ऑयल इंडिया लिमिटेड
(भारत सरकार का उद्यम)
Oil India Limited
(A Government of India Enterprise)

Safety & Environment Department
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Ref. No. S&E/E/111/1734

Date: 04.01.2020

Member Secretary
Ministry of Environment, Forest & Climate Change
Jor Bag Road, New Delhi-110003

Sub: Submission of additional documents sought vide ADS dated 29.11.2020 against the Proposal **No. IA/AS/IND2/72322/2018.**

Sir,

Reference to above subject, we are submitting herewith the following documents for your kind perusal please:

S.No	Points	Annexure Details
1	Details of court cases along with current status.	There is No court case against the instant proposal/study area under reference. However, the details of court cases and enquiries in view of Baghjan Well No.#5 Blowout incident along with current status is enclosed as **Annexure-1 for reference.**
2	Detailed safety and Emergency contingency plan.	Detailed Safety & Emergency contingency plan is enclosed as **Annexure-2.**
3	Status of recommendations from the Standing Committee of NBWL.	NBWL clearance proposal No. FP/AS/MIN/5492/2020. Proposal is under process. OIL shall drill only after obtaining the NBWL clearance or finalization of ESZ of Bherjan-Borajan-Padumoni (BBP) WLS, whichever is earlier.
4	Details on the assessment of Biodiversity of the area, as suggested by the Hon'ble Supreme court of India.	The Biodiversity study has no relation with the proposed Oil & Gas operation in Khagorijan EC block. The Biodiversity study suggested by the Hon'ble Supreme Court of India is for drilling of ERD wells beneath the Dibru-Saikhowa National Park (DSNP) which are yet to be started. OIL is in the process of conducting the required Bio-diversity study through Assam Bio-diversity Board as per the order of the Supreme Court.

5	Soil and ground water quality assessment to understand the impact of drilling activities in the region, if any.	Soil and ground water quality assessment report is enclosed as **Annexure-3**
6	Details of impact of Baghjan blow out in the study area.	Impact in terms of deposition of condensate on vegetation and soil, visible damage due to fire, damage to vegetation etc. were not observed in the Khagorijan Block (study area) because of Baghjan Well#5 Blowout. However, OIL has engaged a NABET accredited consultant to carry out Environment Impact Assessment study of Baghjan area that may arise because of Baghjan Well#5. The scope of this study would be to assess the probable impact on the surroundings based on site observations, environmental parameter monitoring and stakeholder consultations. It is assumed that this study would result in the identification of potential environmental impacts, ecological and community health related issues and recommend remedial/ mitigation measures. The study is under progress and will be completed very soon. The preliminary report is enclosed as **Annexure-4**
7	Damage assessment of the blow out, action plan for remediation.	OIL has engaged a NABET accredited consultant to carry out Environment Impact Assessment study of Baghjan area that may arise because of Baghjan Well#5. The study is under progress and will be completed very soon

Thanking You,

Yours Faithfully,
OIL INDIA LIMITED

(Suranjan Majumder)
Chief General Manager (HSE)
For Resident Chief Executive
OIL INDIA LIMITED

Nodal Officer (EC/FC/NBWL)
OIL INDIA LIMITED

Annexure-1

Details of Court Cases with Current Status

There is no Court case against the instant proposal/study area under reference.

However, the details of Committee's constituted by the various Authorities and Court cases filed in connection to Baghjan Well#5 Blowout is given below for reference:

1.0 Consequent upon incident of blowout incident that taken place on 27.05.2020 and subsequent fire, various Govt Authorities have constituted following committees to enquire into the cause of the Blowout. The details of committees are enumerated below:

i. One Person Enquiry Committee headed by the Addl Chief Secretary, Govt of Assam

ii. Three member High Level Expert Committee constituted by the Ministry of Petroleum and Natural Gas, Govt of India, comprising of Director General Hydrocarbon, Govt of India, Former Chairman ONGC and Former Director, ONGC.

iii. Four member expert committee constituted by the Directorate of Geology and Mining, Govt of Assam vide

iv. One member Expert Committee headed by the Addl PCCF(WL&CWLW) constituted by Environment & Forest Department, Govt. of Assam

v. Two member expert Committee constituted by the Oil Industry Safety Directorate (OISD) under the MoPNG, Govt of India.

vi. Enquiry conducted by the Directorate General of Mines Safety (DGMS), Govt of India under the Mines Act, 1952.

2.0 Subsequently, number of Court cases, have been filed including NGT seeking various reliefs from the Court. Details of the Court cases are as under:

Sl No	**Case No. & Parties**	**Court/ Tribunal**	**Fact and Relief Sought**	**Current Status**
1	PIL No. 35/2020, **Mrinmoy Khataniar** Vs. The Union of India and 13 Ors	Hon'ble Gauhati High Court	The Petitioners have filed the Public Interest Litigation of the environmental clearance dated 11.05.2020 granted to OIL by Union Ministry	As directed by Court, OIL has filed Addl. Affidavit. The Court has fixed the matter on 28.01.2021.

Sl No	Case No. & Parties	Court/ Tribunal	Fact and Relief Sought	Current Status
			of Environment, Forest and Climate Change for Extension Drilling and testing of Hydrocarbons at 7 (seven) locations under the Dibru-Saikhowa National Park.	
2	PIL No. 39/2020, **Gautam Uzir** Vs The Union of India and 5 Ors	Hon'ble Gauhati High Court	The Public Interest Litigation has been filed by one Senior Advocate of Gauhati High Court as Petitioner-in-Person.	The Court has fixed the matter on 05.02.2021.
3	O.A. no. 43/2020/EZ ,**Bonani Kakkar** Vs OIL & Ors	Hon'ble National Green Tribunal, Kolkata (Eastern Zone Bench)	An application has been filed before the Hon'ble NGT by an environmentalist i.e. Bonani Kakkar.	The Tribunal has deferred the hearing as the committee could not submit the final Report and fixed the next dated for hearing on 12.01.2021.
4	O.A. No. 44/2020/EZ ,**Wildlife and Environment Conservation Organisation** Vs. Union of India &Ors	Hon'ble National Green Tribunal, Kolkata (Eastern Zone Bench)	An application has been filed before the Honble NGT by a Non-Governmental Organisation (NGO). i.e. Wildlife & Environment Conservation Organisation against the OIL.	The Tribunal has deferred the hearing as the committee could not submit the final Report and fixed the next dated for hearing on 12.01.2021.
5	O.A. no. 41/2020/EZ, **Sayyan Banerjee** Vs. OIL &Ors	Hon'ble National Green Tribunal, Kolkata (Eastern Zone Bench)	An Application has been filed before the Hon'ble NGT by Sri Sayyan Banerjee pertaining to blowout at the Baghjan Oil Well no. 5.	The case is now listed on 12.01.2021. (Case tagged along with O.A. No. 43/2020/EZ, O.A. No. 44/2020/EZ, O.A. 50/2020/EZ)
6	O.A. 50/2020/EZ, **SoneswarNarah**	Hon'ble National Green	An Application has been filed before the Hon'ble NGT by	The case is now listed on 12.01.2021. (Case tagged along with

Sl No	Case No. & Parties	Court/ Tribunal	Fact and Relief Sought	Current Status
	& Ors vs. OIL &Ors	Tribunal, Kolkata (Eastern Zone Bench)	Soneswar Narah and others pertaining to blowout at the Baghjan Oil Well no. 5.	O.A. No. 41/2020/EZ, O.A. No. 43/2020/EZ, O.A. No. 44/2020/EZ)
7	Appeal No. 04/2020/EZ,(I.A. No. 34/2020) **Bimal Gogoi** & Anr. Vs. Union of India & Ors.	Hon'ble National Green Tribunal, Kolkata (Eastern Zone Bench)	An Appeal has been filed by the Appellant i.e. Sri Bimal Gogoi before the Hon'ble NGT to challenge the Environmental Clearance (EC) dated 11.05.2020 granted by Ministry of Environment, Forest & Climate Change in favour of OIL for drilling seven wells for Hydrocarbon exploration under the Dibru-Saikhowa National Park.	Court has fixed the next dated for hearing on 02.02.2021.
8	W.P. no. (Civil) 835/2020, **Rituraj Phukan** Vs. Union of India & ors.	Hon'ble Supreme Court of India	PIL was filed before the Hon'ble Supreme Court by the Petitioner i.e. Rituraj Phukan	The Hon'ble Supreme Court *vide* its order dated 16.09.2020 issued notice and tag this Writ Petition with W.P. (Civil) no. 625/2020.

5.0 It is pertinent to mention that the Hon'ble HC in PIL No. 39/2020 (Gautam Uzir) has directed the Committee constituted by Govt of Assam and MoPNG as well as OIL India Ltd. to submit their respective reports before the Court in sealed cover as the Court was of the opinion that the findings of these Committee's may be overlapping. Nevertheless, OIL shall implement recommendations of the Committee's unless recommendations are overlapping or contradictory.

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Annexure-2

Safety & Emergency Contingency Plan

Detailed Safety & Emergency contingency plan for the proposed project has been elaborately described in the EIA Report already been submitted vide EC application.

The Safety and Emergency Contingency pertaining to Baghjan well# 5 well blow out is as per followings:

1. **Standard Operating Procedures**: Oil India has been following Good Petroleum Industry Practices and has Standard Operating Procedures for its activities with respect to all operations directly or indirectly related to Drilling, Workover, Production of oil & gas including maintenance, Logging or any other related services. The Blowout incident at well Baghjan-5 has necessitated a review of the existing SOPs and also add relevant ones for further improvement and operational excellence. The Standard Operating Procedures (SOPs) for various activities in the oil & gas installations as well as for other service departments in Oil India Limited have been reviewed (over 1000 activities). All SOPs will be reviewed after every 2 years. However, in case of change or upgradation in equipment / system or adoption of any new system, the relevant SOP will be reviewed / added as and when required.

   A programme will also be implemented for periodic visits of various levels of senior officials to different work centres with proper checklists so that these points are checked during each visit and proper records of such visits are maintained for periodic review by the HoDs, Group Heads, RCE and concerned Directors.

2. **Structural change**: OIL had earlier shifted to an asset based structure for the Main Producing Area under Fields Headquarter with an objective of increasing production through focussed attention to the matured acreages covered by the Mining Leases in Assam and Arunachal Pradesh. The Asset based structure has proved to be effective and the G&R teams have now been reorganised in alignment with the Assets to provide focused support. However, it is perceived that there is scope for improvement in the structure especially in areas of drilling and workover operations. The present processes seem to lead to a blurred state of responsibilities and a lack of single point control. Thus the current system requires a complete overhaul and the systems, processes and reporting hierarchy require an immediate change.

   With the above in view certain structural changes are being brought in the following areas.

A. Work flow for custody transfer of well in different phases of its lifecycle.
B. Restructuring of Organogram for Workover activities in Main Producing Area (MPA)

Under the above initiative, WO Section, which is currently a part of Drilling Services and reports to Director (E&D) will be brought under Director (Operations) along with the rig resources, allied services and personnel on 'as is where is basis'. This will ensure more job focus and single point responsibility in work-over operations.

3. **Mines Structure:** The above will also necessitate restructuring of the Mines Structure. Accordingly actions will be taken to reassign Mines Owner, Mines Agent, Deemed Agent, Mines Manager etc., in line with the new operational structure at Fields Headquarter.
4. **CMT Department:** Oil India currently has a CMT Department. However, in effect this department has not been empowered in its true sense. The department will now be strengthened with adequate numbers of engineers and staff. All CMT persons will be trained up in relevant areas (IWCF/ IADC etc.) and will also be engaged in routine maintenance activities of heavy duty equipment. Frequency of mock drills will be increased to keep the members in full readiness at all times.
5. **Safety Audits**: Presently OIL has a robust system of safety audits with following audits carried out in every Drilling / Workover location:

   i. Pre- Spud audits in Drilling Rigs before starting the operation.
   ii. Pre-Workover audits in Workover Rigs before starting the operation.
   iii. Surprise Safety audit during Drilling & Workover operations
   iv. Multidisciplinary Audit in all operating drilling rigs and workover rigs annually during Internal Safety Week observance.

   However, with the experience of Baghjan-5, the audit systems will be reviewed and more stringent audits will be introduced as per OISD guide lines.

After the incident following committees / agencies are engaged.

- Three members High Level Committee headed by DG, Directorate General of Hydrocarbon constituted by MoPNG Govt. of India
- Committee Constituted by Oil Industry Safety Directorate
- Director General of Mines Safety Ministry of Labour and Employment Govt. of India
- One Person Enquiry Committee headed by Addl. Chief Secretary constituted by Governor of Assam
- One man enquiry committee headed by APCCF constituted by Department of Environment of Forest, Govt. of Assam.
- Committee constituted by Directorate of Geology and Mining Govt. of Assam.
- Committee of Experts headed by Hon'ble Justice B P Katakey as Chairman constituted by Hon'ble National Green Tribunal Principal Bench New Delhi.
- OIL's two nos. of internal committees constituted by Resident Chief Executive one for "blowout" and another for "fire after blowout",

OIL has started implementing the actions suggested by these agencies for prevention of recurrence of such incidents in future.

We would like to inform you that, Oil India Limited has a Crisis Management Team in place with newly procured equipment to handle such kind of eventuality. But considering the nature and the extent of the blowout situation in Baghjan 05, OIL sought help/assistance from ONGCL for controlling the blowout. Subsequent to Baghjan incident and as suggested by you, OIL has decided for enhancing the capabilities of its own Crisis Management Team (CMT) and actions have already been initiated to procure all the equipment generally used in controlling a Blowout situation. Moreover, process has been started to augment the technical manpower and other infrastructure of in-house CMT so that in future, OIL's dependability on others in terms of equipment and technical manpower can be reduced. It is expected that the OIL's CMT will be self-sufficient to handle such situations within a very short time. But for special equipment and expertise, mutual collaboration with other E&P companies like ONGCL in India or service of domain experts is always necessary for combating such situation depending upon the magnitude and criticality of occurrence.

Following different agencies are involved for carrying out various assessment and studies.

- M/s ERM India Pvt. Limited.: For Environmental Impact Assessment study
- The Energy Research Institute (TERI) : For Air and Noise quality monitoring
- Assam Agricultural University: For assessment of impact on crops & tea garden etc.
- CSIR- North East Institute of Science and Technology : For Geophysical studies
- IIT Guwahati : For Thermal mapping and sound frequency measurement.

State/Central Government agencies like Department of Environment and Forest, State Pollution Control Board and CPCB have carried out study and their suggestions/ directives put forward will be duly considered for implementation by OIL.

All precautionary measures are being taken to ensure health and wellbeing of the front line workers working in Baghjan Well No. 05. A team of doctors and paramedical staff with properly equipped ambulances are kept ready at site during the time of the work so that immediate medical assistance can be provided whenever needed. Periodic sanitization of the working area is being carried out to minimize health hazards.

Annexure-3

Soil and Ground Water Quality Assessment to Understand the Impact of Drilling Activities in the Region, if any

Groundwater Quality:

Dibrugarh District: As per the CGWB report (2013), groundwater in the district is fresh and safe, with TDS values ranging from 150 to 1000 ppm. Higher iron concentration compared to the IS:10500 standards in groundwater was reported in some part of the district especially near the Tengakhat area. Higher iron content is generally geogenic in nature. Iodine deficiency in the groundwater of the district had also been reported in some part of the district[1]. District National Rural Drinking Water Programme (NRDWP)-MIS report also suggested presence of high iron concentration in most parts of the district. The report also highlighted, presence of turbidity, hardness and pH in groundwater of some part of the district which exceeds IS 10500, 2012 Standards[2]. J. Borah (2011)[3] reported that pH of groundwater in some part of the district is acidic in nature with fluoride concentration within the acceptable limit of IS 10500, 2012. A.K. Singh (2004)[4] reported presence of high concentration (>50 ppb) of arsenic in groundwater for some parts of the district.

Tinsukia District*:* As per the CGWB report (2013), groundwater in the district is fresh and suitable for both domestic and irrigation purposes. Although, high iron concentration in groundwater was reported in some parts of the district. Higher iron content is generally geogenic in nature[5]. District NRDWP-MIS report also suggest presence high iron concentration in most part of the district. The report also highlighted, presence of turbidity, chloride, hardness, pH and residual chlorine in groundwater of some part of the district which exceeds IS 10500, 2012 standard[6]. A.K. Singh (2004) reported presence of high concentration (>50 ppb) of arsenic in groundwater for some part of the district[7].

Ground water Quality for Primary Data Analysis:

Groundwater quality analyses was conducted as part of the EIA study for the Khagorijan Block during post monsoon season of 2017. Concentrations of majority of the parameters analysed were within the acceptable limits of IS: 10500, 2012 standard. pH values of some groundwater samples were acidic and not in compliance with drinking water standard of IS 10500, 2012. Low pH values in groundwater also reported for Tinsukia and Dibrugarh districts as mentioned above. But compared to the secondary data iron, hardness, chloride and turbidity values of the samples were within the permissible limit of IS 10500: 2012. Arsenic and Fluoride concentrations of the samples were also within the acceptable limit of IS 10500: 2012.

Soil Quality:

Dibrugarh District: As per the CGWB report (2013), soils of the district are acidic in nature with sandy to clayey loam texture and grey in colour. The pH value of the soil ranges from 4.6 to 5.9 within the district. The soils were also characterized by low to medium phosphate and medium to high potash content. Based on pedogenic

1 http://cgwb.gov.in/District_Profile/Assam/DIBRUGARH.pdf
2 https://ejalshakti.gov.in/IMISReports/NRDWP_MIS_NationalRuralDrinkingWaterProgramme.html
3 J. Borah (2011), 'A Comparative Study of Groundwater with special reference to fluoride concentration in some parts of the Dibrugarh District, Assam, India', Advances in Applied Science Research, 2011, 2 (5): 318-322
4 A.K. Singh (2004), 'Arsenic Contamination in Groundwater of North Eastern India', Published in Proceedings of National seminar on Hydrology with focal theme on "Water Quality" held at National Institute of Hydrology, Roorkee during Nov 22-23, 2004.
5 http://cgwb.gov.in/District_Profile/Assam/Tinsukia.pdf
6 https://ejalshakti.gov.in/IMISReports/NRDWP_MIS_NationalRuralDrinkingWaterProgramme.html
7 A.K. Singh (2004), 'Arsenic Contamination in Groundwater of North Eastern India', Published in Proceedings of National seminar on Hydrology with focal theme on "Water Quality" held at National Institute of Hydrology, Roorkee during Nov 22-23, 2004.

and pedological characters, soils of this area may be classified into following classes a) Recent riverine alluvial soils (Antisol), b) Old riverine alluvial soils (Inceptisol) and c) Old mountain valley alluvial soils (Alfisol)[8].

Tinsukia District: As per the CGWB report (2013), soils in the district were classified into three broad categories depending upon the origin and occurrence. These are given below:

(a) Newer alluvial Soil: Flood plain areas of River Brahmaputra and the tributaries in the northern part are characterised by light grey clay with sand and silt. (b) Older alluvial Soil: It occurs mainly in the central part with limonite yellow to reddish yellow clay. (c) Soil cover in forest and hilly areas: It is deep reddish in colour and occurs over the older geological formation in the southern-most part of the district[9].As per the District Census Handbook for Tinsukia, soil in the district are reported to be acidic in nature. The pH values are found to be more acidic for older alluvium soil. The phosphoric content of the soil is found to be good for tea cultivation[10].

Soil Quality for Primary Data Analysis:

Soil quality analyses was conducted as part of the EIA study for the Khagorijan Block during post monsoon season of 2017. Soil samples were found to be clayey, sandy clay and clay loam in texture acidic in pH. Similar soil quality has already been reported in CGWB district wise reports for both Dibrugarh and Tinsukia districts. So, the acidic nature of the soil is due to geogenic condition of the area. Moreover, samples are collected from agricultural land (used primarily for paddy cultivation) and tea gardens where the pH value of the samples are generally acidic in nature. The infiltration capacity of the soil samples also suggest clay texture. The porosity of the soil samples are high due to the clay texture. Macronutrient contents viz. phosphorous and potassium values of the soil samples were found to be very less whereas nitrogen content of soils varied from less to better. The EC values of the samples are found to be below 1000 µs/cm. The Sodium Absorption Ratio (SAR) value of the soil samples also indicates absence sodicity hazard. Heavy metals such as copper, lead and zinc were present in soil samples but concentration are much below the soil remediation intervention values specified in Dutch Soil Remediation Circular (2013).

Impact of drilling on Soil and Groundwater Quality:

Various chemicals are used to prepare the drilling fluid, however, the main components include bentonite and barite. The pH of drilling mud is above 8. The drilling mud comes contact with the soil and groundwater during flushing activity and the impacts are limited to well site boundary only. Moreover, Water Based Mud (WBM) is used for drilling operation which is free from the heavy metals. The pH value of groundwater and the heavy metals (Hg and Cr^{+6}) found during study period is much below the detection limits, which indicates that the drilling activity in the area have no influence in the groundwater and soil quality of the area.

8 http://cgwb.gov.in/District_Profile/Assam/DIBRUGARH.pdf
9 http://cgwb.gov.in/District_Profile/Assam/Tinsukia.pdf
10 https://www.censusindia.gov.in/2011census/dchb/DCHB_A/18/1810_PART_A_DCHB_TINSUKIA.pdf

Further, casing is used during drilling to prevent wall-collapse within the well. Two diameter casing are used during drilling, one of the casing extent from surface to 20 mbgl and the other one is from surface to 180-200 mbgl. This casing further prevent interaction with the flushing fluid after its installation.

The other impact that may occur from drilling activity is from spillage of fuel, lubricants and chemicals from storage areas. Fuels, chemical lubricant etc., are stored at a designated paved area within drill site which resulted in less chances of groundwater and soil contamination unless any puncture occur in the liner system that can lead to the potential leakage of chemicals and has potential to contaminate soil and subsequently groundwater. Heavy metals and mineral oil concentration in the sampled groundwater were found to be below detection limit. Drilling activity of OIL is being carried out for more than 60 years in the area. Secondary data and primary soil and groundwater analyses did not indicate presence of such pollutants in groundwater and soil, which suggests that previous drilling activities in the area have not polluted the soil and groundwater.

Annexure-4

Details of Impact of Baghjan Blowout in the Study Area

Impact in terms of deposition of condensate on vegetation and soil, visible damage due to fire, damage to vegetation etc. were not observed in the Khagorijan Block (study area) because of Baghjan Well#5 Blowout.

However, OIL has engaged a NABET accredited consultant to carry out Environment Impact Assessment study of Baghjan area that may arise because of Baghjan Well#5. The scope of this study would be to assess the probable impact on the surroundings based on site observations, environmental parameter monitoring and stakeholder consultations. It is assumed that this study would result in the identification of potential environmental impacts, ecological and community health related issues and recommend remedial/ mitigation measures. The study is under progress and will be completed very soon. The preliminary report is per followings:

INTRODUCTION

The Baghjan Oil & Gas field of Oil India Limited (OIL) is located in Baghjan area of Doomdooma Circle of Tinsukia District in the State of Assam.

Within 1 km radius of Baghjan-5 (BGN-5) well, the Dibru-Saikhowa National Park (DSNP) & Biosphere Reserve, Maguri-Motapung Beel (MMB), an Important Bird Area (IBA) and the Dangori River are located. There are also number of tea estates, homestead tea garden and plantations in the settlement area.

The blowout of BGN-5 well occurred during on May 27, 2020 around 10.30 am; while workover operations were ongoing to produce gas from a new sand. The well caught fire on June 9, 2020 around 1.30 pm and continued till third week of November, 2020 when the well was successfully capped.

BLOWOUT EVENT AND RELEASE OF POLLUTANTS

Blowout- Pre fire stage

During the blowout- pre fire stage period, uncontrolled natural gas and condensate were released to the environment for 14 days (May 27, 2020-June 9, 2020). The velocity of released gas and condensate from the blowout was very high, so that the plume moved upwards for about 60-70m from the well-head. As condensates were produced along with natural gas from the reservoir and due to drop in pressure when it reached the surface, it condensed into a liquid phase and settled in and around the BGN-5 well.

Characteristics of Natural Gas

The principal component of natural gas is methane hydrocarbon (92.97%); other components include non-methane hydrocarbons (5.72%) comprising of ethane, propane, n-butane, i butane, n-pentane, i- pentane and hexane and non-hydrocarbon gases (1.31%) comprising of nitrogen and carbon dioxide.

The condensate consisted of alkanes (saturated hydrocarbons C_{13} to C_{30}).

Spread of Natural Gas & Condensate during Pre-fire stage

The dispersion of pollutants from BGN-5 was influenced by climatic conditions *viz.* wind speed & direction, rain, flooding & waterlogging in MMB. The predominant wind direction during the blowout period was from north-east. The spread of the condensate was more towards the south and south-west direction. It has been estimated that during this period the condensate had spread over an area of 3.15 km^2 comprising of tea gardens, homestead plantations, settlement areas and Maguri Motapung grassland areas. The condensate spread was more towards south and south-west direction due to the pre-dominant wind direction.

During this period, the MMB was flooded and grassland areas were in undated (27^{th} May to 5^{th} June, 2020). The condensate deposited over grassland area was carried into the MMB and was ultimately discharged into the Dangori River through the Dibru River.

Blowout-Jetfire stage

After the well caught fire, it was observed that huge quantity of un burnt hydrocarbon in the form of black smoke was released from the well during initial phase on 9^{th} June. The fire also spread into the condensate deposited areas of homestead tea garden and plantation areas of Baghjan Gaon & Maguri-Motapung grassland areas (MMGL). The spread of fire and affected area was determined through images available in the public domain and ground verification. Due to spread of fire, around 0.72 km^2 area was affected.

Combustion of Natural gas (NG) and Natural Gas Condensate (NGC) released air pollutants like CO, CO_2, NOx, Particulate matter (PM), Volatile Organic Carbons (VOC), Polynuclear Aromatic Hydrocarbons (PAH) and un burnt Hydrocarbons (HCs)etc. The gaseous pollutants were dispersed in the atmosphere, which was also governed by wind speed and direction. The PAH, PM and unburnt HC was deposited on land and surface water bodies due wet deposition process.

STUDY APPROACH & METHODOLOGY

Present status of environmental parameters

The Area of Influence (AOI) of the blowout event was determined based on spread of air pollutants through air quality screening exercise; extent of noise generated from BGN-5, effect of thermal radiation, extent of light and spread of condensate at land and surface water bodies. Considering all the above mentioned factors, AOI was considered for 5 km radius area around the BGN-5. Considering sensitive ecological habitats like Bherjan Borjan Podumoni Wildlife Sanctuary (BBPWLS) and DSNP which are located outside the 5 km radius area or extended beyond 5 km radius area of BGN-5, limited environmental monitoring and sensitivity based ecological survey also carried out within 5 km to 10 km buffer area of BGN-5.

The pre-blowout period conditions of the Baghjan area has been assessed from the previous EIA studies carried out by OIL for North Hapjan – Tinsukia-Dhola (NHTD) area and in the Khagorijan area. As part of the EIA studies baseline monitoring was carried out during October-December 2017.

Ambient Air Quality

Average concentrations of PM_{10} in the AOI ranged between 63.65-76.43 µg/m^3, the values are comparable with the pre-blowout values of 84.21-89.50 µg/m^3. The average concentration of $PM_{2.5}$ in the AOI ranged between 34.32 -41.40 µg/m^3 the values are comparable with the pre-blowout average values of 43.54-47.29 µg/m^3. Average concentrations of PM_{10} and $PM_{2.5}$ during the blowout period were within the NAAQS values of 100 µg/m^3 and 60 µg/m^3 respectively.

During the blowout period (jet fire stage) average concentrations of NO_2 (17.93-24.93 µg/m^3) and CO (0.43-0.69 mg/m^3) were found to be slightly higher than the pre-blowout period values forNO_2 (19.35-21.04 µg/m^3), CO (0.45-0.52 mg/m^3).

Average concentrations of methane HC (1.86-2.11 ppm) during blowout period were higher than average pre-blowout baseline values (0.86-1.08ppm). Average VOC concentration (<4.2-187.50 µg/m^3) recorded during the blow out period were also higher than the pre-blowout concentration (<4.2 µg/m^3 at all the monitoring locations).

Ambient air quality was also monitored in two locations in Baghjan Gaon during pre-fire stage. The Concentration of benzene varied from 7.92 µg/m^3 from 38.96 µg/m^3; the values were higher than the NAAQS limits for both the locations. The concentration of benzene during jet-fire stage were found to be below detection limits for all the stations, except for two locations.

Noise Quality

The noise levels recorded during pre-fire stage was about 100.4 dB(A) at a distance of 50 m from the BGN-5 and during jet fire stage was about 128 dB(A) at 1m distance from BGN-5.

<u>Blowout-Pre-fire stage</u>

Instantaneous noise monitoring was conducted at various locations in proximity to the site during 7th-9th June 2020. The distance wise measures noise level was as follows:

- 0.38 km to 0.49 km: 93.23 dB(A) and 91.12 dB(A)
- 0.63 km to 1.0 km: 84.8 dB(A) and 76.64 dB(A)
- 4.3 km to 5.9 km: 69.07 dB(A) and 57.56 dB(A

<u>Blowout-Jet fire stage</u>

During jet fire stage 24 hourly noise was monitored at 8 locations and instantaneous noise levels were monitored in 33 locations.

The 24 hourly noise monitoring results at 8 stations indicated that the Leq day maximum noise levels at the residential areas ranged between 63.1 –

90.5 dB(A) and Leq night maximum levels varied from 61.6-91.2 dB(A). Leq day maximum and Leq night maximum noise levels were found to be exceeding the daytime and night noise limits as per the Noise Rules, 2000 for residential areas. Leq day minimum noise levels ranged between 54.7 – 84.7 dB (A) and Leq night minimum noise levels varied from 48.9-85.1 dB(A). Leq day and night minimum noise levels at almost all stations were found to be exceeding the noise limits as per the Noise Rules, 2000 for residential areas.

This instantaneous noise monitoring was conducted to understand the distance wise noise levels and noise levels in the sensitive ecological areas within the AOI. The instantaneous noise monitoring results are presented in the table below:

Radial distance from BGN-5 well	**Minimum noise level**	**Maximum noise level**
0.5 km radius	78.7 dB(A)	103.22 dB(A)
0.5 km to 1.0 km	76.64 dB(A)	84.8 dB(A)
1.0 km to 1.5 km	80.59 dB(A)	91.94 dB(A)
1.5 km to 2.0 km	56.15 dB(A)	64.05 dB(A)
2.0 km to 3.0 km	60.11 dB(A)	71.16 dB(A)
3.0 km to 3.5 km	48.38 dB(A)	49.61 dB(A)
3.5 km to 4.5 km	49.7 dB(A)	57.56 dB(A)
4.5 km to 6.5 km	47.22 dB(A)	69.07 dB(A)
8.0 km	-	46.1dB(A)

Soil Quality

Soil samples were collected from 10 locations within the AOI during blowout period. The locations have been selected based on field observations (affected or potentially affected) and sensitive ecological area like MMGL ecosystem, DSNP. The results are presented below

TPH: Monitoring results showed that Total Petroleum Hydrocarbons (TPH) concentrations in MMGL area varied from 32 mg/kg –736 mg/kg. Very high TPH concentrations were recorded MMGL which is at downwind from the BGN-5 and also closest to ditch from the BGN-5 that received site runoffs. TPH concentration in DSNP soil varied from 17.73 mg/kg -40.73 mg/kg. TPH concentration in tea-estate soil varied from 16 mg/kg to 28.44 mg/kg. TPH concentration in homestead tea garden and agriculture land varied from 17 mg/kg to 53 mg/kg.

The TPH compounds N-Hexadecane ($C_{16}H_{34}$) and N-Heptadecane ($C_{17}H_{36}$) were higher than the Canadian Council of Ministers of the Environment

(CCME) standard (300 mg/kg), which was recorded in MMGL area. The other TPH compounds were within CCME standard[1].

Benzene Toluene Ethylbenzene and Xylene (BTEX): BTEX concentration in MMGL varied from 2.05 mg/kg-4.82 mg/kg. The concentration in DSNP soil varied from 1.19 mg/kg -5.8 mg/kg. The concentration in tea-estate soil varied from 3.09 mg/kg to 3.15 mg/kg. The concentration in homestead tea garden and agriculture land varies from 2.47 mg/kg to 14.02 mg/kg. The reported concentration of BTEX were higher than the CCME's standard.

PAH: The PAH was recorded in MMGL area and at Baghjan Gaon Homestead tea plantation area. The PAH concentrations varied from 0.02 mg/kg to 0.04 mg/kg. The PAH compounds like phenanthrene, pyrene, benz(a)anthracene, benzo(a)pyrene and dibenz(ah)anthracene were recorded in soil and all these compounds were within CCME's standard.

Ground water quality

Groundwater samples were collected from six monitoring locations within the AOI during the blowout period. The locations have been selected based on condensate deposition observed during field visit).

pH: pH of the groundwater samples varied from 5.57 to 6.92. pH values measured during this phase was not in compliance with IS 10500: 2012 drinking water standard for majority of the locations.

Total Dissolved Solids (TDS): TDS in ground water samples ranged between 50 mg/l to 128 mg/l. All the monitoring values were in compliance with the acceptable limit of IS: 10500, 2012 drinking water standard of 500 mg/l.

TPH: The concentration of TPH in groundwater samples ranged between 5.65 mg/l and 11.23 mg/l. There is no national or international recognized standard for TPH in drinking water.

BTEX and PAH: BTEX contents of all the samples were found to be less than 0.05 mg/l. PAH contents of all the samples were found to be less than 0.00001 mg/l.

Ground water quality of almost all the parameters were within the limits of IS:10500 standards.

Surface Water Quality

Blowout-Pre-fire stage

As part of reconnaissance survey monitoring of surface water was conducted during 7th - 9th June 2020 (before fire outbreak). Samples were collected from four locations from Dangori River i.e. near Baghjan Gaon (SW2) and near Guijan Ferry Ghat (SW4) and at Dibru River at the Junction of Dangori River (SW3) and one sample was collected at low lying area near MMB at Baghjan Gaon (SW1).

[1] There are no regulatory standards for soil quality in India. The internationally recognised assessment values for soil CCME's (Canadian Council of Ministers of the Environment) Screening levels Soil Quality Guidelines for the Protection of Environmental and Human Health has been referred.

pH: pH value of the samples ranged between 6.33-7.2. pH value of the sample collected from SW1 was found to be comparatively lower than the other samples.

DO: DO values of the samples collected from SW1 i.e. low lying area near MMB were found to be 3.6-4 mg/l while the other samples collected from Dangori River and Dibru River revealed DO values between 4.8-5.7 mg/l.

Oil & Grease & TPH: Very high oil & grease (160000 mg/l) and TPH contents (155090 mg/l) were recorded from SW1 sample for 7th June; whereas the oil & grease (390 mg/l) and TPH contents (357 mg/l) were much less for the samples collected on 8th June. This was primarily due to the flow of condensate contaminated water from the BGN-5 area towards the open water of MMB and then towards the Dangori River through Dibru River. Other samples revealed low oil & grease and TPH contents, <1.4-2.8 mg/l and 1.18-2.95 mg/l respectively for SW2; <1.4 mg/l and <1 mg/l respectively for SW3 and <1.4-8.4 mg/l and <1-6.1 mg/l respectively for SW4.

PAH: Comparatively high PAH concentrations were recorded for the samples collected from low lying area near MMB (0.67 and 0.69 mg/l respectively); while the other samples collected from Dangori River and Dibru River revealed PAH values varying between 0.16-0.34 mg/l.

Blowout-Jet-fire stage

Surface water quality samples were collected from 10 monitoring locations within the AOI. The frequency of monitoring was weekly once at each location. The locations were selected based on field observations (affected or potentially affected) and considering sensitive surface water bodies viz. MMB, Dibru River and Dangori River.

pH: The pH value of the samples collected varied between 6.06 to 7.46. Compared to the CPCB Class D criteria[2] (6.5-8.5) value slightly acidic pH values are recorded for the sample collected from the Junction of Dibru River and Dangori River and MMB.

Oil and Grease: Oil & grease was recorded only at the surface water sample collected from the low lying areas near MMB with levels varied from 1.4-120 mg/l. Oil & grease contents were found to be less than 1.4 mg/l for the other stations.

TPH: TPH contents were found to be less than 1 mg/l for all the samples excepting the low lying areas near MMB. The TPH concentration in week-1 was 100 mg/l, in week-2 5.5 mg/l and in week-3 11.19. TPH concentration were detected in all the samples during 3rd week. TPH concentration in samples varied from 3.44 to 11.19 mg/l.

PAH: PAH concentrations were recorded at low lying areas near MMB, MMGL area MMB area and at the Natun Gaon Bridge. PAH concentrations were not recorded (<0.00001 mg/l) from Dangori River samples and

[2] As per CPCB water use criteria pH values of 6.5-8.5 is required for propagation of wildlife and fisheries (Class D, water use criteria)

Junction of Dibru-Dangori River. Maximum values of few PAHs *viz.* Anthracene, Benz (a) anthracene and Benzo (a) pyrene were found to be higher than the CCME Guideline values for the Protection of Aquatic Life.

Free ammonia: Free ammonia concentrations for all the samples revealed values less than 0.1 mg/l except for the first week sample collected from low lying areas near MMB having values of 1.1 mg/l.

DO: The DO value of the samples collected for the first week varied between 4.5-6.1 mg/l, for the 2nd week varied between 5.0-6.1 mg/l and varied between 5.7-6.2 mg/l for the 3rd week. Compared to the Class D criteria value all the samples reveal DO values greater than 4.0 mg/l i.e. conforming to the Class D Criteria.

Sediment Quality

Sediment quality samples were collected from 10 monitoring locations within the AOI during study period. The locations has been selected based on field observations (affected or potentially affected) and sensitive ecological area like MMB, Dibru River and Dangori River.

PAH: PAH concentration was recorded in MMB sediment samples and the sample collected from near the Natun Gaon bridge and concentration varied from 0.05mg/kg - 0.08mg/kg. PAH compound like Phenanthrene, Pyrene, Chrysene, Benzo (a) pyrene and Indeno(1,2,3-cd) Pyrene recorded in the sediment samples were within CCME standard. PAH concentrations were not recorded from Dangori River sediment samples and also from the Junction of Dibru River &Dangori River.

BTEX: BTEX concentration in all the monitoring locations were found to be below detection limit of 0.2 mg/kg during entire tenure of monitoring.

TPH: TPH concentrations was recorded in the sediment samples collected from MMB, Dibru River and Dangori River. The concentration varied from 2.5 mg/kg to 56.49 mg/kg.

Organic carbon: The organic carbon of the sediment samples varied between 0.05% to 3.76%. Organic carbon percentage was higher in MMB than Dangori River and Dibru River.

Ecology & Biodiversity

BGN-5 well is located in “Himalaya Biodiversity Hot Spot” and “Assam Plains Endemic Bird Area”.

Terrestrial - Dibru Saikhowa National Park (DSNP), located less than 1 km from BGN-5. Apart from being an ecologically protected area, DSNP is globally recognised as “Important Bird Area”(IBA). “Maguri Motapung Beel”(MMB), another IBA is located adjacent south of BGN-5. MMB is a habitat complex of large freshwater waterbody and associated swamp, grassland, and agricultural field. Such wetland associated grassland is ideal habitat for Endangered species [IUCN v2020-2] Swamp Grass Babbler (*Houbaropsis bengalensis*) and other threatened grassland bird species. Distribution of these species are governed by distribution of riverine

grassland habitat, and distribution range of all these birds are restricted to suitable grasslands of Himalayan foothills, particularly flood plains of Brahmaputra in Assam. DSNP and MMB still retains considerable stretch of grassland habitat. None of these birds were recorded during the current survey from the grassland habitats. Apart from these threatened birds, two Endangered (IUCN v2020-2) as well as Scheduled I (WPA, 1972) mammalian species *viz*. Wild Water Buffalo (*Bubalus arnee*) and Indian Hog Deer (*Hyelaphus porcinus*) were recorded form the grasslands of MMB. A herd of approximately 15 wild buffalo was recorded multiple times in MMB. No hydrocarbon condensate or fire related damage was visually recorded at DSNP. In contrast, mostly because of the predominant wind direction, the MMGL was exposed to condensate fallout. Vegetation of about 31% (7.4km^2) of MMGL was observed to be damaged (chlorosis of vegetation, leaf fall, necrosis of leaf, fall of pod) by condensate and about 7.6% (2.3 km^2) of MMGL area has been totally burnt down after the fire event of 9th June. So grazing mammals like Wild Buffalo and Indian Hog Deer are directly affected by this habitat loss and loss of potential fodder.

Out of eight major migratory bird flyways, two overlaps over the AOI, *viz*. the "Central Asia" and "East Asia-Australasia" migratory flyway. MMB and MMGL provide ideal wintering ground for migratory birds. More than 120 migratory birds reported from MMB-IBA. More than 20 species of migratory waterfowl were reported from the wetlands, including number of threatened species. A Critically Endangered [IUCN (v2020-2)] waterfowl, *viz*. Baer's Pochard (*Aythya baeri*) was reported in low numbers from MMB. Two Vulnerable species were reported *viz*. Lesser White-fronted Goose (*Anser erythropus*) and Common Pochard (*Aythya farina*).

Aquatic: Two significant water systems of the Brahmaputra River basin, the Dangori River, and Dibru River are present within the AOI. Dangori in true sense is an offshoot of Brahmaputra River and flows within 500m of the BGN-5. Dibru River drains into the MMB system. It also forms a crucial 4-5 km long connection between the Dangori River and MMB system. Both Dangori River and the section of Dibru River between Dangori and MMB is significant for Gangetic Dolphin (*Platanista gangetica*) [EN (IUCN v2020-2)]. Carcass of a Gangetic Dolphin was recovered near Maguri Bridge by local villagers from Dibru River on 27.05.2020, immediately after the blowout of the BGN-5 (before explosion and fire). During survey few dolphins were recorded from the Dangori River, and a pod of 4-7 dolphins was recorded from stretch of Dibru river between confluence with Dangori and MMB. Considering migratory behaviour of Gangetic dolphin, during monsoon low dolphin abundance is expected in the main river channel (in this case Dangori) and dolphins are expected to increase movement in smaller tributaries (in this case Dibru).

These water bodies particularly MMB wetland supports a diverse range of aquatic life. Carcass of a soft shelled turtle (species unidentified) was reported post blow-out, by the local community. The region is located about 1.3 km south east of BGN-5. Large number of dead fishes surfaced in this part of the wetland. Subsequent surface water testing found that particular region (low lying areas near MMB) had higher Oil & Grease, PAH, TPH,

BTEX, and TDS compared to the rest of MMB. This clearly indicates higher level of condensate contamination in this particular region. Bioassay test, concluded that water sample collected from low lying areas near MMB, had higher Toxicity Factor (TF), however the other samples does not reveal higher toxicity factors.

IMPACT ASSESSMENT

Ambient Air quality

Pollutants like Particulate Matter (PM_{10} and $PM_{2.5}$), NO_2, CO, HC, benzene and other VOCs was generated from the blowout of BGN-5. The average concentration of PM and NO_2 during the blowout period at the AOI of the BGN-5 were found to be comparable to pre-blowout baseline value and within the NAAQS. Significant changes have not been observed; this may be due rain and wet deposition of pollutants. The concentration CO was slightly higher compared to pre-blowout baseline value; however, within the values are within NAAQS. The concentration of methane HC and VOC was higher than the pre-blowout baseline values. Benzene recorded only in two locations once/twice during monitoring period. The concentration of Benzene was higher than the NAAQS (5.0 $\mu g/m^3$). The concentration of BAP in all the monitoring locations were below detection limits (<0.5 ng/m^3), as well as NAAQS (1.0 ng/m^3).

Noise quality

The monitored noise level data indicated high noise within the 5 km AOI during the blowout period. The noise levels were above the limits of Noise Pollution (Regulation and Control) (Amendment) Rules, 2002; i.e. 55 dB(A) during day time and 45 dB(A) during night-time for residential areas. High noise levels may adversely impact on human health and fauna in the AOI.

Soil quality

Soil quality assessment revealed that there were high levels of diffuse petroleum hydrocarbons in the area near the blowout site; mainly at the condensate deposited area. The higher concentration of petroleum hydrocarbons in soil can cause of adverse impact to soil quality which include the following;

Because of the low density, higher viscosity and lower emulsifying ability of petroleum hydrocarbons, they can be easily absorbed at soil surface, affecting the permeability and porosity of soil. The petroleum is rich in carbon and a small amount of nitrogen compounds, so it can change the composition and structure of soil organic matter and impact the C/N, C/P, pH, and conductivity of soil and can impede the normal growth of crops such as reduce the germination rate and fertility and decline the resistance to pests and diseases.

The study also showed that homestead tea garden & plantation area, MMGL area and agricultural land may have been negatively impacted upon due to the visible presence of spilled petroleum hydrocarbons.

Ground water quality

Ground water quality of almost all the parameters at the monitored stations were within the limits of IS:10500 standards. Once the Petroleum Hydrocarbons (PHCs) are released into the soil, depending on their chemical properties the complex PHCs mixture are separated into individual compounds. Compounds with lower molecular weight e.g. BTEX compounds are highly mobile in the environment and more volatile and easily leach to the groundwater than higher molecular weight PHC. Generally, hydrocarbons with straight chain and short chains can degrade more readily than those with complex chains. Compounds with longer chains, such as PAHs and aromatics tend to bind strongly to soil particles and soil organic matter plays a vital role in the degradation of contaminants. PAH concentration were not recorded in ground water samples. TPH concentrations recorded from in few water samples only. However, with limited sampling contamination of TPH cannot be established.

Surface water quality

During the pre-fire stage, significant TPH concentration was recorded in sample collected from the low-lying areas of the MMB. This period had experienced heavy rainfall and runoff along with condensate from ditches has spread into the MMGL area, MMB area and subsequently in Dibru River and Dangori River. Spread of TPH may inhibit the diffusion of oxygen to water surface from air and may cause anoxic-anaerobic conditions. Under the anoxic-anaerobic conditions, TPH degradation by microorganism driven metabolic processes also becomes limited.

PAHs was recorded in the MMB and Dibru River during the sampling period. The PAHs are not likely to be mobile in the environment due their low water solubility. Upon entering aquatic systems, PAHs are diffused by currents and sooner or later become integrated with the sediment. Most of the PAH values recorded in the study area were within the limits of CCME values which includes Acenapthalene, Fluorene, Phenanthrene, Fluoranthene and Pyrene. However, maximum values of Anthracene, Benz (a) anthracene and Benzo (a) pyrene values were found to be higher than the CCME values. Higher concentrations of these compounds in MMB areas can present threat to aquatic life.

The concentration of DO in the MMB during the pre-fire stage varied from 3.6 -4.0 mg/l; corresponding to high concentration of TPH recorded at the same location. Whereas concentration of DO in the Dibru River and the Dangori River ranged between 4.8 -5.7 mg/l corresponding to low concentration of TPH. DO concentrations of samples during jet-fire stage varied between4.5 mg/l-6.2mg/l. The concentration of DO level has been compared to the propagation of wildlife and fisheries (CPCB Class D Water Use criteria) value; the DO levels in all the samples were higher than 4.0 mg/l i.e. conforming to the Class D Criteria.

Free ammonia concentration for all the samples during jet-fire stage revealed values less than 0.1 mg/l except for the first week sample collected from low-lying area near MMB having values of 1.1 mg/l. The spread of HC

has an effect on concentration of free ammonia in surface water body. Impact has been recorded in low lying areas of MMB; however, similar impact has not been recorded in open water of the wetland or Dibru River and Dangori River.

Sediment Quality

Sediment quality monitoring during jet-fire stage of blowout reveals that the concentration of TPH recorded in sediments collected from of MMB, Dibru River and Dangori. The light aliphatic hydrocarbons in the C_5-C_8 and C_9-C_{12} fractions are sufficiently soluble that they probably contribute to the toxicity of sediments contaminated with condensate. However, these types of aliphatic hydrocarbons were not recorded in sediment during primary monitoring. The high molecular weight aliphatic hydrocarbons (aliphatic fractions C_{13}-C_{18} and C_{19}-C_{36}) have low solubility and have high affinity for the sediment organic carbon phase or oil phase in the sediments. The high molecular weight aliphatic hydrocarbons probably do not contribute significantly to the chemical toxicity of HC-contaminated sediments. These aliphatic compounds were recorded in the sediment.

PAH was recorded in the sediments collected from MMB and opening of Maguri Beel to Dibru River near the Natun Gaon Bridge; however, not recorded in the sediment samples collected from Dangori River. The PAH values recorded in the study area were within the limits of CCME values.

Ecological Environment

Observed Effect of blowout on Terrestrial Habitats

Condensate or fire related damage was visually not recorded from DSNP area. In contrast, mostly because of the predominant wind direction (towards south west), post blowout of the BGN-5 well, MMGL area was exposed to condensate fallout. Vegetation of about 31% (7.4 km^2) of MMB's grassland was observed to be damaged (chlorosis of vegetation, leaf fall, necrosis of leaf, fall of pod) by condensate and about 7.6% (2.3 km^2) of grassland (along with agriculture) area has been totally burnt down after the fire of 9th June. Within a radius of approximately 2 km, grasslands dominated by species such as *Phragmites karka*, *Arundo donax*, *Saccharum spontaneum* and *S. ravennae* were largely found to be burnt. However, there were evidences of growth of germinating seedlings within 2 km radius in some sectors of the largely burnout grasslands. The mixed deciduous vegetation in Baghjan Gaon at the immediate vicinity of BGN-5, after the fire, was found to be completely burnt. There was no sign of immediate recovery unlike for the grasslands where germinating seedlings were found.

Visible condensate observed in soil and vegetation of homestead plantation areas, homestead tea garden and wooded areas in Baghjan side villages (Baghjan Gaon and Dighaltarang villages, north of MMB) while the same were not observed at the Guijan side villages (Natun Gaon, Bebejia, Motapung, Guijan, Balijan, Barekuri etc., south of MMB). Visible condensate material observed at the waterbodies, ponds within Baghjan Gaon.

Extensive damage to homestead plantation, homestead tea gardens observed in Baghjan Gaon due to condensate deposition and fire as mentioned below;

- Chlorosis of vegetation- Bamboo, jackfruit, mango, tea, banana
- Leaf fall- Jackfruit, Bamboo, Betel nut, banana
- Necrosis of fruit/pod- Bamboo, jackfruit, banana, mango, betel nut
- Necrosis of leaves- Tea, Jackfruit, Banana, Mango
- Rupture of stem- Banana
- Fire damage to vegetation- Bamboo, jackfruit, banana, mango, betel nut, tea

Impact to vegetation as mentioned above not observed at other villages within AOI.

Chlorophyll content index unit (CCI) study conducted to understand the extent of damage of chlorophyll of plants, reflect an initial trend of possible stress being faced by vegetation representing nearest to the site of gas blowout compared to the sites far from the blowout area.

High noise levels could be perceived across the entire MMGL area. Around 500m from BGN-5, noise level was found to be 91.12 dB(A), at 1 km noise was recorded to be 80.59 dB(A) and at 3 km from BGN-5 noise was recorded to be 71.16 dB(A). Earlier studies have indicated that sound levels above about 90 dB are likely to be aversive to mammals[3] and are associated with a number of behaviours such as retreat from the sound source, freezing, or a strong startle response. Mammals of MMGL exposed to higher sound pressure level can experience these effects. Population of Endangered (IUCN v2020-2) mammals like Wild Water Buffalo and Hog Deer residing in MMGL are thought to be isolated from DSNP by Dangori River, at least during the monsoon season (due to high water level in Dangori). Therefore, these animals have very little scope of displacement from MMGL area in response to the high noise levels.

Primary survey carried out indicates displacement of avian species up to 2-3 km from the blowout site. Number of studies indicate avoidance and displacement of birds from noisy environment. Such impacts on breeding resident grassland bird species cannot be ruled out.

The radiation impacts from the jet- fire will be mostly pronounced at the MMGL areas as they are close to the BGN-5 well. Thermal radiation could range between 0.02-15 kW/m^2 at the MMGL areas. IUCN threatened mammalian, avian and reptilian species could be present in the MMGL areas and could be impacted from the high thermal radiation levels from the BGN-5 blowout. The radiation levels will be reduced to less than 1 kW/m^2 (radiation level of a day with bright sunlight) within a distance of 400 m from BGN-5. Hence, major impact to fauna of MMGL may happen within 400 m from the BGN-5 well. Radiation levels at a bright sunlight day is expected to be approximately 1 kW/m^2. Radiation levels are expected to be much lower (< 0.2 kW/m^2) at DSNP and MMB areas hence, are not expected to cause major impact to the faunal species.

[3]Effect of Aircraft Noise and Sonic Boom on Domestic Animals and Wildlife: A Literature Synthesis. 1988. Engineering and Services Center US Air force. Fish and Wildlife Service, US Department of the Interior.

Light from the jet fire could be perceived by the animals either directly within direct line of sight, or as sky glow. Sky glow is the diffused glow caused from the jet fire that is screened from view, but through reflection and refraction, the light creates a glow in the atmosphere. Sky glow from the jet fire is visible from more than 10 km from the BGN-5 well. The activity patterns of particularly the nocturnal animals would likely to be impacted due to the jet fire from the BGN-5. Illumination effects include temporal niche partitioning; altered repair and recovery of physiological function; interference with detection of predators and environmental resources, signalling, and camouflage; changes in reproductive behaviour; and alterations in circadian rhythms[4].IUCN endangered mammalian species *viz*. Indian Hog Deer, Wild Water Buffalo; threatened bird species *viz*. Swamp Prinia (*Prinia cinerascens*), Swamp Francolin (*Francolinus gularis*), Black-breasted Parrotbill(*Paradoxornis flavirostris*), Marsh Babbler (*Pellorneum palustre*), Jerdon's Babbler(*Chrysomma altirostre*) etc. may be impacted from the high illumination levels from the BGN-5 blowout.

Observed Effect of blowout on Aquatic Habitats

The waterbodies particularly MMB supports a diverse range of aquatic life. Carcass of a soft shelled turtle (species unidentified) was reported post blow-out, by the local community. The region is located about 1.3 km south east of BGN-5. At few areas mortality of fish was observed within the waterlogged grassland areas of MMB. Local villagers and Forest department reported mass mortality of fish in the MMB grassland areas during early stage of blowout (27th May-31st May) and also when the MMB and Dibru river were flooded. However, mortality reports were primarily recorded during the early stages of blowout. After the well caught fire, mortality reports were much less and spatially limited to the waterlogged grassland areas of MMB where some condensate were observed to be trapped.

Both Dangori River and the section of Dibru River between Dangori and MMB is significant for Gangetic Dolphin. Carcass of a Gangetic Dolphin was recovered near Maguri Bridge by local villagers from Dibru River on 27.05.2020, immediately after the blowout of the BGN-5 (before explosion and fire). Gangetic dolphins need to surface to breathe. Post blowout, as considerable amount of condensate was floating over water in Dibru river, so exposure of cetaceans to floating hydrocarbon (in this case condensate), via eye, mouth or blowhole cannot be ruled out.

Surface water test results indicated that waterlogged areas near Baghjan Gaon north of MMB area (close to BGN-5), was the area with highest concentrations of oil and grease and TPH. The area also revealed a relatively high toxicity factor (fish bioassay test revealed toxicity factor=4), which may have resulted in some fish mortality. However, samples collected from other locations of the MMB, Dibru River and Dangori River did not reveal high

[4] Rodríguez A, Holmes ND, Ryan PG, Wilson K-J, Faulquier L, Murillo Y, Raine AF, Penniman J, Neves V, Rodríguez B, Negro JJ, Chiaradia A, Dann P, Anderson T, Metzger B, Shirai M, Deppe L, Wheeler J, Hodum P, Gouveia C, Carmo V, Carreira GP, Delgado-Alburqueque L, Guerra-Correa C, Couzi F-X, Travers M & Le Corre M (2017) A global review of seabird mortality caused by land-based artificial lights. Conservation Biology 31:986-1001.

toxicity factor (toxicity factor=1). Water sampling conducted during 3rd week of June (18-22 June) at all locations in MMB, Dibru River and Dangori River does not reveal high toxicity levels with respect to fish. This was primarily due to the flow of condensate contaminated water from the area towards the open water of MMB and then towards the Dangori River through Dibru River.

It is to be noted that due to high rainfall and repeated flooding of the area during the blowout period may have resulted in considerable dilution of contaminants due to higher run-offs and precipitation induced hydrological flow of water. However, after the water receded, spilled condensate did get concentrated in some pockets and potentially can result in some measure of bioaccumulation in fish and other aquatic organisms.

Vibration Related Studies

Seismological studies during the blowout period has been conducted by Council of Scientific and Industrial Research–North East Institute of Science & Technology (CSIR–NEIST), Jorhat. Summary of observations of CSIR-NEIST study has been presented below;

- Occurrence of local earthquake tremors were observed although of smaller magnitude.
- The magnetic field declination was observed at the blowout site (Latitude 27.597150N and Longitude 95.3798940E).
- High frequency disturbances (noise) are observed as recorded by the seismographs, most probably originated from the blowout site.

Measurement of Thermal Mapping of Structure and Sonic Boom

OIL engaged Indian Institute of Technology (IIT)-Guwahati to investigate whether the Sonic boom and thermal currents generated from the BGN-5 fire caused cracks in structures in villages surrounding the blow out site. The

- **Sound Intensity Measurement Inference**: The sound time history with high pressure intensity in dB emitting at low occurrence rate is not detrimental to the structural integrity.
- **Spectral Energy Inference**: Overall, the sound intensity is not too intense to cause any detrimental effect on structural integrity.
- **Frequency Inference**: The sound pressure intensities from the gas blowout has no significant influence on formation of cracks in the buildings.
- **Thermal Measurement Inference:** Based on the thermal maps, we conclude that there is no significant effect of fire in blowout well in Baghjan well 5 on the formation of crack in the structures.

IMPACT OF BAGHJAN BLOWOUT ON KHAGORIJAN BLOCK

The Khagorijan Block is located at a distance of 3.1 km from the BGN-5 well. Nearest proposed well of Khagorijan Block is located at an approximate

distance of 7 km from BGN-5 well. The north-eastern corner of the Khagorijan Block is included within the 5 km AOI of the BGN-5 well.

Impact of the BGN-5 blowout to the different environmental media with respect to the Khagorijan Block is presented below;

Ambient Air quality

Average baseline concentrations of PM, NO_2, CO were within the NAAQS during the blowout period. Higher HC and VOCs were recorded during the blowout period within the AOI of BGN-5, however BAP concentrations were below detection limits. Hence, impact of release of pollutants from the blowout is not expected to cause significant change in the air quality of Khagorijan Block area.

Noise quality

Noise levels at 3 km distance from the BGN-5 well was higher than the day time and nighttime noise limits of Noise Pollution (Regulation and Control) (Amendment) Rules, 2002. The high noise levels had the potential to cause adverse impact on human health and fauna within the areas of Khagorijan Block particularly at the north-eastern corner nearing the Guijan, Balijan, Rongagora tea estate areas.

Soil quality

Airborne condensate deposition due to the blowout occurred within approximately 2 km from the BGN-5 well. However, due to the flooding of the area for several times during the blow-out period the deposited condensate were washed out and impacted areas beyond 2 km of the BGN-5 well. At the north-eastern corner of the Khagorijan Block impact to soil quality may have happened due to the flow of condensate mixed water. It has been pointed out earlier that the condensate mixed water have the potential to affect the permeability and porosity of soil impact the C/N, C/P, pH, and conductivity and have the potential to impact growth of crops and also affect tea production in the area.

Ground water quality

Ground water quality of almost all the parameters were within the limits of IS:10500 standards. Concentration of PAH and BTEX in groundwater samples during blowout period were below detection limits. TPH was detected in the groundwater samples.

Surface water quality

Part of Dibru River between the MMB and Dangori Rover and a stretch of Dangori River within the AOI are located at the north eastern corner of the Khagorijan Block. DO levels for the Dibru River and Dangori River samples were found to be greater than 5 mg/l. Samples collected from Dangori River revealed BOD values less than 2.0 mg/l; the sample collected from the Junction of Dangori River and Dibru River reveal BOD values <2 mg/l - 3 mg/l. Oil & grease contents of the Dibru River and Dangori River samples

were found to be less than 1.4 mg/l. TPH concentrations was recorded from Dibru River and Dangori River samples. PAH concentrations were not recorded (<0.00001 mg/l) from Dangori River samples and Junction of Dibru-Dangori River.

Sediment Quality

Sediment quality monitoring revealed presence of TPH in sediments from Dibru River and Dangori River. PAH was recorded in the sediments collected from MMB and opening of Maguri Beel to Dibru River near the Natun Gaon Bridge; however, not recorded in the sediment samples collected from Dangori River.

Impact on Ecological Environment

Observed Effect of blowout on Terrestrial Habitats

Visible damage due to condensate or fire was not observed at the terrestrial habitats within the Khagorijan block due to the blowout. Damage to vegetation of homestead plantation, homestead tea gardens at the Khagorijan Block area were also not observed due to the blowout. As mentioned earlier, noise and light related impacts (including the sky glow) could have happened to the faunal species within the areas of Khagorijan Block particularly at the north-eastern corner nearing the Guijan, Balijan, Rongagora tea estate areas.

Observed Effect of blowout on Aquatic Habitats

Local villagers and Forest department reported mortality of fish in the MMB grassland areas during early stage of blowout (27th May-31st May) and also when the MMB and Dibru river were flooded. However, mortality reports were primarily recorded during the early stages of blowout. Samples collected from Dibru River and Dangori River does not reveal high toxicity factor (toxicity factor=1) with respect to survival of fish. Both Dangori River and the section of Dibru River between Dangori and MMB is significant for Gangetic Dolphin. Carcass of a Gangetic Dolphin was recovered near Maguri Bridge on 27.05.2020. During blowout, as considerable amount of condensate was floating over water in Dibru River, so exposure of cetaceans to floating hydrocarbon (in this case condensate), via eye, mouth or blowhole cannot be ruled out.
