remain within the statutory norms:

a) Smelter ID Fan and PS Converter ID Fan will be enabled to start only after satisfying conditions of the bed temperatures as mentioned above.
b) Smelter feed start enabling only after satisfying process interlocks as defined by the process licensors of Smelter and Sulphuric acid Plant.

b. Normal Plant Operations:

During Normal Plant Operations, surge in SO_2 emissions can occur. This can be controlled by adopting following measures;

i. **Low SO_2 Strength:** This can lead to Poor converter reaction and Loss of temperature control to converter passes. Possible causes can be Poor smelter operation Or excessive Dilution air due to controller malfunction.

Remedies:

- Increase SO_2 concentration from smelter, If possible.
- Check dilution air controller function.
- If converter continues to cool, supply supplemental heat from preheater if possible.

Interlocking Arrangements:

a) Roll out PS Converter operation and disable PS Converter ID fan after evacuating gases in the ducts connected to sulphuric acid plant, as per standard operating procedures provided by process technology Licensor.

ii. **High SO_2 Strength:** This can lead to Poor converter reaction and High Stack Emissions. Possible causes can be Poor smelter operation Or less Dilution air due to controller malfunction.

Remedies:

- Decrease SO_2 concentration from smelter by reducing Oxygen enrichment.
- Check air filter.
- Check instrumentation and controller functions.

Interlocking Arrangements:

a) Roll out PS Converter operation and disable PS Converter ID fan after evacuating gases in the ducts connected to sulphuric acid plant, as per standard operating procedures provided by process technology Licensor.
b) Reduction in concentrate feed to smelter by 20% and observe for 30 minutes.
c) If no improvement post item b); further reduction in concentrate feed to smelter by 20% and observe for 30 minutes.
d) If no improvement post item c); suspension of the concentrate feed to smelting furnace as per standard operating procedures provided by process technology Licensor.

iii. **Poor Converter Reaction**: This can lead to inadequate Temperature rise in converter and high stack emissions possible causes can be High or Low SO_2 strength, Low Converter pass Inlet temperatures.

Remedies:

- Confirm gas strength by analytical methods.
- Correct operating conditions so that $\%SO_2$ and $\%O_2$ are within specs.
- Preheat converter in start-up to 400°C for 2^{nd} & 3^{rd} passes and for 1^{st}, 4^{th} & 5th pass inlet temperatures should be over 390°C

Interlocking Arrangements:

a) Roll out PS Converter operation and disable PS Converter ID fan after evacuating gases in the ducts connected to sulphuric acid plant, as per standard operating procedures provided by process technology Licensor.
b) Reduction in concentrate feed to smelter by 20% and observe for 30 minutes.
c) If no improvement post item b); further reduction in concentrate feed to smelter by 20% and observe for 30 additional minutes.
d) If no improvement post item c); suspension of the concentrate feed to smelting furnace as per standard operating procedures provided by process technology Licensor.

EAC OBSERVATION NO.-19

EAC OBSERVATION:

Define the precaution to be taken during construction stage

REPLY:

- All infrastructure facilities such as sanitation, fuel, restroom, drinking water, domestic toilets and shelters sheds etc. will be provided to the labour force during construction.
- Use of firewood for cooking and also open air burning of any kind of wastes will be avoided.
- Awareness camp will be organized for diseases and cleanliness.
- Harm to the local species strictly prohibited.
- Safety training will be provided for workers and mock drill will be conducted.
- Proper maintenance of vehicles, equipment and machines is carried out to reduce noise pollution
- Enforce deployment of good condition vehicles with speed restrictions inside the project boundary
- Deploy mobile water tankers to moist the vehicle movement paths to suppress dust
- Provision of earmuff to the worker in high noise area and enforcement of required PPE.

Proposed mitigation measures to be implemented during construction phase:

1) Water sprinkling in vulnerable areas.
2) Proper maintenance of vehicles & construction equipment.
3) Transportation of construction material in covered trucks, wherever possible.
4) Proper maintenance of vehicles, equipment and machinery.
5) Provision of accoustic covers/ enclosures on equipment and machinery, wherever possible.
6) Provision of earmuffs/ earplugs to the workers in high noise areas and enforcement of its use.
7) Channelization and construction of temporary sedimentation tanks for effluents from construction area through network of drains.
8) Provision of environmentally safe camping area for the migrant laborers.
9) Arrangements for water supply and sanitation.
10) Disposal of surplus earth and construction debris.
11) Reclaiming of un-built area with appropriate vegetation/ land scaping.

Environmental monitoring during project construction phase:

a) Air Emissions:

- All equipments are operated within specified design parameters
- Vehicle trips to be optimized to the extent possible
- Maintenance of DG set emissions to meet stipulated standards
- Ambient air quality within the premises of the proposed unit to be monitored

b) Noise:

- List of all noise generating machinery onsite along with age to be prepared.
- Equipment to be maintained in good working order.
- Night working is to be minimized.

EAC OBSERVATION NO.-19

- Noise to be monitored in ambient air within the plant premises.
- No untreated discharge to be made to surface water, groundwater or soil.

c) Soil Erosion:

- Protect topsoil stockpile where possible at edge of site.
- Implement waste management plan that identifies and characterizes every waste arising associated with proposed activities and which identifies the procedures for collection, handling & disposal of each waste arising.
- Re-vegetation as per Forest guidelines

d) Drainage & Wastewater Management:

- Ensure drainage system and specific design measures are working effectively.
- The design to incorporate existing drainage pattern and avoid disturbing the same

EAC OBSERVATION NO.-19

PROPOSED MITIGATION MEASURES TO BE IMPLEMENTED DURING CONSTRUCTION PHASE

Sr. No.	Proposed Mitigation Measures	Responsibility for Implementation	Targets to Achieve	Risks and Consequence of Failure, if any
1	**Air Pollution Control**			
	Water sprinkling in vulnerable areas	AEL + Contractor	Control of fugitive dust from construction areas	Increase in PM emissions
	Proper maintenance of vehicles & construction equipment	AEL + Contractor	Control of CO & NOx emissions	Increase in gaseous pollutant
	Transportation of construction material in covered trucks, wherever possible	AEL + Contractor	Control of fugitive dust during transportation	Increase in PM emissions
2	**Noise Pollution Control**			
	Proper maintenance of vehicles, equipment and machinery	AEL + Contractor	Control of ambient and site noise levels	Increase in noise levels
	Provision of accoustic covers/ enclosures on equipment and machinery, wherever possible	AEL + Contractor	Control of ambient and site noise levels	Increase in noise levels
	Provision of earmuffs/ earplugs to the workers in high noise areas and enforcement of its use	AEL + Contractor	Protection of workers	Health effects on individual workers
3	**Water Pollution Control**			
	Channelization and construction of temporary sedimentation tanks for effluents from construction area through network of drains.	AEL + Contractor	Control of suspended solids and oil & grease in effluents from construction area	Increase in total suspended solids and oil & grease in effluents
4	**Socio-Economic Environment**			
	Provision of environmentally safe camping area for the migrant laborers	AEL + Contractor	To provide clean & healthy living environment to work force	Unhealthy living conditions, spread of diseases
	Arrangements for water supply and sanitation	Contractor	To reduce stress on surrounding population	Stress on existing utilities, conflicts with local people
5	**Solid Waste Management**			
	Disposal of surplus earth and construction debris	Contractor + AEL	Control of pollution	Air/ water pollution
	Reclaiming of un-built area with appropriate vegetation/ land scaping	AEL	Create a good visual environment. Aesthetics improvement.	Unpleasant surroundings

EAC OBSERVATION NO.-19

ENVIRONMENTAL MONITORING DURING PROJECT CONSTRUCTION PHASE

Sr. No.	Potential Impact	Action to be Followed	Parameters for Monitoring	Frequency of Monitoring
1	Air Emissions	All equipments are operated within specified design parameters	Random checks of equipment logs/ manuals	Periodic
		Vehicle trips to be optimized to the extent possible	Vehicle logs	Periodic during site clearance & construction activities
		Maintenance of DG set emissions to meet stipulated standards	Gaseous emissions (SO_2, HC, CO, NOx)	Periodic emission monitoring
		Ambient air quality within the premises of the proposed unit to be monitored	The ambient air quality shall conform to the standards for PM_{10}, $PM_{2.5}$, SO_2, NO_x, and CO	As per CPCB / GPCB requirement or on monthly basis whichever is earlier
2	Noise	List of all noise generating machinery onsite along with age to be prepared. Equipment to be maintained in good working order.	Equipment logs, noise reading	Regular during construction activities
		Night working is to be minimized.	Working hour records	Daily records
		Generation of vehicular noise.	Maintenance of records of vehicles	Daily records
		Noise to be monitored in ambient air within the plant premises.	Spot noise recording	As per CPCB/ GPCB requirement or on quarterly basis whichever is earlier.
3	Wastewater Discharge	No untreated discharge to be made to surface water, groundwater or soil.	No discharge hoses shall be in vicinity of watercourses.	Periodic during construction activities
4	Soil Erosion	Protect topsoil stockpile where possible at edge of site.	Effective cover in place.	Periodic during construction activities
5	Drainage and wastewater Management	Ensure drainage system and specific design measures are working effectively. The design to incorporate existing drainage pattern and avoid disturbing the same.	Visual inspection of drainage and records thereof	Periodic during construction activities
6	Waste Management	Implement waste management plan that identifies and characterizes every waste arising associated with proposed activities and which identifies the procedures for collection, handling &	Comprehensive Waste Management Plan should be in place and available for inspection on-site. Compliance with MSW Rules, 2016 and Hazardous Wastes	Periodic check during construction activities

EAC OBSERVATION NO.-19

Sr. No.	Potential Impact	Action to be Followed	Parameters for Monitoring	Frequency of Monitoring
		disposal of each waste arising.	(Management, Handling and Transboundary Movement) Rules, 2016	
7	Health	Employees and migrant labour health check ups	All relevant parameters including HIV	Regular check ups
8	Loss of flora and fauna	Re-vegetation as per Forest guidelines	No. of plants, species	During site clearance