Environmental and Social Impact Assessment for Sewage Treatment Plant in Arupara

Ganga STP Project Private Limited

Final Report

25 September 2020

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Acronyms and Abbreviations

BOD	Biological Oxygen Demand
C&D	Construction and Demolition
CMP	Contractor Management Plan
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CTE	Consent To Establish
CTO	Consent To Operate
DPR	Detail Project Report
DTCP	Department of Town and City Planning
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPC	Engineering Procurement Construction
ERM	Environmental Resources Management
ERP	Emergency Preparedness and Response Plan
ESIA	Environment and Social Impact Assessment
E&S	Environment and Social
ESAP	Environmental and Social Action Plan
ESDD	Environment and Social Due Diligence
FC	Fecal Count
FI	Financial Institute

GAP	Ganga Action Plan
GRC	Grievance Redress Committee
GRM	Grievance Redress Mechanism
GSPPL	Ganga STP Projects Private Ltd.
HAM	Hybrid-Annuity Model
HSE	Health, Safety and Environment
I&D	Interception and Diversion
IFC	International Finance Corporation
IFC PS	International Finance Corporation Performance Standard
IIT	Indian Institute of Technology
KMC	Kolkata Municipal Corporation
KMDA	Kolkata Metropolitan Development Authority
LMP	Labour Management Plan
LS	Lifting Station
MLD	Million-Liter per Day
MoEF&CC	Ministry of Environment, Forests & Climate Change
MPS	Main Pumping Station
NEERI	National Environmental Engineering Research Institute
NGT	National Green Tribunal
NH	National Highway
NMCG	National Mission for Clean Ganga
NOC	No Objection Certificate
OHS	Occupational Health and Safety
O&M	Operation and Maintenance
PAP	Project Affected Person
PWD	Public Works Department
PPP	Public Private Partnership
RAP	Resettlement Action Plan
QHSE	Quality, Health, Safety and Environment
ROW	Rights Of Way
SBR	Sequencing Batch Reactor
SEP	Stakeholder Engagement Plan
SOP	Standard Operating Procedure
SPMG	State Program Management Groups
SOP	Standard Operating Procedures
SPV	Special Purpose Vehicle
SR	Safeguarding Requirements
SS	Suspended Solids
STP	Sewage Treatment Plant
TSS	Total Suspended Solids

ULB	Urban Local Bodies
WBPCB	West Bengal Pollution Control Board

EXECUTIVE SUMMARY

A) Introduction

1. Over the years, the river Ganga has been subject to pollution from various sources which include discharge of urban liquid wastes and sewage, industrial liquid wastes, large scale wallowing and bathing of cattle, throwing of carcasses and dead bodies in the river, surface run-off from agricultural fields using pesticides and insecticides and leachate from solid and industrial waste dumps. Government of India identified cleaning of the river Ganga as one of its key priorities, and recognizing the need, National Mission for Clean Ganga (NMCG) has been constituted under Ministry of Water Resources, River Development & Ganga Rejuvenation and has set an objective to ensure effective abatement of pollution and conservation of the river Ganga and its tributaries by adopting a river basin approach for comprehensive planning and management. Under NMCG an Integrated Ganga Conservation Mission namely “Namami Gange” has been approved as ‘Flagship Programme’ set up in June 2015 to accomplish effective abatement of pollution, conservation and rejuvenation of the river. The overall scheme aims at preventing the discharge of untreated industrial and municipal waste into the River Ganga through a number of water treatment projects.

2. The Government of India had accorded Cabinet approval to Hybrid Annuity- Public Private Partnership (PPP) model for creation and maintenance of sewage treatment infrastructure under the Namami Gange Programme. Under this model, the development, operation and maintenance of the STPs will be undertaken by a Special Purpose Vehicle (SPV) to be created by the winning bidder at the local level. As per this model, 40% of the Capital cost quoted would be paid on completion of construction while the remaining 60% of the cost will be paid over the life of the project as annuities along with operation and maintenance (O&M) cost. As the most important features of this model is that, the Annuity and O&M payments are linked to the performance of the STP, which will ensure continued performance of the assets created. Based on better accountability, ownership and optimal performance.

3. Under the flagship program of Namami Gange, NMCG in association with Kolkata Metropolitan Development Authority, has conceived to implement the project titled “Development of Sewage Treatment Plants – Kolkata City Area”, under sub-project pertaining to existing Arupara STP. The existing Arupara STP Site is located at Dharsh area under HMC (majority of the site falls within ward 48 of HMC) and is one of the sub-projects under the project titled “Development of Sewerage Treatment Plants – Kolkata City Area” of KMDA. The proposed scenario involves construction of a new STP of 65 MLD capacity within the existing STP complex. The existing STP and its linked sewerage infrastructure fall under southern part of Howrah Municipality Corporation area. These fall under the administrative jurisdiction of the Howrah district of West Bengal.

4. M/s Ganga STP Projects Private Ltd (GSPPL) has been selected as the successful bidder for the project. M/s GSPPL (the “Concessionaire”) has been incorporated by M/s VA Tech Wabag Limited as a 100% equity funded entity to fulfil the requirement towards Hybrid-Annuity based Public Private Partnership (PPP) model. GSPPL is the developer of the project and will hold the ownership of the project assets till the end of concession period of fifteen (15) years. M/s GSPPL in turn will subcontract the Design, Build as well as Operation and Maintenance (O&M) scope for the project to M/s VA Tech Wabag Limited (Wabag). The Concession Agreement includes three components i.e. Arupara, Baranagar and Bally, and this ESIA is only focused on Arupara and separate ESIAs have been completed for Baranagar and Bally.

5. GSPPL has therefore initiated an environmental and social impact assessment (ESIA) study to comply with the requirements of the Concession Agreement. GSPPL is also seeking finance from international lenders for setting up of the Project and subsequent operation and maintenance

during the concession period hence the ESIA also needs to conform to the environment and social safeguard guidelines and requirements of the International Finance Corporation (IFC).

B) Policy, Legal & Administrative Framework

Environment

6. The proposed project activity involves construction of new Arupara STP at sludge drying pond area used during pervious STP operation, renovation, rehabilitation and installation linked sewerage infrastructure. The proposed project does not qualify for obtaining statutory Environmental Clearance under the listed project as per EIA Notification, 2006 under the Environment (Protection) Rules, 1986.

Land Acquisition

7. The existing project does not require any fresh land acquisition. The proposed STP will be developed within the existing land owned by KMDA at all the three locations. The proposed rehabilitation or laying of sewer pipelines will be carried out within the RoW of existing government roads. Hence, the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 will not be applicable.

International Safeguard Requirements

8. Financing support for the Project will be sought from multi-lateral financial institutions, such as the IFC. This support from the multi-lateral financial institutions requires adherence of international best practices and environmental and social safeguard requirements of the lenders. The major relevant guidelines and policies considered for this project are as included in paragraph nos. 9 to 12.

9. **IFC's Performance Standard, 2012** – IFC's Environmental and Social Performance Standards define IFC clients' responsibilities for managing their environmental and social risks. It applies to all investment and advisory clients whose projects go through IFC's initial credit review process after January 1, 2012.

10. This **Project** has been classified as Category B project as per IFC PS, 2012. The project will also confirm to the requirements under IFC PS, 2012 in respect of consultation, disclosure requirements and safeguard documentation to meet safeguard principles and requirements of the lenders.

11. **Applicable EHS Standards** – All relevant national and state-specific EHS and Social regulations in India will be applicable for this Project. In addition to that IFC General EHS Guidelines, 2007 and Industry Sector Guidelines: Water and Sanitation, 10 December 2007 applies to the project. The Project will conform to National Mission for Clean Ganga Environmental and Social Management Framework for Navami Gange Program.

C) Description of the Project

12. The old 45 MLD Arupara STP and linked infrastructures i.e. underground sewer network, three (3 numbers) Lift Stations (LS) and two(2 numbers) Main Pumping Stations (MPS) were reportedly installed and commissioned during 1970 and it was handed over to Kolkata Metropolitan Water and Sanitation Authority (KMW&SA) at non-operational stage in 1983. The old STP was non-functional since March 2019 as reported from project site visit conducted during June 2019 and it was also reported that the purification system has not been functional since handover to KMW&SA even though few repair initiatives were undertaken. All the lifting station were reported to be partially working, however in the present condition, the raw sewage is being released to the river Hooghly through the outfall points along the river banks.

13. The existing Arupara STP Site is located at Dharsh area under HMC, on the western side of the Howrah Kharagpur main railway line and is adjacent to residential settlements at the southern and eastern vicinity. The Ichapur MPS is located at Ramrajatala on Kamardanga Road, BESU lifting station is located at the junction of R.R. Choudhary Lane and College Road along the boundary of Indian Institute of Engineering Science and Technology, Shibpur. Foreshore road lifting station is located in Shibpur, near Food Corporation of India building on Upper Foreshore road. Roundtank lifting station is located at Mullick Fatak on Roundtank lane. Existing trunk sewer lines were laid along the main urban roads namely Dr. P. K. Banerjee road, Panchanantala Road, Narasingha Dutta Road, New HIT Road, Upper Foreshore Road, Swarnomoyee Road, College Ghat Road, Andul Road and Dr. Bholanath Chakraborty Sarani.

14. A new 65 MLD STP will be constructed in place of sludge drying pond area used during pervious 45 MLD STP operation, a septage management facility of 150 cum/d capacity will be constructed, lifting stations, main pumping station (MPS) will renovated, new pipelines will laid in place of existing pipelines in some areas and existing pipelines will be rehabilitated. The proposed new STP project will utilize the existing land and infrastructure of the sewage treatment facility and linked sewerage infrastructure of the old Arupara STP. The total area of the proposed STP facility will be 19,200 m^2.

15. The gravity sewer lines, rising main and effluent discharge lines are within the ROW of the public roads under the ownership of PWD (Government of West Bengal) and Municipal roads therefore no additional ROW/ land acquisition in the project scenario will be involved.

Resource Requirement

16. **Manpower**: During construction period, labour will be required for construction work for STP, and for laying and excavation work of the sewer pipelines. Reportedly, the man power requirement for the construction phase is approximately 100-150 workers for STP and additionally for the sewer pipeline work will be mobilized for the construction and civil work. These includes unskilled, semi-skilled and skilled workers. Reportedly, 80% of the labour is expected to be sourced from outside the district and only 20% will be sourced locally.

17. **Water:** During construction period, water will be required for mainly dust suppression and drinking water purpose at the labour camp. The source of water during construction phase will be arranged by KMDA through the existing municipal water supply pipeline in the locality. Concessionaire has not estimated the water requirement for this phase. During operational phase, water will be required for preparation of caustic solution for biogas scrubber and chlorine gas neutralization scrubber operation as well as for chlorination tank operation. Raw water will be also required for drinking purpose for the workers during the operational phase. The main source water is pipe water supply and the amount of required during this phase is 0.5 m^3/day. Another 0.1 m^3/day of water will be required to maintain the present greenbelt within the facility. The source of water during operational phase will be arranged by KMDA through the existing municipal water supply pipeline in the locality.

18. **Land:** The proposed project will utilize the existing land available in the old STP facility and its linked infrastructure and will not involve any additional ROW/ land acquisition. The total requirement for the proposed STP facility will be 19,200 m^2 and the new STP will be constructed in place of sludge drying pond area used during pervious STP operation. The renovation work at the MPS and lifting stations will be done within the existing MPS and lifting stations facility respectively, so no additional land will be required. For laying of new pipeline or replacement of existing pipeline, temporarily 60 to 75 m2 (30m of length and 2 to 2.5 m width) of land will be

required. The area requirement may change with the depth of pipeline laying or depth of existing pipelines to be replaced.

19. As reported in the Land Ownership Declaration letter pertaining to KMDA's ownership of the land area for the Arupara STP and linked facilities, there are no land issues or disputes, grievances or court cases raised against the land area for the STP and its linked facilities. Moreover, during execution of the project, if necessary for land acquisition, this will be carried out as per the direction of the Government of West Bengal.

20. **Power:** During construction phase of the project portable back-up Diesel Generator (DG) sets shall be used along with the existing grid as this common practice in India. During operational phase, existing grid will be used as the primary electricity source for STP and linked facilities. Whereas, a back-up DG sets of 800 KVA will also be installed for emergency purpose during the operational phase of the project. As proposed an 800 kW capacity biogas engine will be installed and the power generated from it will be utilized for day to day operations of STP. The power requirement for construction phase has not been estimated by concessionaire. The total power requirement for both construction and operation phase will be available after the finalization of detailed project engineering design.

Pollution Sources and Characterisation

21. The Project will have following potential effects on the environment:
    a) **Air Emissions:** Construction activities will generate emission of fugitive dust, on-site excavation and movement of earth materials, contact of construction machinery with bare soil, and exposure of bare soil and soil piles to wind. DG sets will be used during construction period which will generate exhaust gas. Biogas will be generated during the operation phase.

    b) **Solid Waste:** Waste shall be generated during construction phase activities i.e. packaging materials, cement bags, ready mix concrete discards, excavated materials, empty barrels etc. These waste can be hazardous and non-hazardous in nature and are categorized as Construction and Demolition (C&D) wastes governed by Construction and Demolition Waste Rules, 2016 for the proposed project site and linked faculties. As reported, at the end of days' work de-silted materials or sludge from renovation or de-slitting jobs for identified sewer line stretch shall be stored temporarily at respective location and then disposed to designated landfill sites assigned by KMDA as per Concession Agreement. During operation phase, periodic maintenance of the sewer line will generate de-silted sludge. De-watered sludge will be generated due to treatment of sewage water. Solid wastes from grit chambers and screens will be generated at the pumping stations. Used oil and grease and cotton waste (contaminated with oil) generated from maintenance activities at the LS, PS and STP equipment are the sources of hazardous wastes during operation phase.

    c) **Hazardous Wastes:** Both during construction and operation phases, may generate small quantities of petroleum based wastes, such as lubricants, hydraulic fluids, or fuels during their storage, transfer, or use in equipment. Dedicated areas will be earmarked for temporary storage of hazardous wastes on impervious surface at the project site. All construction and operation phase hazardous wastes will be disposed through authorized recycler/ disposal agency as per the regulatory requirements.

    d) **Noise Emissions:** During construction activities, noise and vibration will be caused by the operation of pile drivers, earthmoving and excavation equipment, concrete mixers, cranes and the transportation vehicle. High noise equipment and machineries like hydraulic pumps, mixing pit pump, digestor loading pump, HGV movement, material tipping, air blower and compressors will be the main noise sources during the operational phase of the STP.

D) Description of Environment

22. A 1 km radial buffer zone around the STP site and one hundred meter area around the proposed sewer network line (50m on both side of the sewer network line) has been considered as study area based on the Area of Influence of the proposed project activity.

Physical Environment

23. **Topography:** The study area is a part of lower gangetic deltaic plain and the entire district has flat topography with average elevation from MSL (mean sea level) varies from 7 to 11m. The overall slope of the district is toward south. The rivers within the district flow from North to South which again indicate the general slope of the district is toward south.

24. **Geology:** The study area is a part of lower Gangetic Deltaic plain of Bengal basin. Presently, the configuration of Bengal basin can be inferred by the presence of Gangetic-Brahmaputra delta system in the north and the Bengal Deep Sea Fan on the south. The study area is characterized by thick quaternary alluvium deposit, laid down by Bhagirathi-Hooghly River system. The alluvial sediments in the form of flood plain deposits consist of the sands of various grades, silt and clay with occasional gravel beds. Immediately below the land surface a thick layer of sticky clay ranging in thickness between 30-70 m.

25. **Landuse:** The study area is located in predominantly urban settings. The broad landuse classes identified in the study area are settlements, water bodies, industry, drainage channels, low marshy land, railway track and green cover. The railway track and green cover are relatively small in this area. The sewer pipeline network passes through the main load with settlements on both side of the road.

26. **Drainage:** The main rivers of Howrah district are Rupnarayan River, Mundeswari River Bhagirathi and Hooghly River. The boundaries of the district are naturally defined by these three (3) rivers - Rupnarayan River flows along the West and South-west part of the district; Bhagirathi-Hooghly River flows along East and South-east part of the district and Damodar River flows from north-west boundary of the district. Apart from rivers there is an artificial canal called Bally Khal present along the north-eastern boundary of the district. The Bally Khal meets the Hooghly River at the North-eastern part of the district. In addition to Bally Khal, there are so many khals and channel like, Howrah Drainage Channel, Mahishdhara khal, Barjola khal, Rajapur khal, Medinipur Main khal, Champa khal, Rampur khal, Gaighata khal etc. which play very important role in respect to flood and irrigation control. Besides the above, other small rivers like Saraswati, Maza Damodar, Kana Damodar etc. serves drainage purpose in the district.

27. Howrah Drainage Channel flows from the eastern side of the STP facility. The channel drains gravitational flows from its basin area. Howrah drainage channel flows in south direction before it meet the Hooghly River at Mourigram. The Howrah drainage channel covers almost entire district through its distributary channels. The entire drainage load of the channel is discharged into the Hooghly River. The channel is used to drain both storm and sewage water from its basin area. The drainage system of the study area is controlled by the Howrah Drainage Channel. HowrahDrainage Channel is a covered drainage channel in most of its course.

28. **Inland Surface Water Quality**: Surface water has been monitored at four locations within the study area. The sampling locations have been designed to capture the water quality of the existing ponds within the study area that could be impacted due to the operation of STP. The pond water of Dharsa Chowdhury Para can be categorized as CPCB class B water as per CPCB Water Quality Criteria. The pond water can be used for outdoor bathing. The pond water of

Shibtala and near the STP gate can be categorized as CPCB class C water. It can be used for drinking water after conventional treatment and disinfection.

29. **Groundwater Quality:** The shallow and deeper aquifers in Howrah district are classified as Sodium-Bicarbonate facies. Presence of brackish water in the aquifers up to a depth of 150 m are reported from some part of the district. Groundwater throughout the district is slightly alkaline with pH varies from 7.90 to 8.40. Arsenic is mainly present in the shallow aquifers to deeper aquifers up to a depth of 50m in some parts of the district. The groundwater of the district is suitable domestic use except few pockets of contaminated groundwater.

30. In order to assess the suitability of existing drinking water sources in the immediate vicinity to STP, monitoring was conducted at two stations near the study area. One groundwater sample was collected from dug well tapping the shallow aquifer (5-15m of depth) and the other sample was collected from tube well tapping the deep aquifer (60-80m of depth). The Concentration of majority of the parameters analyzed were within the permissible limit of IS 10500, 2012 standard. pH values of groundwater samples were found to be below drinking water standard of IS 10500: 2012. The high values of Total Hardness, Iron, Faecal Coliform and Total Coliform were detected in the samples.

31. **Soil Quality**: Soil quality was monitored at two (2) different locations within the Arupara area. The soil samples were collected from the top-soil within 15cm depth from the surface. The soil samples are collected and analysed to estimate the extent of soil pollution due to previous operation of STP. Soil samples in the study area were found to be clay loam with pH values indicating moderately alkaline soil. Nitrogen status was less to good, phosphorus status was very less and potassium status was very less to less. The heavy metal concentration in soil samples were found to be below remediation intervention values as per Dutch Soil Remediation Circular.

32. **Climate and Meteorology:** The climate of Howrah district is tropical, like the rest of the Gangetic West Bengal. It is characterized by hot summer, high humidity nearly all around the year and well distributed monsoon season. The winter season starts from December and continues till end of February, followed by the summer from March to May. Rainfall occurs primarily during the south-west monsoon months i.e. June to September and constitutes of more than 70% of the total annual rainfall. Mean temperature for most period of the year besides winter season remains around 24.1 to 30.4 ºC with May being the hottest at 38 ºC (mean maximum temperature). The relative humidity of Howrah district is reported to be high (71% to 85%) throughout the year. The average annual rainfall of the district is about 1579 mm.

33. **Ambient Air Quality:** Ambient air quality was monitored at three locations around the study area. The parameters studied were Particulate Matter (PM_{10} and $PM_{2.5}$), NOx, SO_2, CO, NH_3, Hydrocarbon and H_2S. The result of the parameters monitored were compared with the National Ambient Air Quality Standards (NAAQS) stipulated for residential, commercial and industrial area as well as with the WHO air quality values. All the parameter were in compliance with the NAAQS standards. $PM_{2.5}$ values in all station and PM_{10} value in one station were not in compliance with WHO air quality values.

34. **Ambient Noise Quality:** Ambient noise monitoring was conducted at four stations within the study area to understand prevailing noise levels in the project area and its vicinity involving 24 hours Sound Pressure Level and Noise Level. The results so obtained were compared with ambient noise standards specified for respective category under the Noise Pollution (Regulation & Control) Rules, 2000 as well as WHO limits. The equivalent day time noise values in all the locations except the location within the facility were exceed the day time CPCB standard of 55 dB(A) for residential areas and WHO day time standard of 55 dB(A) for outdoor living area. The equivalent night time noise values in two locations were exceed the night time CPCB standard of

45 dB(A) for residential areas but all station comply with WHO night time standard of 50 dB(A) for outdoor living area. The vehicles in the roads and sound from railways are the major source of day-time Noise in the area. The major source in night-time are the insect-roar within the facility along with railways.

35. **Natural Hazards:** The Project site is located in Earthquake Zone –III classified as Moderate Risk Zone (MSK VII) as per India earthquake hazard zoning map. The study area is characterized by low-lying areas of alluvium deposits of Hooghly River. However, extensive man-made alterations of natural drainages in Howrah district has been carried out through the building of drainage systems (canals) and embankments making the area a highly modified watershed. As a result, the vulnerability of these area to flooding events has been significantly reduced. Consultations with stakeholders in the study area indicate that area around the STP facility has not recently experienced any flooding situation although the area experience water-logging situation during heavy rainfall. In case of heavy rainfall the area faces temporary water-logging which lasts for maximum 3 to 4 hours duration. The area near MPS site do face water-logging situation during heavy rainfall as expressed by the local people. Based on the report prepared by Climate Central on 29th October 2019 referring to the peer-reviewed paper published by Nature Communications, it is estimated that 237 million people in six Asian countries are at risk due to coastal flooding by 2050 . West Bengal and coastal Odisha are projected to be particularly vulnerable, as is the eastern city of Kolkata. It is estimated that by 2050, a major part of Kolkata urban area and its surroundings could lie in the annual coastal flood risk zone.

Ecological Environment

36. **Terrestrial ecosystem:** The vegetation was recorded in the internal road and open area of the STP. The predominant tree species recorded during site visit were Lagerstroemia speciose, Eucalyptus spp., Leucaena leucocephala, Caryota urens, Trema orientalis, Putranjiva roxburghii, Moringa oleifera, Ficus racemose, Swietenia macrophylla, Dalbergia sissoo, Bombax ceiba, Polyalthia longifolia, Azadirachta indica, Albizia lebbeck, Ficus benghalensis, Ficus religiosa, Magnolia champaca, Delonix regia, Peltophorum pterocarpum, Swietenia macrophylla, Phoenix dactylifera, Cocos nucifera, Lagerstroemia speciose, Terminalia cattapa, Tamarindus indica, etc. The shrubs and herbs species recorded during site visit were Caesalpinia pulcherrima, Calotropis procera, Amaranthus spinosus, Boerhavia repens, Cassia sophera, Cassia tora, Ervatamia divaricate, Jatropha curcas, Hibiscus rosa-sinensis, Tabernaemontana divaricate, Pennisetum purpureum etc. No protected floral species were recorded.

37. There is no natural forests in the entire study area. The diversity of fauna (native population of mammals, birds, reptiles and amphibian) species recorded in the modified habitat was low. A total of 10 species of terrestrial mammals, 29 species of avi-fauna, 2 amphibian species and 7 reptilian species are reported from the study area. Apart from Black Kite (*Milvus migrans*) Schedule I species under Indian Wildlife Protestation Act 1972, no other falunal species recorded/ reported from the study area are not protected under Indian regulation Wildlife Protestation Act 1972 or IUCN Red List.

38. **Aquatic Ecosystem:** Aquatic macrophytes are mainly recorded in the surface waterbodies and marshy land in the study area. Major species recorded in these habitats were Ipomea aquatica, Ipomoea carnea, Alternanthera sessilis, Enhydra fluctuens, Typha angustifolia, Lemna perpusilla, Phragmites karka, Pistia stratiotes, Typha angustifolia, Wolffia arrhizal, etc. The canal system i.e. Howrah Drainage Channel in the study area is used for discharge of untreated sewage from the urban area and drainage of surface runoff during monsoon season. The canal is not suitable habitat for aquatic fauna, especially for fishes. Fishes are mostly reported from the surface water bodies (ponds) in the study area involving mostly local species *Anguilla bengalensis bengalensis (Ban), Amblypharyngodon mola (Morala), Anabas testudineus (Koi), Catla (Catla), Channa*

punctatus (Lata), Channa striatus (Shol), Cirrhina mrigala (Mrigel), Clarius batrachus (Magur), Glossogobius giuris (Beley) etc.

Socioeconomic Environment

39. The study area for the primary socio-economic survey includes receptors who are situated within 100 meters i.e. 50 meters on each side of the sewer pipelines, where the proposed pipeline laying or replacement work will take place, as these receptors may potentially be directly impacted by the project activities. In addition, receptors who are situated within the vicinity of the locations for the proposed laying or replacement of the sewer pipelines, have also been considered for the primary socio-economic survey, as these receptors may potentially be indirectly impacted by the project activities. Available primary information through site assessments as well as secondary data from the 2011 Census of India reports were analysed to ascertain the socio-economic parameters and trends of the study area.

40. Arupara STP is surrounded by various settlements within the one-kilometre radius, namely Dharsa Panchanantala, Dharsa Kanta Pukur, Old Jagacha, Ramrajatala, Arupara, Hatpukur Para, GIP Colony, Kamardanga, Sitala Tola, Dasnagar, Kalitala, Balitkuri and Surkimill. These identified settlements are located in various wards across HMC. Since some proportions of the settlements fall outside the defined radius of one- kilometre from the STP, the proportions have been defined accordingly, based on google imagery analysis. Therefore, the following percentage of the respective municipal wards have been considered for the baseline study: 10% of the population in Ward 44, 40% of the population in ward 47, 90% of the population in ward 48, 70% of the population in ward 49, and 30% of the population in ward 50.

41. As per the 2011 Census of India, Howrah Municipal Corporation has a total population of 1,077,075 individuals residing in 244,135 households and constitutes approximately 22.2 percent of the total population of Howrah district. Out of the total population, men constitute 561220 while women constitute 515,855. The population density of the municipality is 20,817 individuals per sq. km, which is much higher than the district average i.e. 3,306 individuals per square kilometre.

42. Analysis on the demographic profile of the municipal wards and settlements within the one kilometer radius of the STP site indicates that there are approximately 18,777 HHs and a population of 77,763 persons, collectively, within the defined radius of one km from the Arupara STP. Out of 77,763 persons, 51% (39,430) are male, and 49% (38,333) are female and the average HH size is 4.1. It is observed that ward number 48 has the highest population density with 25,594 inhabitants residing in 6,269 HHs, followed by ward number 50 with 17,748 inhabitants and 4,208 HHs. Ward number 47 has 16,353 inhabitants residing in 3,895 HHs. Ward number 49 has 15,973 inhabitants residing in 3846 HHs. Ward 44 only has 2,095 inhabitants residing in 559 HHs.

43. An analysis of the data indicates that there are approximately 65,626 HHs and a population of 280,627 persons, collectively, within the defined buffer zone. Out of 280,627 persons, 52% (145,525) are male, and 48% (135,103) are female and the average HH size is 4.3. It is observed that ward number 29 of HMC has the highest population density with 23,233 persons, followed by ward number 39 followed by 19,873 persons.

44. Based on the analysis on the occupational profile of the surveyed local population, out of 100 surveyed persons, 29 individuals are presently working. Over 31% (9 numbers) of the surveyed population are working as daily labourers and all of them are male. Over 28% (8 numbers) are shop owners and all of them are male. 10% (3 numbers) are tea, food stall owners and all of them are male. Over 7% (2 numbers) are engaged in trading, and 17% (5 numbers) are engaged in

private service and all of them are male. Over 10% (2 numbers) are engaged in other activities which include tailoring and domestic work.

E) Potential Impacts and Mitigation Measures

45. The impacts have been identified based on the information presently available from the project proponent on the Project configuration through stakeholder consultations with government officials, local community members, reconnaissance visit and broad assessment of the high power satellite imagery. The potential environmental and social impacts have been assessed for each phase of the Project – construction (including pre-construction and operational).

Potential Impacts on Aesthetics and Visual Quality

46. The construction activity will be a short term activity. The sources of aesthetic and visual impacts can result from storage of the construction and demolition waste due to construction activity; storage of construction materials; continuous stacking builds heaps of C&D wastes, physical presence of labour camps; movement of transportation C&D waste through trucks, tippers and dumpers, earth work along the pipeline route etc. The aesthetics and visual impact is assessed to be moderate but considering the implementation of embedded control system the residual impact is assessed as minor.

Potential Impact on Air Quality

47. During construction phase, the sources of emission are fugitive emission from storage and handling of construction waste and emission from machinery and vehicles. Stack emissions from these portable DG sets and vehicular emissions will increase the HC, NOx, PM and CO pollutant load in the air, however this activity will be continuing during the construction phase only. The impact is assessed to be of **minor** significance.

48. During the operation phase, the main source of air pollution from proposed project will be from the emergency bio-gas flaring on non-operational condition of bio-gas engine during STP operation. The emissions from the biogas flaring will primarily be Carbon Monoxide, Total Volatile Organic Carbon (VOC) and Oxides of Nitrogen.

49. Impacts due to the operation of STP facility of the project were assessed by modelling projected emission through using the AMS/EPA Regulatory Model (AERMOD).

50. The results from the predictive modelling exercise revealed that maximum ground level concentration in the Project AOI with biogas as fuel will be well within the applicable standards for air quality. The additional pollution load of PM_{10} and NO_x from proposed project activity against the baseline condition may not cause major changes in the existing baseline conditions or exceed the National Ambient Air Quality Standard (NAAQS), 2009. The emissions from the plant will however be long term, i.e. will occur for entire life of the plant. The potential impact on air quality due to emissions from the plant is assessed to be moderate.

Potential Impact on Noise Quality

51. Machineries and equipment, vehicles and backup DG sets are the major sources which may increase in the ambient noise levels in and around the project site during construction phase. The noise generated from the aforementioned activities may cause discomfort to the construction workers onsite and also to the nearby local community. The potential impact on noise quality during construction stage is assessed to be moderate.

52. In construction phase, the Equivalent Sound Pressure Level (Leq) from different equipment and vehicle operation was calculated to be 100.2 dB.

53. Noise during operations will be primarily generated from pumps and air compressor having noise range of 60-90dB or DG set operation for providing back up for administrative building and noise generated from it with enclosure is within range of 60-70dB.

54. In operation phase, the Leq from 800 KW Biogas plant and 800 KVA DG set is calculated to be 90.14 dB.

Potential Impact due to odour

55. Odour dispersion has been predicted using AERMOD steady-state plume model in area source mode resulting in estimation of ground level odour concentrations (GLC) as odour units / m3 at specific receptor locations and as contours of specified odour levels within 1 km radius around plant.

56. The dispersion of odour concentrations based on emissions from source of origin shows that the highest concentrations 4.76 OU/m^3 at a point located within 100 m from the source. As per guidance available in the UK, it is generally accepted that odour concentrations of 5 – 10 OU/m^3 give rise to a faint odour which may just exceed the annoyance threshold of human receptors and distinct odour which can give rise to a nuisance results from a concentration of > 10 OU/m^3. Low impacts will be caused by the operation of the STP for the residents of Arupara. As these residential houses are within ~50 m from STP southern boundary.

Potential Impact on Drainage

57. During project life-cycle potential scenarios impacting the surrounding drainage system are, firstly, storm water from northern boundary entering into STP complex through broken boundary, secondly, flood scenario developed due to heavy rainfall. Lastly, daily operation of STP resulting in discharge of treated wastewater.

58. Under all scenarios discussed above, discharge will happen into Howrah drainage channel connected through brick sewer line due to natural slope. As discussed in baseline the carrying capacity of Howrah drainage channel is 7968 MLD. Hence we infer that excess load of 65 MLD from STP operation will not have any impact on the drainage of the surrounding. The potential impact scenarios as discussed above will also have negligible impact on the drainage due to buffer carrying capacity of ~7000 MLD. Therefore the impact significance is assessed to be negligible.

Potential Impact on Surface Water Quality

59. No adverse impact on surface water quality is envisaged as no discharge into surface water is proposed during construction phase and all proposed phase activities will happen within the STP complex as result the there is no interaction with surface water resource also.

60. During operational phase of the proposed project activity, treated water due to operation of the proposed 65 MLD STP will be discharged into Howrah Drainage Channel. The qualitative discharge characteristics will be maintaining stipulated regulatory limits for the STP operation under Environment (Protection) Amendment Rules, 2017 by Ministry of Environment, Forests and Climate Change, Government of India and as stipulated under the Concession Agreement. Howrah Drainage Channel, the surface water stream that would receive the discharge is already significantly polluted by untreated sewage and waste water load from upstream areas in it catchment and the downstream Howrah Drainage system has also been observed to be having

similar conditions with the average observed BOD concentration in the range of 50 – 60 mg/l. So the treated effluent discharge which is to be having BOD levels (design) of 20 mg/l is unlikely to cause any incremental adverse impact to the receiving surface water environment. Therefore, both during construction and operational phases of the proposed project activity will have negligible impact on surface water quality.

Potential Impact on Ground Water Quality

61. There will be no groundwater extraction during project life-cycle, as per site observation, there exist a borewell near the entrance gate along the eastern boundary or west of existing MPS within the STP complex, which is used for drinking and domestic purpose presently. All water during construction and will be sourced through water tankers and during operation phase water will sourced from municipal supply with daily withdrawal rate of 0.5 m3/day as mentioned in Consent to Established (CTE) applied by Wabag. Hence there will no impact on ground water resource. Potential sources of impact for ground water contamination are minor oil and grease spillage, during maintenance of construction machinery, repair of pumps and compressors during operational phase. Leakage from brick sewer line along the H.I.T road and affecting the sub-surface area cannot be ruled out as the soil layer surrounding the STP is sandy-clayey and having high porosity in nature.

Potential Impact on Soil Quality

62. During construction phase, Impact scenario envisaged for the project phase are firstly wastewater generated during suppression of fugitive emission during this phase and secondly, chances of oil spills and oil/grease mixed cotton waste not properly disposed after maintenance/repairing activities of construction equipment.

63. Contamination of soil can happen only due to accidental spillage of fuel, lubricants and paints from storage areas and during the transfer of fuels and chemicals. The above mentioned soil quality impacts will be localized within the project site or immediate vicinity. The potential impact on soil quality is assessed to be **minor**.

Potential Impact on Road Traffic

64. The STP site is connected through one major route i.e. H.I.T road connecting to Dr.Bholanath Chakraborty Sarani which meets Kona expressway. To understand the baseline condition and traffic influx, baseline monitoring was undertaken on H.I.T road, which would be predominantly used during the de-construction phase for trucks, tippers, and other heavy machinery that will be mobilized. During construction phase, additional 10-15 PUC/day carrying construction material, disposal of construction waste and transportation of plant machineries and raw materials will be using the Kona Expressway through H.I.T road and Dr.Bholanath Chakraborty Sarani. Based on the baseline traffic survey conducted (Refer Section 4.2.13). The average peak hourly traffic on this route was 4.01 PCU/Hr (up) and 3.85 PCU/hr (down) number of vehicles per hour and maximum traffic load was 10.75 PCU/Hr (up) and 7.5 PCU/Hr (down).

65. Additionally, another cause of traffic congestion is the excavation works that will take place during the laying of the sewer lines, along the main roads. This will cause disturbance to traffic movement, which may cause some inconvenience to inhabitants, especially during the peak hours. As observed during site visit, the line passes through busy roads such as the Swarnamoyee road, Laxman Narayan Tola Road, and Ichapur road (HIT Road). These traffic and access disruption impacts will arise due to transportation of construction materials, movement of machinery and equipment, as well as excavation work. The potential impact on road and traffic due to operational traffic is assessed to be **minor**.

Potential Impact on Community Health & Safety

66. During the construction stage of the project, there will be an influx of workmen and labours, with some of them being from different socio-cultural settings as compared to the residential settlement around site. In the case that hygienic conditions are not maintained at the project site, there may be a vector borne and other ailments in the immediate vicinity. Unless proper sensitization of neighboring communities is undertaken and appropriate safeguards are adopted, there is a possibility for increase in sexually transmitted diseases, though the possibility appears quite remote.

67. Very few people living near the site, no significant health related impacts are expected to the communities in the area. The increase in vehicular movements as a result of plying of construction vehicles on the adjoining roads and the site access road would add to the risk of accidents in which local residents may be involved. Although there is a public concern over the potential health effects associated with the exposure to noise, odour and fugitive emissions, empirical data is insufficient to demonstrate adverse health impacts from typical STP projects. Considering good construction practices and planned embedded measures for mitigating these impacts, the overall significance of community health and safety impacts can be rated to be **minor**.

Potential Impact on Occupational Health & Safety

68. During construction phase, the sources of impact are waste handling and storage, material handling and storage, welding and gas cutting activities, use of earth moving equipment, Installation of electrical equipment, Installation of chlorination unit. Personal Protective Equipments (PPE) such as Protective footwear and protective goggles, Welder's protective eye-shields shall be provided to workers who are engaged in welding works, earplugs shall be provided to workers exposed to loud noise, and workers working in crushing, compaction, or concrete mixing operation. Workers deployed for renovation of brick sewer line will work in confined space, with low oxygen availability is another aspect which cannot be neglected. The overall impact with considering the embedded control systems is minor.

69. During operational a number activity i.e. regular maintenance of STP equipment resulting in discharge of lube oils and grease, change over chlorine tonners, sample collection for quality analysis, planned shutdown of STP for cleaning purpose, handling and storage of sludge from sludge digester etc. all of these activity pose potential health and safety risk for employees involved during these activities as well as to the environment. Due to embedded control measures impact from above mentioned activities is estimated to be minor.

Potential Social Impact due to Access Disruption

70. During construction phase, the proposed project will entail temporary access disruption during renovation and replacement of the sewer lines involving laying of raising main and replacement of gravity sewer line. These will involve, excavation work, removal of debris and piling up of mud earth along replacement of raising main. The proposed project will entail access disruption during the laying of new rising main of 700m as identified during the joint site visit. Movement of large construction machinery and vehicular movement for transportation of construction materials will also likely to cause access disruption.

71. The potential receptors that will be impacted due to access disruption are approximately seven shops, which are located along the Swarnamoyee Road and five shops located along Botanical Garden road, near the RoW of the project footprint. The access towards these shops will be

disrupted during the construction work, particularly if there is excavation work involved. Similarly, it has been observed that one college is located near the alignment of the proposed work. As observed, the roads along where the sewer line traverses through are very narrow and congested areas. Reportedly, the alignment of the pipeline is along the middle of the road.

72. Construction work along the raising main pipeline will consider the necessary safeguarding measures to minimize the durations and extend of the impacts, the concessionaire will carry out excavation through machine (backhoe excavator). Additionally during excavation works, safety measures such as used of danger lighting, sight rails, safety barricades, signage of retro-reflective sheet of high intensity grade will be used for avoiding any kinds of mishaps and incident to the commuters and pedestrians.

73. As reported by the project concessionaire, the number of days for the construction will be carried out in stretches and the excavation, replacement and backfilling of a 25 m stretch, will take approximately three days. Therefore the estimated time period that will cause access disruption for the local communities and commuters along these stretches is estimated to be three days. Moreover, as reported by the project concessionaire, the design of the sewers will be laid based on the depth of existing sewer line. The width of the trench excavation along the roads will vary from 0.8 m to 1.5 m and the depth varies from a minimum of 1.5 m to 2 m or as per the existing pipe line. Thus taking into consideration the diameter of the pipeline, the exaction work for replacement of sewer line will affect approximately 5 ft of the total width of the road which comprises of 2.5 m on the left hand side (LHS) and 2.5 m on the right hand side (RHS).The excavation work for replacement will be carried out in stretches.

Potential Social Impact due to temporary Loss of Income

74. Road side vendors and shops who are operating their businesses as squatters within the RoW of the existing rising main will be impacted due to replacement of the 700 mm dia and 700 m rising main from BESU Lifting Station, along Swarnamoyee Road and Botanical Garden road. The excavation work may potentially lead to road blockage and access disruption, and as a result the commercial establishments and vendors located near the RoW of the project footprint will face some disturbance in operating their businesses on daily basis. On the basis of screening and site visits along the road stretches through which sewer lines are likely to be laid/replaced reveal that there will be temporary disruption to on-going commercial and vending activities, thus leading temporary income loss during the period of construction period (which is assessed to be around three days).

75. Construction work along the sewer line will consider the necessary safeguarding measures to minimize the durations and extend of the impacts. Since the resulting impact will be temporary therefore, overall impact due to access disruption with considering the embedded control systems is assessed to be **minor**.

Potential Impact on Gender

76. The project is found to have least adverse impact on women. As per the baseline survey conducted as part of the SIA in Arupara project area of influence only two woman-headed HHs which are both located near the Arupara STP site. However, both these two households are not projet affected person.
77. Review of female workforce participation reveal that the surveyed population indicates that majority of the women are not participating in the workforce and the consultations also revealed that majority of the women are engaged in unpaid domestic work. Similarly, a review of the workforce participation at the Arupara STP and linked facilities reveal that all the workers are male workers, with the exception of one female employee at LS 2 Foreshore Road. As a result,

there is need to promote gender equality in all aspects of economic development. Women's roles in construction are mainly confined to supply of unskilled labour and vending of foodstuffs to the construction workers. As civil construction work will take place at Arupara STP, including at the linked facilities during the construction phase, the participation of women in the construction workforce should be ensured to reduce gender disparity and enhance gender mainstreaming. Accordingly, detailed methods of engagement for women in the project area are presented in the Gender Action Plan (GAP) developed for the Project.

Potential Social Impact due to Loss of Employment for the Existing Worker

78. At present there are 24 contractual workers employed at the Arupara STP, 9 workers at Arupara MPS, 8 workers at Itchapur MPS, 6 workers at LS-3 and 5 workers at LS-2 under the 'Associated Cooperative Labour Contractor and Construction Society Limited' and 5 workers at LS-1 under MCE Construction contractor. Additionally, 6 secuirity personnel were directly engaged by the KMDA. During project operational phase, the new STP and linked facilities like pumping stations will be operated and maintained by the new O&M entity engaged by GSPPL, therefore, there is a probability of retrenchment scenario of the existing contracted workers, which may lead to a loss of livelihood for those existing workers.

79. As the mitigation measure, it has been mutually agreed and accorded between GSPPL and KMDA to ensure livelihood of the existing workers, that KMDA they will re-deploy the existing contractual workers from Arupara and Baranagar facilities to other facilities of KMDA, while GSPPL will be responsible for re-engaging 32 existing contractual workers from Bally MPS and the linked facilities.

F) Analysis of Alternatives

Site Location Alternatives

80. The proposed project involves involve construction of a new STP of 65 MLD capacity at sludge drying pond area of the existing STP facility, construction of septage plant and renovation of linked intersection and diversion sewerage network. As part of the project bidding process under NMCG programme, the Concessionaire GSPPL is entrusted to implement and operate, the project within the pre-existing premises and piece of land, therefore no alternate sites were considered. Moreover, he proposed plant site is in accordance with Ministry of Environment, Forests and Climate Change, Government of India guidelines, i.e. there are no National Parks/Sanctuaries within 10 km radius of the proposed project site as well as there are no Historical places/places of tourist importance within 10 km radius of the proposed project location.

Technology Alternatives

81. Comparative statement of different STP technology such as Conventional Activated Sludge, Process (ASP), Extended Aeration (EA), Sequencing, Batch Reactor (SBR), Cyclic Activated Sludge (CAS), Membrane Bio Reactor (MBR) and Trickling Filter along with the corresponding environmental and social impacts are analysed. Based on analysis, it has been objectively established that Sewage treatment plant based on sequential batch reactor (SBR) as selected for the proposed project activity is a proven technology and has specific advantages compared to other conventional sewage treatment technologies.

Sewer Pipeline Route Alternatives

82. The proposed work for replacement of sewer line and laying of rising main will be carried out in the existing RoW; hence, no alignment route will be required. As a result, the scope for analysing

the alternative alignment/site for sewer line is very limited. However as reported by the site representative of the Project Concessionaire, the following alternatives will be adopted. Therefore as per the scope of the bounding Concession Agreement to GSPPL, opportunity on analyzing alternative sewer pipeline alignment route will be very limited.

83. Reportedly, during construction phase GSPPL will consider the alternatives. *Alternative A:* in case the stretches for carrying out the proposed work is found to have any sort of displacement (physical or economical), the alignment of the sewer line, will be adjusted either shifting the alignment of the existing sewer line from the flank of the roads towards the centre of the road or likewise. Such approach will not cause any physical displacement by the project. *Alternative B:* In case the stretches for undertaken the work were found to have any severe impact such as displacement (physical or economical), the proposed work will be revisited to avoid major impacts. Moreover, for impacts that are unavoidable, including temporary impacts, consultation will be undertaken and mitigation measures will be taken meeting the safeguard requirements of IFC Performance Standards.

G) Information Disclosure, Consultation and Participation

84. Series of consultations and meeting were held during the ESIA process with relevant stakeholders (government officials, local community, project affected people and existing workers) to have an insight of the baseline situation of the site and regulatory and administrative setups in relation to the proposed project activity, site and envisaged social impacts. This in turn helped in developing an understanding of the perceptions of stakeholders with regards to the project and also allowed for a means of recording their feedback. The stakeholder views expressed were incorporated in the ESIA and the planning and development of the project. Furthermore, GSSPL will establish a stakeholder engagement program for the proposed project site which includes a comprehensive suite of stakeholder consultation, disclosure activities and engagement exercises and media interactions.

H) Grievance Redressal Mechanism

85. A Grievance Redressal Mechanism (GRM) will be in place to handle and resolve the conflicts and aggrieved situations. The GRM will aim to provide a time bound and transparent mechanism for expressing and resolving social and environmental concerns linked to the project. GSSPL will establish a Grievance Redress Cell for reporting and addressing grievances of the affected communities and workers. The Grievance Redress Cell (GRC) will comprised of key members from GSPPL, District Magistrate (if required), KMDA, Local Authority, Local NGOs and key members of the local Municipal ward. The proposed GRC will involve at least two female members.

I) Environment and Social Management Plan

86. Project specific Environment and Social Management Plans (ESMP) have been developed with an aim to avoid, reduce, mitigate, or compensate for adverse environmental and social impacts/risks and to propose enhancement measures. The plan covers;

- Mitigation of potentially adverse impacts;
- Monitoring of impacts and mitigation measures during project implementation and operation;
- Institutional capacity building and training;
- Compliance to statutory requirements; and
- Integration of the ESMP with project planning, design, construction and operation.

Livelihood Restoration Plan

87. As a part of the ESMP, a standalone Livelihood Restoration Framework (LRF) has been prepared. Based on further detailing of project plans and firming of the project footprint and subsequent land requirements, a Livelihood Restoration Plan (LRP) will be prepared by GSPPL that will delineate the exact magnitude of impact, number of APs and their compensation entitlement along with cost for implementing the LRP. Impacts related to land acquisition, involuntary resettlement and livelihood restoration of the affected persons (APs) - titleholders, non-titleholders, land users groups, encroachers will be covered in the LRP based on the final project footprint.

Environmental Monitoring

88. The environmental monitoring programme has been devised with the following objectives:

- To evaluate the effectiveness of the proposed mitigation measures and the protection of the ambient environment as per prescribed/ applicable standards for the Project;
- To identify the need for improvements in the management plans;
- To verify compliance with statutory and community obligations; and
- To allow comparison against baseline conditions and assess the changes in environmental quality in the Project area.

Reporting Mechanism for Environmental and Social Monitoring Program

89. A robust reporting system will provide the Project with the necessary feedback mechanisms to ensure quality and timely implementation of the works. The reporting system will ensure regular flows of information from the Project site to the Project headquarters and, as necessary, to regulatory authorities and funding agencies. The reporting system will provide a mechanism for ensuring that the measures proposed in the Project's ESMP are implemented.

90. Reporting will be done in form of environmental checklist, incident record register, environmental and social performance reports on periodic basis (monthly, quarterly, half-yearly, yearly etc.)

91. The quarterly reports of the management measures will form an integral part of the Quarterly Progress Reports that can be submitted to KMDA, NMCG and the lenders involved.

1. INTRODUCTION

1.1 Background

Kolkata Metropolitan Development Authority (KMDA) is the statutory planning and development agency with the specific purpose of carrying out major infrastructure development projects in Kolkata Metropolitan Area in the state of West Bengal. KMDA (through State Government of West Bengal) is the owner of the existing Arupara STP, linked sewerage infrastructure and land as well as the designated executing agency for the renovation and upgradation of the Arupara STP under the NMCG Programme[1] and the principal project titled "Development of Sewage Treatment Plants – Kolkata City Area".

The existing STP is located in Arupara, under Howrah Municipal Corporation (HMC) and is one of the identified sub-projects under project titled "Development of Sewage Treatment Plants – Kolkata City Area" of KMDA. This project would involve construction of a new STP of 65 MLD capacity and renovation of linked pumping stations, intersection and diversion sewerage network. The existing Arupara Sewage Treatment Plant is located near Dharsh locality at Arupara, Dasnagar, Howrah and the linked project components are spread across Howrah Municipal Corporation area which falls under the administrative jurisdisdiction of district of Howrah, West Bengal.

M/s Ganga STP Projects Private Ltd (GSPPL) has been selected as the successful bidder of the project. M/s Ganga STP Projects Private Ltd (the "Concessionaire") has been incorporated by M/s VA Tech Wabag Limited as a 100% equity funded entity to fulfil the requirement towards Hybrid-Annuity based Public Private Partnership (PPP) model. GSPPL is the developer of the project and will hold the ownership of the project assets till the end of concession period of fifteen (15) years. M/s GSPPL in turn will subcontract the Design, Build as well as Operation and Maintenance (O&M) scope for the project to M/s VA Tech Wabag Limited (Wabag). The concession includes 3 components i.e. Baranagar, Arupara and Bally, and this ESIA is only focussed on Arupara. Also that separate ESIAs have been completed for Baranagar and Bally.

1.2 Overview of the Project

The river Ganga, which flows from north to east India, has more than 500 million people living along its basin. Most of the sewage generated in the towns and cities along the river Ganges flows untreated into it without any treatment. Previous attempts to clean the river under the Ganga Action Plan (GAP) launched in 1985 largely focused on creating sewerage infrastructure assets that was operated and maintained by state governments or urban local bodies (ULBs). This approach has failed to improve the water quality of river Ganges[2].

The Government of India (hereinafter referred as "GOI") identified cleaning of the river Ganga as one of its key priorities, and approved the Namami Ganga program (Clean Ganga initiative) for cleaning, rejuvenation, and protection of the river Ganga. Over the years, the river Ganga has been subjected to pollution from various sources which include discharge of urban liquid wastes and sewage, industrial liquid wastes, large scale wallowing and bathing of cattle, throwing of carcasses and dead bodies in the river, surface run-off from agricultural fields using pesticides and insecticides and leachate from solid and industrial waste dumps. The overall scheme aims at preventing the discharge of untreated industrial and municipal wastewater into the River Ganga through several water treatment projects.

[1] NMGC Administrative Approval and Expenditure Sanction (No. T-15/2015-16/1245/NMCG); dated 10.10.2017

[2] IFC, Public Private Partnership Stories, Clean Ganges (Varanasi & Haridwar) PPP http://documents.worldbank.org/curated/en/406501542222553654/text/132039-BRI-PUBLIC-India-Clean-Ganga-PPP-Stories.txt

Recognising the need, National Mission for Clean Ganga (NMCG) constituted under Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India has set an objective to ensure effective abatement of pollution and conservation of the river Ganga and its tributaries by adopting a river basin approach for comprehensive planning and management. An Integrated Ganga Conservation Mission namely “Namami Gange” has been approved as ‘Flagship Programme’ set up in June 2015 to accomplish effective abatement of pollution, conservation and rejuvenation of the river. The approach to achieving this objective entailed the preparation of an integrated and comprehensive scheme to intercept and treat the entire quantity of waste water generated in the town and would flow through the drains into the Ganga. The program is being implemented by the National Mission for Clean Ganga (NMCG), and its state counterpart organizations i.e., State Program Management Groups (SPMGs). The ‘Urban Development & Municipal Affairs Development (Urban Development Branch), under State Government is the designated SPMG, which is a registered society of the State Government constituted with the objective of serving as the dedicated institution for effective implementation of the Namami Gange programme activities at the State level. The Government of India had accorded Cabinet approval to Hybrid Annuity- Public Private Partnership (PPP) model for creation and maintenance of sewage treatment infrastructure under the Namami Gange Programme[3]. Under this model, the development, operation and maintenance of the sewage treatment STPs will be undertaken by a Special Purpose Vehicle (SPV) to be created by the winning bidder at the local level. As per this model, 40% of the capital cost quoted would be paid on completion of construction while the remaining 60% of the cost will be paid over the life of the project as annuities along with operation and maintenance (O&M) cost. A key element of this model will entail making Annuity and O&M payments linked to the performance of the STP in order to, which will ensure continued performance of the assets created due to better accountability, ownership and optimal performance.

The principle scheme objective is to prevent untreated wastewater of drains from joining the river by intercepting the drains that have outfalls in the Ganga, divert them through sewers to Sewage Treatment Plants for treatment and allow only treated sewage to be discharged into the river Ganga.

The overall scheme envisages implementation of a number of wastewater treatment projects along the river to clean municipal wastewater before discharge. Under the flagship program of Namami Gange, NMCG in association with Kolkata Metropolitan Development Authority (KMDA), has conceived to implement the project titled “Development of Sewage Treatment Plants – Kolkata City Area”, which for the Arupara STP specifically comprises of the following components:

i. Construction of a new STP with existing Arupara STP compound with a proposed capacity of 65 MLD,
ii. Construction of a septage management facility of 150 cum/d capacity,
iii. Renovate, operate and maintain Arupara linked Infrastructure which include lifting stations, main pumping station (MPS) and Sewer pipeline network,
iv. Operation and maintenance of the Arupara STP for 15 years after completion of its construction and renovation work.

Reportedly, the previous STP of capacity 45 MLD at Arupara, was constructed based on Activated Sludge Process (ASP) Technology. The proposed new STP will be constructed with similar ASP technology but with a higher treatment capacity i.e. 65 MLD and provision of power generation through biogas plant as part of the project design.

The project is being implemented on hybrid annuity based PPP mode and for the implementation of the project, M/s VA Tech Wabag Ltd. as the selected bidder has incorporated a Special Purpose

[3] Market Conference on Hybrid-Annuity based Public Private Partnership (PPP) model for creation of sewage treatment Infrastructure under Namami Gange Programme, Dated 24th Feb 2016, Vigyan Bhawan. https://www.nmcg.nic.in/writereaddata/fileupload/4_Market%20Conference%20summary%20report%20v2compressed.pdf

Vehicle (SPV) – the "Concessionaire" entity M/s Ganga STP Projects Private Ltd. (GSPPL) under Indian Companies Act, 2013 on 5th April 2019 for development of the project "Development of Sewage Treatment Plants – Kolkata City Area". Subsequently a Concession Agreement (tripartite) has been signed among NMCG, KMDA and M/s GSSPL. In the proposed project context, KMDA is the client to the Concessionaire and will be the owner of all assets after the end of concession period of fifteen (15) years. The NMCG will operate as the governing authority and will be governing the overall escrow mechanism and payments to Concessionaire.

Previously KMDA had commissioned one ESAMP study on the STP project through external agency Centre for Studies in International Relations and Development for Namami Ganga Scheme during 2017-2018. As the earlier ESAMP study has captured the quantitative nature of impacts based primary monitoring and analysis, along with other insufficiencies and gaps. Hence, as per requirement of Concession Agreement, the Concessionaire i.e. GSPPL has commissioned a fresh ESIA-EMP study for the proposed project activity by engaging ERM India Pvt. Ltd (hereinafter referred as "ERM") during May, 2019 in order to identify and address all the impacts due to project activity.

1.3 Need of the Project

The Government of India (the GOI) identified cleaning of the river Ganga as one of its key priorities, and approved the Namami Ganga program (Clean Ganga initiative) for cleaning, rejuvenation, and protection of the river Ganga. Over the years, the river Ganga has been subjected to pollution from various sources which include discharge of urban liquid wastes and sewage, industrial liquid wastes, large scale wallowing and bathing of cattle, throwing of carcasses and dead bodies in the river, surface run-off from agricultural fields using pesticides and insecticides and leachate from solid and industrial waste dumps. The overall scheme aims at preventing the discharge of untreated industrial and municipal waste into the River Ganga through a number of water treatment projects.

Arupara STP with 45 MLD capacity was built to treat the sewage water generated in western part of Howrah municipality area but the STP stopped functioning since 2016. The old STP has completed its operational life-cycle and through feasibility studies it was concluded that 100% functional efficiency cannot be achieved through repairing. Thus, the concept of building new STP has been conceived by KMDA through complete demolition of existing non-functional STP structure. The new STP will treat 65 MLD (as per the project documents) of sewage water generated from the catchment area, which is presently discharged into Hooghly River without any treatment through the Howrah drainage channel.The STP will treat the sewage water coming from Western part of Howrah municipality. The treated water from the STP will improve the water quality of the Hooghly River in addition to surface waterbodies/streams in the area and result in a reduction of pollution load of the same.

The capacity of the old STP was built based on the previous population load. The generation of the wastewater has increased with the increase in population. The enhanced capacity of the new STP designed to accommodate the increasing population load. It is to be noted that the capacity of the STP was pre-determined by KMDA under the NMCG scheme and accordingly it has governed under the Concessionaire Agreement with GSPPL.

1.4 Objective and Scope of the Study

The primary objective of the assignment is to ensure that the proposed sewerage treatment and linked infrastructure project complies with the national and international policy frameworks and safeguards for environmental and social compliance (as per IFC Performance Standards 2012; IFC General EHS Guidelines (2007) including Industry Sector Guidelines for wastewater treatment plant; and applicable national and international laws, regulations, standards pertaining to environment, health, safety, social and labour in India) while carrying out the construction and pre-commission operations and maintenance work.

The objectives of the overall assignment is to support VA Tech Wabag Ltd. :

a) Conducting environmental and social gap assessment of the existing facilities under the project;

b) Update/ revalidate and prepare an environmental and social (E&S) impact assessment of the existing and new facilities proposed under the project; and

c) Formulating E&S management plans, entitlement framework along with stakeholder engagement plan (SEP), gender action plan, and labour management plan.

1.4.1 Scope of Work

The scope of work for this ESIA project is elaborated below:

Sl. No.	Scope Items
Phase I	
1.	Environmental and Social (E&S) Gap Assessment
2.	Preparing Environmental and Social Baseline Assessment for the project's area of influence
3.	Updating and preparation of Environmental and Social Impact Assessment (ESIA) Addendum of existing new components under the project
4.	Formulating E& S Management Plans that will include Stakeholder Engagement Plan (SEP), Gender Action Plan (GAP) and Social Impact Assessment , Livelihood Restoration Framework and Labour Management Framework
Phase II	
6.	Undertake Census Survey and prepare of Livelihood Restoration Plan (LRP)

As the part of the overall scope of work, Phase I of the assignment entails preparation of the environmental and social baseline of the project's study area and assessing impacts associated with the proposed project activities, covering the following points:

The assessment shall include the following components:

- Review of existing EIA/ ESMP report for Arupara STP area;
- Conducting enviornmental and social baseline assessment based on secondary information and environmental primary data collection through monitoring of environmental parameters in the study area and social primary data collection through socio-economic sample survey;
- Conducting environmental and social impact studies for Arupara STP project in accordance with IFC PS, covering the following issues and risks
  - The location and impacts on sensitive receptors including residential houses, schools, health care facilities, aged care facilities, ecological sensitive habitats etc.;
  - Monitoring of the receiving environment, including water quantity and quality;
  - Noise, vibration, air quality and odour impacts (including airborne pathogens) during construction and operation, in comparison to national and international standards;
  - Assessment of the terrestrial and aquatic ecology of the site, surrounds and receiving environment, including presence of Modified Habitat, Natural Habitat, and/or Critical Habitat, protected areas, protected or endangered species or habitats;
  - Study proposed solid and hazardous wastes management practice, including waste management during construction, volumes of sludge to be produced, processing, recycling and reuse of treated wastewater and bio solids, storage and/or disposal;

- Assess flood risk and draw up mitigation measures focusing on design and operation, including impacts of heavy rainfall events and climate change, as well as discharges from the STPs, PS or trunk sewers in such events;
- Prepare plan for protection of workers and community health and safety during construction and operation, including construction camps, traffic management, hazardous substances, solid waste and effluent discharge.
- Identify any impacts on physical cultural resources and heritage sites;
- Assess the social impacts of the Project, including completion of a socioeconomic survey with gender -disaggregated baseline socio-economic data, compare survey results, undertake focus groups and key informant interviews to validate predictions in the social impact section of the existing Environment and Social Management Framework reports;
- Undertake a gender analysis and conduct focus groups with women in the communities and among female employees and staff to identify issues, develop measures to address time poverty, improve living conditions and promote economic empowerment and other opportunities for gender mainstreaming; and
- Provide the process and outcomes of meaningful consultation with project affected people and concerned stakeholders, how concerns have been addressed, and how engagement will continue during construction and operation.

Note: It has been recognised that bio-aerosols (which may include microorganisms such as viruses, pathogenic bacteria, and fungi) emitted by STP components may constitute a health risk to STP workers and neighbouring community. However, as the STP is not presently operational, there is no way that the bio-aerosol load on atmosphere in the immediate vicinity of the STP can be monitored in terms of colony-forming units per unit volume of air (CFU/m^3). There are also no standardised predictive approaches to estimate potential bio-aerosol emissions based on a proposed STP design. In terms of treatment through this ESIA, ERM proposes a monitoring plan through which bio-aerosol concentrations can be monitored periodically and appropriate mitigation actions can be planned, as required during operational phase of the project.

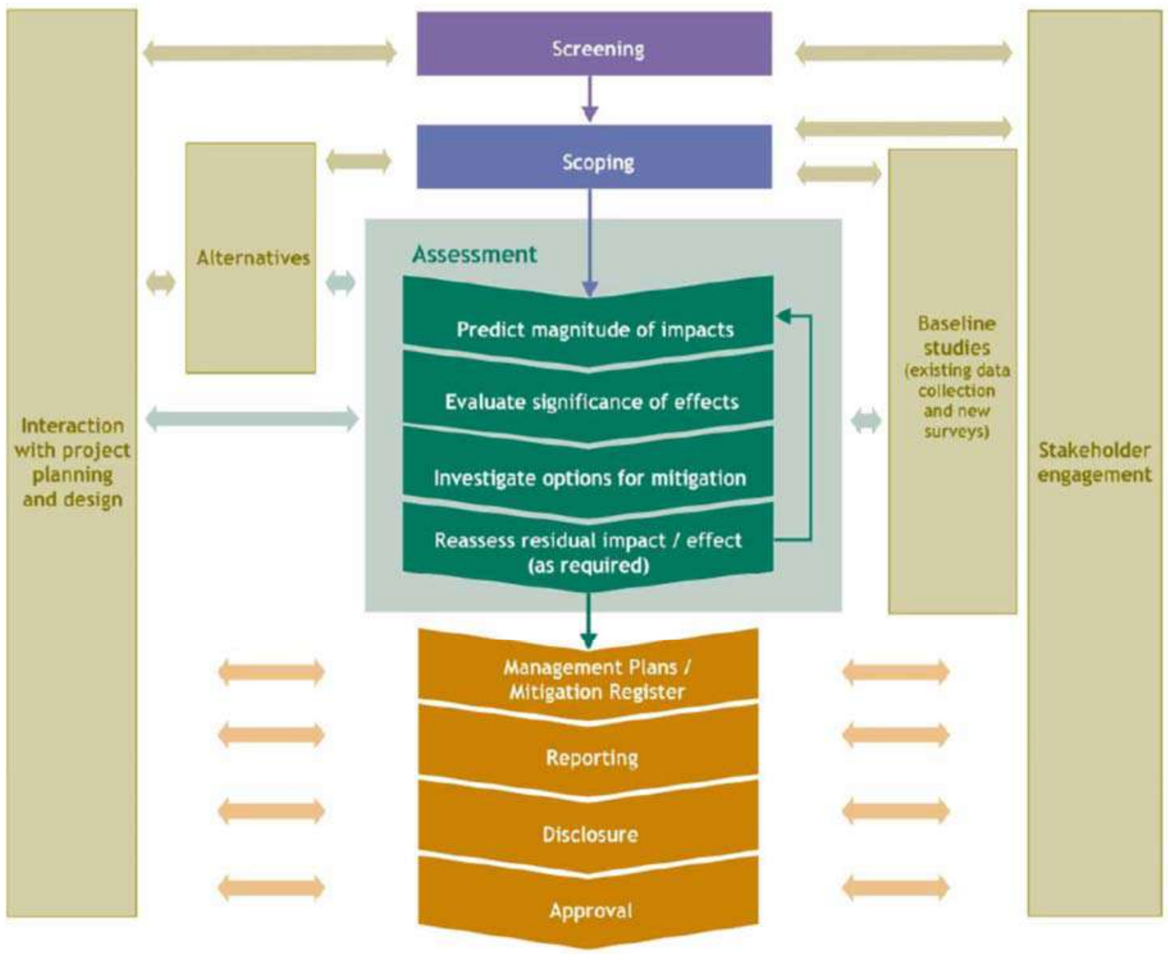
- Formulate mitigation measures and actions, where impacts and risks cannot be avoided or prevented and prepare an Environmental and Social Management Plan (ESMP) for the project. The ESMP shall also include a Stakeholder Engagement Plan (SEP), Gender Action Plan (GAP), Livelihood Restoration Framework and Labour Management Framework
- The ESMP has charted out of feasible control technologies, embedded controls and mitigation measures for implementation by the Client to minimize adverse impacts of proposed activities such as:
  - Pollution control measures proposed to meet the emission, effluent and noise standards etc.;
  - Solid/hazardous waste management practices;
  - Mitigations on Occupational health and including an occupational health surveillance programme.
  - Mitigations for management of social impacts through mitigation measure at community level;
  - Mitigation measures and management plans for implementation with defined timelines and responsibilities;
  - Organisation required for implementation of management program during construction and operation phases of the Project;
  - Monitoring and reporting mechanism both for regulatory compliance as well as internal assurance within the Client organisation;

- Environmental quality monitoring programme during construction phase and operational phase will be provided;
- Emergency response procedures, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators.

1.5 Approach and Methodology of ESIA

The ESIA has been undertaken following a systematic process that predicts and evaluates the impacts on aspects of the physical, biological, social/socio-economic and cultural environment of the surrounding due to project activity. It also identifies measures that need to be taken to avoid, minimise/reduce, mitigate, offset or compensate for adverse impacts; and to enhance positive impacts where practicable. The ESIA methodology follows the overall impact assessment approach illustrated in ***Figure 1.1***.

Figure 1.1 Impact Assessment Process



1.5.1 Screening

The screening process has been carried out based on preliminary information provided to ERM determining applicability of relevant GoI legal regulations, IFC performance standard requirements to the project. This step was conducted via document review and on-site assessment of the Project and their linked facilities. The screening process involved the following:

- Reviewing of available project related documents which include Process design document, T & D (Technical and Design) work document, previous study reports etc.
- Reviewing of applicable regulatory framework for the proposed project;
- Collection and compilation of available secondary baseline data from different sources;
- Categorisation as per EIA notification 2006
- Categorisation of Project as per IFC guidelines; and

1.5.1.1 Project Categorization as per EIA notification 2006

The proposed project activity involves construction of Arupara STP, renovation and installation of sewage treatment plant and linked sewerage infrastructure which does not fall under the listed project as per EIA Notification, 2006 and therefore does not require Environmental Clearance.

1.5.1.2 Categorization as per IFC PS (2012)

IFC's has provided a provisional categorization tool for projects. The tool assigns an E&S category based on risk inherent to the particular sector, as well as on the likelihood of a development taking place and on what can be reasonably ascertained about the environmental and social characterization of the Project's likely geographical setting. As part of the review of environmental and social risks, impacts and magnitude for the proposed project, it is envisaged that the impacts on are few in number, site- specific, largely reversible, and readily addressed through mitigation measures.

Hence, the proposed project can be categorized as Category B project as per IFC PS (2012).

For Environment, the project has been categorized as B because though the project is expected to have certain has environment and social impacts, they are site specific which can be managed by with targeted mitigation measures.

The project is also categorized as B as the Project will mainly trigger temporary livelihood loss due to renovation activities such as replacement, laying of new pipelines and desilting work undertaken for the sewer pipelines causing temporary income loss of road side vendors, kiosks, carts and shops along the stretch of the project sewer line

1.5.2 Scoping

The purpose of scoping exercise was to identify the likely project activities influencing the environmental components which should be covered in the ESIA study. Scoping was further used as a basis for defining the impact assessment, planning and implementation of mitigation, monitoring and reporting mechanisms for the project to meet potential Lender's requirements. The scoping identified the range of environmental and socio-economic topics to be studied and the geographical area to be covered (spatial scope). No separate scoping study was conducted for this project although an Impact Identification Matrix for Arupara STP and linked Facilities has been developed and elaborated in ***Section 5.3*** for assessing the overall impact of the project on various environmental and social components.

1.5.3 Baseline Data Generation

The required environmental and socio-economic baseline data were collected and compiled from primary and secondary sources. Primary environmental monitoring data surrounding the STP area was collected during June, 2019 to August, 2019 and primary socio-economic data was collected during July, 2019 to September, 2019.

Apart from primary data, secondary data was also collected from different government departments, local bodies, literature surveys etc. All data were compiled and compared with applicable standards where relevant, and is presented in ***Section 4*** of this report.

1.5.4 Impact Assessment and Management

Impact identification and assessment commenced with scoping and continued through the remainder of the IA Process. The detailed methodology for assessing the impacts were given in ***Section 5***. The section covers the identification, prediction and quantification through modelling (where appropriate) of potential impacts due to proposed project.

The impact assessment involved the prediction and evaluation of impacts from the Project in different phases, including construction and operation phases of the Project and included consideration of mitigation measures towards the same.

Impact prediction covered residual impacts (impacts remaining after all possible mitigation has been incorporated) and took into account control measures that are part of the Project design. Additional measures aimed at further avoiding, minimizing and mitigating predicted impacts were suggested where necessary or appropriate.

Impact assessment has also covered potential for cumulative impacts if any due to presence of existing and planned features in the region. Impact assessment also involved risk assessment covering hazard identification, consequence analysis and risk reduction measures and recommendations.

1.5.5 Environmental and Social Management Plan

Based on the findings from the impact assessment process, an Environmental and Social Management Plan (ESMP) (in **Section 9**) has been developed for the proposed STP project. ESMP includes suggested mitigation measure, roles and responsibilities for implementation.

1.6 Report Structure

The layout of the Report has been divided into 10 sections as briefly described in **Table 1.1.**

Table 1.1: Layout of ESIA Report

Chapter No.	Chapter Title	Description
0	Executive Summary	This section includes ■ Brief summary of the entire ESIA report
1	Introduction	This section includes ■ Introduction about the project, ■ Project background, ■ Brief description, ■ Scope of the ESIA study ■ Approach and Methodology ■ ESIA team
2	Project Description	This section describes ■ The proposed project; ■ Its major components; and ■ Its geographic, ecological, social, and temporal context, including This section also examines ■ Alternatives to the proposed project site, technology, design, and operation. ■ It also states the basis for selecting the particular project design proposed and, justifies recommended emission levels and approaches to pollution prevention and abatement.
3	Administrative Framework	This section discusses

Chapter No.	Chapter Title	Description
		It also covers the applicable reference framework being used for the ESIA study in addition to the national regulatory requirements for project financing.
4	Environmental and Social Baseline Conditions	This section describes ■ relevant socioeconomic conditions within the study area, and ■ Looks at current and proposed development activities within the project's area of influence, including those not directly connected to the project. It indicates the accuracy, reliability, and sources of the data.
5	Impact Assessment and Mitigation Measures	This section ■ predicts and assesses the project's likely positive and negative direct and indirect impacts to physical, biological, socioeconomic (including occupational health and safety, community health and safety, vulnerable groups and gender issues, and impacts on livelihoods through environmental media, and physical cultural resources in the project's area of influence, in quantitative terms to the extent possible; ■ identifies mitigation measures and any residual negative impacts that cannot be mitigated; explores opportunities for enhancement; identifies and estimates the extent and quality of available data, key data gaps, and uncertainties associated with predictions and specifies topics that do not require further attention; and examines global, transboundary, and cumulative impacts as appropriate.
6	Alternative Analysis	This section provides analysis of the followings: ■ Technological alternative ■ No Project Scenario
7	Stakeholder Consultations and Participation	This section describes ■ Describes the process undertaken during project design and preparation for engaging stakeholders, including information disclosure and consultation with affected people and other stakeholders; ■ Summarizes comments and concerns received from affected people and other stakeholders and how these comments have been addressed in project design and mitigation measures, with special attention paid to the needs and concerns of vulnerable groups; and describes the planned information disclosure measures and the process for carrying out consultation with affected people and facilitating their participation during project implementation.
8	Grievance Redress Mechanism	This section deals with: ■ compensation payment, ■ improper estimation of affected assets, ■ failure to fulfil commitments, ■ poor management of construction activities, ■ accidents due to inappropriate planning of vehicle movement, ■ Cultural conflicts between migrant workers and local communities etc.

Chapter No.	Chapter Title	Description
9	Environmental and Social Management Plan (ESMP)	This section deals with ■ the set of mitigation and management measures to be taken during project implementation to avoid, reduce, mitigate, or compensate for adverse environmental and social impacts; ■ describes the mitigation, monitoring, implementation arrangements and performance indicators for effective implementation of the ESMP; and ■ Framework management plans for construction phase of the project. This section also describes: ■ the grievance redress framework, setting out the time frame and mechanisms for resolving complaints about environmental performance; and ■ Structure of the grievance redress cell to be formed for the project.
10	Conclusion and Recommendation	This section provides ■ the conclusions drawn from the impact assessment; and ■ Recommendations for environmental and social management during the project lifecycle.

1.7 Limitations

The ESIA study is based on certain scientific principles and professional judgement to certain facts with resultant subjective interpretation. Professional judgement expressed herein is based on the available information.

The assessment was conducted based on the information and documents made available by Wabag along with key informant discussions with relevant stakeholders including KMDA and local inhabitants in and around the project area. While this report has endeavoured to present all identified gaps, issues and impacts against the relevant standards, the following disclaimers should be noted that the review is based upon certain facts with resultant subjective interpretations based on professional judgements. The professional judgements expressed are based on the available facts within the limits of the existing data, budget, schedule and other limitations highlighted above.

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1.8 Uses of this Report

The Client acknowledges that report provided by ERM in relation to the provision of Services is delivered to the Client solely for the Client's benefit. ERM, its officers, employees, contractors, and agents shall owe no duties, obligations or liabilities to any persons in connection with any use of or reliance on the Project information provided by the Client. We make no warranties, express or implied, including without limitation, warranties as to merchantability or fitness for a particular purpose.

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The information provided to ERM on the work done for the linked project facilities are limited. Documents shared by KMDA show that certain stretches of the work will involve laying of new pipeline, though specific detail in this regard is yet to be finalised.

2. PROJECT DESCRIPTION

2.1 Project Background

The existing sewage treatment plant of capacity 45 MLD at Arupara and linked infrastructures i.e underground sewer network, three (3 numbers) Lift Stations (LS) and two(2 numbers) Main Pumping Stations (MPS) were reportedly installed and commissioned during 1970 and it was handed over to Kolkata Metropolitan Water and Sanitation Authority (KMW&SA) at non-operational stage in 1983. During project site visit conducted during June 2019, it was observed that the existing Arupara STP was non-functional since March 2019. It was also reported that the purification system has not been functional since handover to KMW&SA even though few repair initiatives were undertaken. All the lifting station were reported to be partially working to relay the raw sewage, however in the present condition, the raw sewage is being released to the Howrah Drainage Channel and to river Hooghly through the outfall points along the river banks. It was also found that the condition of lifting stations were poor in terms of health and safety measure, absence of barricades and handrails in the location of grid or chambers.

The proposed Arupara STP project will include:

- The proposed scenario involves construction of a new STP of 65 MLD capacity within the existing STP complex. The proposed STP will be constructed at of the eartswhile sludge drying pond area used during pervious STP operation.
- Laying of 700 m of new gravity sewer line (700 mm diameter) in place of defunct existing sewage pipeline near BESU lifting Station.
- Laying of 800 m of new gravity sewer line in place of defunct pipeline and 1.2 km of desilting of existing pipeline inside the premises of GKWL.
- Renovation of 650 m of Brick Sewer line of 2.75 m diameter near Ichapur MPS.
- Rehabilitation of linked sewerage infrastructure which include trunk sewer lines, lift stations and main pumping station.

2.2 Existing and Proposed Project Facility Location

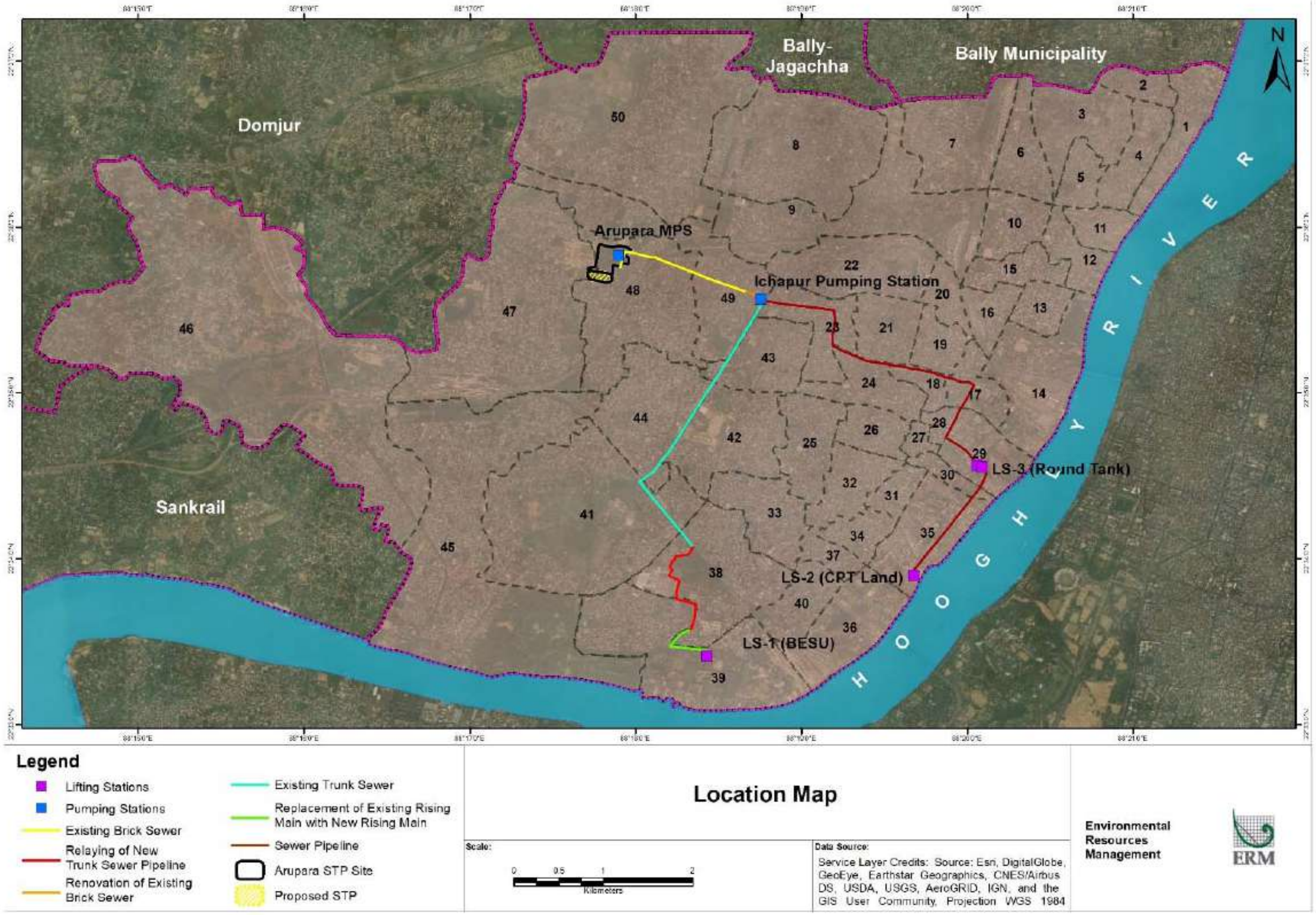
The proposed project area for Arupara Sewage Treatment facility comprised for Howrah Municipal Corporation located in Howrah District of West Bengal State.The existing Arupara STP, which is presently not in operation, is located at Dharsh locality at Arupara, Dasnagar, Howrah, on the western side of the Howrah Kharagpur main railway line and is adjacent to residential settlements at the southern and eastern vicinity. The STP Site is also located in proximity to the Dasnagar Railway Station. The majority of the site falls within ward 48 of Howrah Municipal Corporation. The linked project components are spread across densely populated areas of the Howrah Municipal Corporation.

Old Arupara STP is linked with four pumping/lifting stations including Ichapur pumping station, BESU lifting station, Foreshore Road lifting station and Roundtank lifting station apart from the Main Pumping Station located within the STP complex. Ichapur pumping station is located at Ramrajatala area on Kamardanga Road, BESU lifting station is located at the junction of R.R. Choudhary Lane and College Road along the boundary of Indian Institute of Engineering Science and Technology, Shibpur. Foreshore Road lifting station is located in Shibpur, near Food Corporation of India building on Upper Foreshore road. Roundtank lifting station is located at Mullick Fatak area on Roundtank Lane. Existing trunk sewer lines were laid along the main urban roads namely Dr. P. K. Banerjee road, Panchanantala Road, Narasingha Dutta Road, New HIT Road, Upper Foreshore Road, Swarnomoyee Road, College Ghat Road, Andul Road and Dr. Bholanath Chakraborty Sarani under Howrah Municipal Corporation area. The location map is given in **Figure 2.1**.

The proposed project will utilise the existing land and infrastructure of the sewage treatment facility and linked sewerage infrastructure. The gravity sewer lines, rising main and effluent discharge lines are within the ROW of the public roads under the ownership of PWD (Government of West Bengal) and Municipal roads therefore no additional ROW/ land acquisition in the project scenario will be involved.

Reportedly based on the proposed project implementation details, the existing Main Pumping Station for the Arupara STP, located within the STP complex will be renovated and upgraded, all other structures linked to pervious STP operations, within the STP complex, will not be considered for the proposed project and will be remained as it is where is basis.

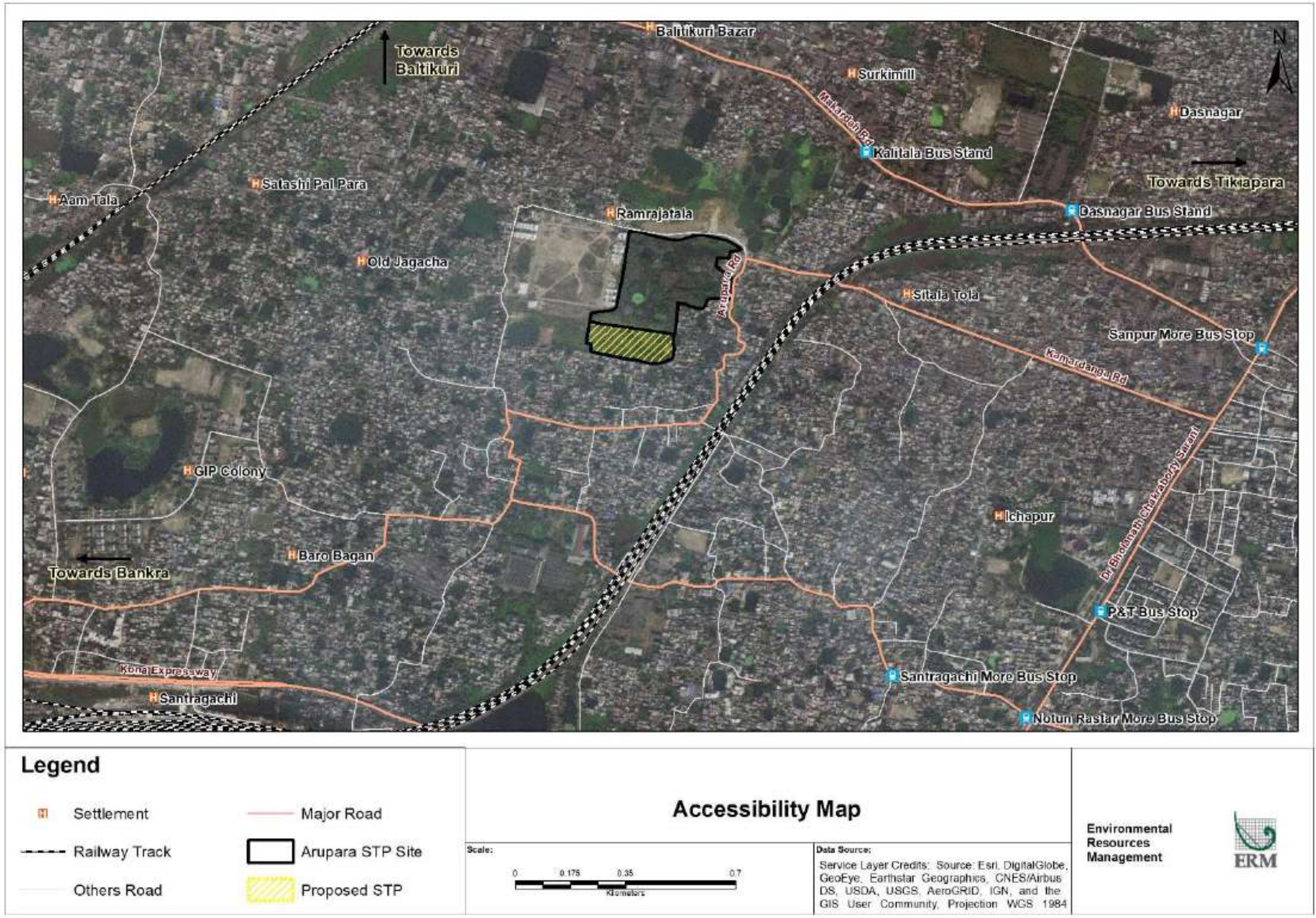
Figure 2.1 Project Location Map



2.3 Accessibility

The project site is located in proximity to the Kona Expressway through two connecting roads, first through Dr.Bholanath Chakraborty Sarani also called as Canal Side Road, till Ichapur water tank junction (~2.23 km) and then connected by Howrah Improvement Trust (H.I.T) Road which is also called as Kamardanga Road (~1.47 km).The project site shall be accessed through above mentioned roads. Both connecting roads to Kona expressway handles dense traffic movements during day time. Dr.Bholanath Chakraborty Sarani is two lane road while H.I.T road is single lane having varying width till STP facility.Width of H.I.T road at Ichapur MPS is ~20 ft for ~0.5 km, then the width reduces to ~15 ft till the railway crossing and after which the width further reduces to ~12 ft till Arupara STP.The site is surrounded by Arupara road which is of ~8-10 ft. The accessibility map is given in **Figure 2.2.**

Figure 2.2 Accessibility Map of the Project Site



2.4 Environmental Setting

As discussed in **Section 2.2**, the Arupara STP is located in HMC. The STP facility shares boundary with Kolkata Police Training Ground (22°35'50.34"N, 88°17'40.73"E) in West direction. The Southern part of the STP facility is surrounded by residential areas of Arupara (22°35'44.59"N, 88°17'56.29"E), GIP colony (22°35'37.00"N, 88°17'47.64"E) and Hatpukur (22°35'41.15"N, 88°17'31.30"E). Eastern part of the STP has H.I.T road and residents of Kamardanga (22°35'48.84"N, 88°18'2.28"E). On northern side, the site has open low lying land and few ponds which are used for local community for daily activities i.e bathing cleaning etc. is present within the STP facility. Kona Express Way is located approximately 1.49 Km away from the southern boundary of the STP at an elevation of 8 to 10 m from the surrounding roads. A green cover is present within the STP facility along its western boundary which was developed as green belt during pervious STP operations. The environmental sensitivities present within 1 km of the STP site are given below:

a) The site is surrounded by settlements of Arupara, Hatpukur and GIP colony at an aerial distance of 0.07 km south.
b) Site shares boundary with Kolkata Police training ground on western side.
c) The site is surrounded by few small ponds, the nearest pond is at Arupara at an aerial distance of 0.05 km from the south-eastern boundary of the STP facility. The ponds are used for occasional bathing and washing by the local people.
d) The Site has small and micro scale industries spreads across the North-west side at an aerial distance of 0.40 km.
e) The site has Bibhuti Engineering Work, a bearing and casting manufacturer on south-eastern side within the residential settlements of GIP colony at an aerial distance of 0.28 km.
f) There is a daily temporary market, which is along the railway line which is on eastern direction of STP at an aerial distance of 0.53 km.
g) There is a small Shiva temple sharing the boundary of STP on southern direction and Sri Sri Shitala Mandir on eastern boundary just at the entrance of STP complex.
h) There is playground under the local club authority used for different functions, i.e. weddings, arranging fairs etc. throughout the year on eastern side just at the entrance of the STP complex.
i) There is industrial area consisting of micro and small scale industries majorly producing iron cast, iron works and fabrication, vest manufacturing etc.

Figure 2.3 Site Setting Photographs

Police Training Ground on the western side of the Arupara STP

Small Industry at HIT Road near Arupara STP

Shops and House on the southern side of the HIT road

Industry behind the Aruapara STP with Stack

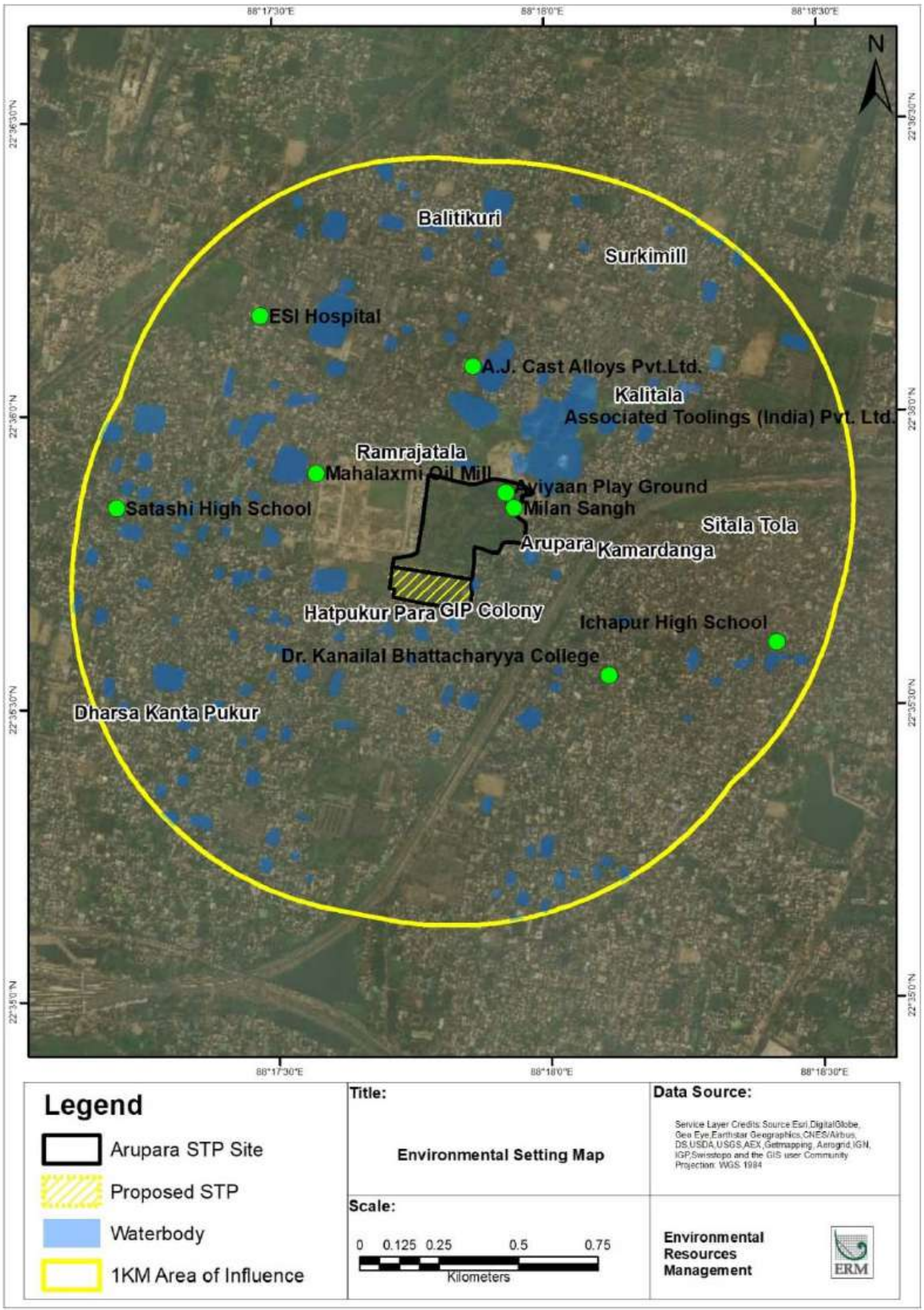
Temple and playground near entrance of the STP Complex

Pond at the northern side of the STP complex

Residential houses on the southern side of the STP complex boundary

Green cover within the STP complex

Figure 2.4 Environmental Settings Map of the STP Site

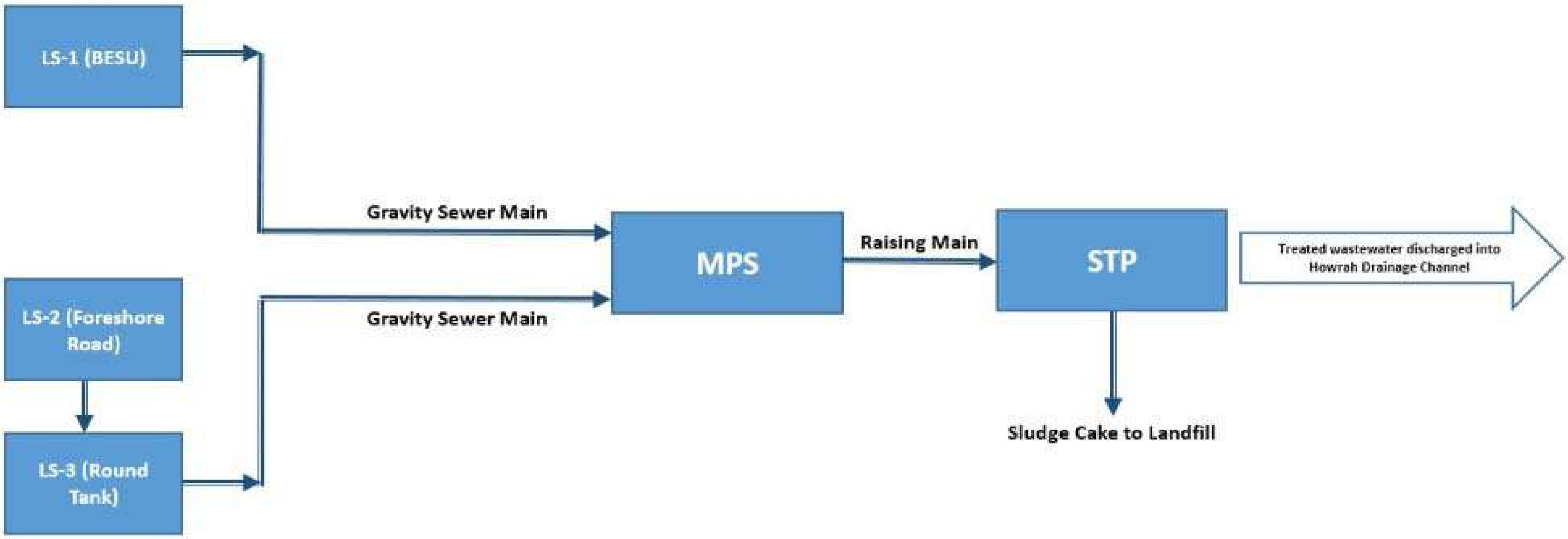


2.5 Project Components

As a part of the re-development project, the sewage water from western part of Howrah Municipal Corporation Area area will flow towards three lifting stations (BESU lifting station, Foreshore Road lifting station and Roundtank lifting station) which will then divert to Ichapur pumping station through gravity sewer line. From Ichapur pumping station the raw sewage water will go to Main Pumping Station (located inside the Arupara STP complex) via rising main connecting to the STP . The treated sewage water from the STP will be discharged to Howrah Drainage Channel via output pipeline. The major components of the STP project will include:

a) Lifting Stations
b) Gravity Sewer Line (Trunk Sewer line)
c) Main Pumping Station (MPS)
d) Raising Main
e) Sewage Treatment Plant (STP)
f) Outlet Pipeline

Figure 2.5 Schematic diagram of Sewage Water flow for the Proposed Project



2.5.1 Lifting Stations (LS)

There are three (3) lifting stations present for the Arupara STP projects. The three (3) lifting stations are:

a) Bengal Engineering Science University (BESU) Lifting Station (22°33'26.74"N, 88°18'27.49"E)

b) Foreshore Road Lifting Station (22°33'53.73"N, 88°19'40.41"E)

c) Roundtank Lifting Station (22°34'32.51"N, 88°20'4.04"E)

Lifting stations act as a collection point for nearby areas and pump the wastewater through gravity sewer lines towards STP. As reported during site visit (i) for BESU lifting station (LS-1) wastewater intake is from Botanical Garden and Swarnamoyee area, (ii) for Foreshore Road lifting station (LS-2) wastewater intake is from Chouri Basti and for B E College area and (iii) for Round Tank Lifting Station (LS-3) wastewater intake is from Sri Ramkrishnapur area and covers approximately 6-7 wards of HMC. The wastewater from LS-2 is further connected with the sewer network at the upstream of LS-3 and the waste water is combinedly diverted to the Ichapur pumping station. The existing LS buildings will be retained and renovated along with replacement or repairing of the existing pump sets and electrical installations. The flow of sewage water from lifting stations are shown in **Figure 2.5** above.

Figure 2.6 Photographs of Lifting Stations

Sewage water source for BESU LS

Inside of BESU LS

Foreshore Roas LS

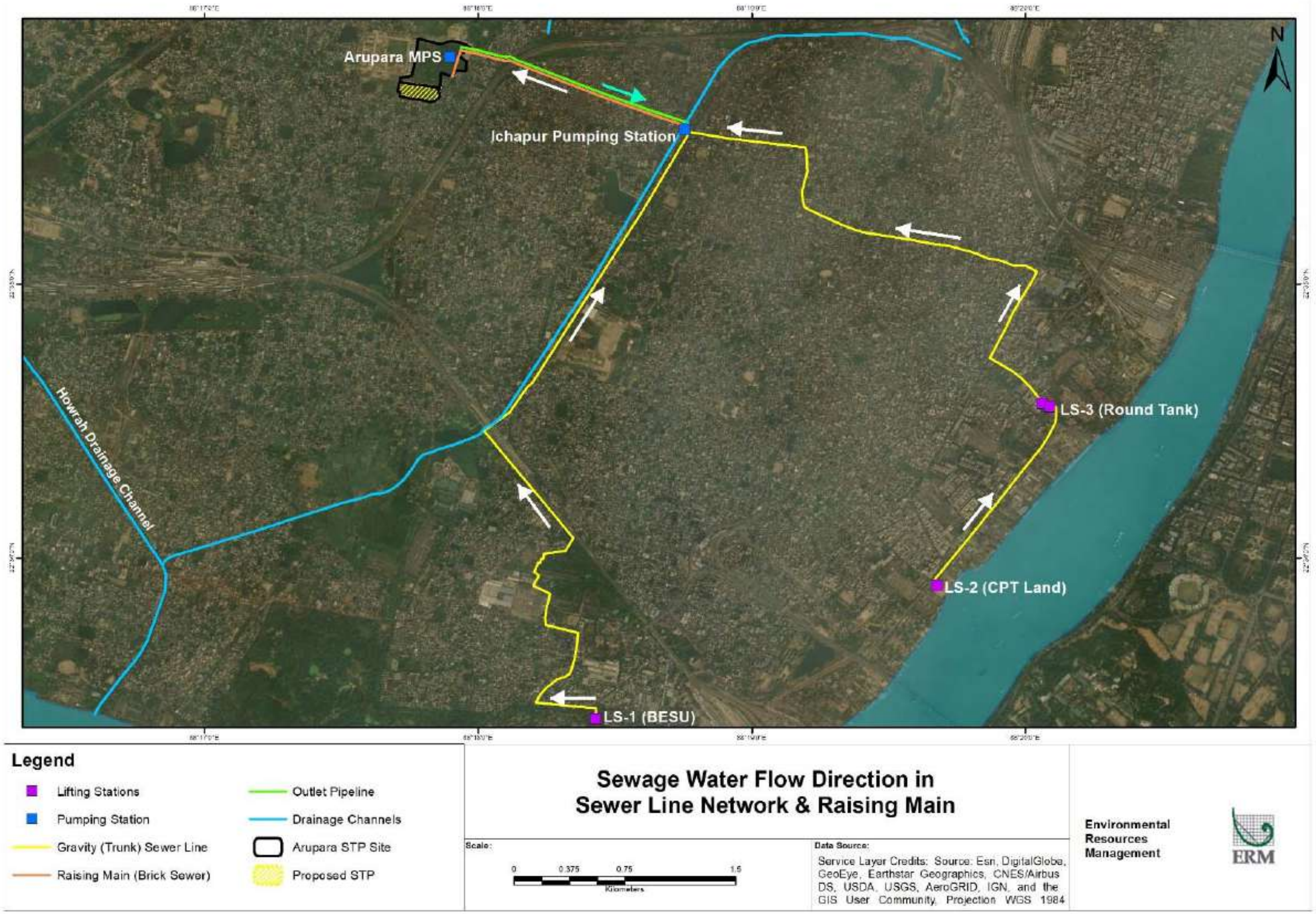
Round Tank LS

2.5.2 Gravity Sewer Line

The sewage water from lifting stations flows towards the MPS through the gravity sewer line. The diameter of the gravity sewer line varies from 700mm to 1000mm. The diameter of the gravity sewer line increases towards the MPS. The depth of the gravity sewer line varies from 1.5 to 2.5 m below the ground surface. The exact distribution of gravity sewer line is not known due to absence of sewage network map. The locations of the gravity sewer line as discussed during joint field visit are given in **Section 2.2**. New gravity sewer lines will be laid in the stretch between BESU LS to Ichapur

MPS. Breakup of the new gravity sewer line are as follows: (i) new 700m gravity sewer line starting from BESU LS will be laid along the College Ghat road, (ii) new gravity sewer line of 800m will be laid within the GKWL premises, and (iii) desilting will be done in the remaining 1.2km of Gravity sewer line within the GKWL premises. Open-cut method will be used during laying of new pipeline. The flow from gravity sewer lines are given in **Figure 2**7*.*

Figure 2.7 Flow of Sewage Water from Lifting Stations to Arupara STP



2.5.3 Main Pumping Station)MPS(

Ichapur pumping station is located on Kamardanga Road in Howrah municipality covering approximately 350 m^2 area. A wet well present within the MPS which temporarily stores the sewage water before passing the sewage water towards the STP through pumping. The existing pump sets present at the MPS are two (2) pumps with 22.5 MLD capacity and two (2) pumps with 45 MLD capacity. A grit chamber is present at the inlet point of the MPS to separate the floating material from the sewage water. The waste generated at screens or grit chambers, is temporarily stored at the MPS premises before handing over to municipality for disposal. The existing building structure will be renovated and the existing pump sets will be changed. Presently the sewage water from MPS is directly discharged into the Howrah Drainage channel. The screens at the grit chamber will also be changed. During operational phase, waste which will generate at the screens will be disposed bi-weekly at the KMDA designated site. The MPS facility is covered by boundary walls and permission is needed to enter the facility.

The main pumping station is present within the Arupara STP complex covering approximately 348 m^2 area which is used for drawing incoming wastewater from the Ichapur pumping station and then divert towards the treatment plant. Details of existing pump sets are as follows: (i) Two (2) pumps with 22.5 MLD capacity and (ii) Two (2) pump with 45 MLD capacity. The existing puming facility will be retained and renovated along with augentation of the pumpsets and linked electrical installations.

Figure 2.8 Photographs of Ichapur Pumping Station

Ichapur MPS

Inside Ichapur MPS

Grid Chamber at Ichapur MPS

Grid Chamber at Arupara PS

2.5.4 Raising Main

The existingsewerline of 1.44 km designed to carry pumped sewage from Ichapur pumping station to the STP facility. The pumps at the Ichapur pumping station create a pressure to transfer the raw sewage to the STP. The existing raising main is a brick sewer line with 2.75m of diameter. The location of the raising main is already discussed in the **Section 2.2**. The existing raising main is damaged and it will be repaired and renovated. As per the Conssesion agreement for GSPPL, 650m of exiting brick sewer line will be repaired and the rest of the line will be desilted. The raising main pipeline will be laid across the above mentioned road section some of which are congested areas. The information have been provided in **Table 5.7**.The detail design for the project is yet to be finalised.

2.5.5 Sewage Treatment Plant (STP)

The proposed 65 MLD STP will involve four (4) sequential treatment stages including preliminary treatment, primary treatment, secondary treatment and final chlorine based disinfection stages. Considering the required treated wastewater characteristics, land availability and ease of operation, conventional Activated Sludge Process (ASP) is considered by the Concessionaire for secondary treatment process. Further the sludge generated from the treatment plant is anaerobically digested to produce Biogas which in turn will be used for generation of power from the gas engines. Details of the process are described below and represented in **Figure 2.9**.

In general, sizing criteria are based on the requirements of the contract and the Central Public Health and Environmental Engineering Organisation (CPHEEO) Manual for Sewage and Sewerage Treatment. For design parameters which are not mentioned in the contract specifications or CPHEEO Manual, the limits are taken from other standard literatures and based on WABAG's operational experience of similar plants in India and other countries. Reference for the same are submitted as **Appendix B** in Process Design Calculations for the plant.

The treatment plant consists of the following sections:

- Preliminary Treatment
- Primary Treatment
- Secondary Treatment
- Disinfection and Disposal
- Sludge Handling
- Biogas Handling and Power Generation
- Heat Recovery System
- Auxiliary Units

2.5.5.1 Preliminary Treatment

The preliminary treatment comprises of Screenings and grit removal operations. During this operation, solid substances like floatables, rags, grit etc. are removed from the wastewater. This is achieved in two process steps:

- Coarse and fine solids and clogging constituents are removed from the sewage by fine screen units.
- In the grit chamber heavy particles (grit) with high settling velocities are removed by sedimentation.

This preliminary treatment section comprises of the following units:

Stilling Chamber
The purpose of Stilling Chamber is to arrest the turbulence of flow from the rising main and to ensure smooth gravity flow of wastewater to the downstream units. The inlet chamber receives flow from the Main Sewage Pumping Station and the chamber is designed with adequate depth and free board above top water level to avoid splashing.

Mechanical Fine Screen
Raw sewage from the Stilling Chamber flows by gravity to the downstream 2 Nos.)2W(Screen Channels. The purpose of the screens is to remove fine solids from the sewage and to protect the subsequent aggregates and components against blocking and damage. Beside the screen, the other required equipment for collection and storage of screenings trapped by the Mechanical Fine Screens are also provided. Isolation of the screen from the flow during either repairs or due to low flow conditions are made through the sluice gates, placed in the upstream and downstream of each of the screen chambers.
Mechanical Fine Screens will be provided to trap the screenings exceeding 6 mm in size from the sewage flow. Two)2(Nos.)2W(.
The expected quantity of grit generation at the proposed Arupara STP will be 5 m3/d. The screenings from the screen chamber will be washed and transported through conveyors and collected in screening containers. The grit particles from the detritor are then passed through frit washer and classifier before being collected in grit bins. The organics will be returned back to the inlet of detritor. The collected screenings and grit will be disposed in a place identified by KMDA.

Grit Distribution Chamber & Grit Basin
Grit comprises of sand, gravel, food particles or other heavy solid materials that are "heavier" (higher specific gravity(than the organic biodegradable solids in the wastewater and has has the potential to cause increased wear and tear of the mechanical equipment, cause pipe blockages, can settle and reduce the effective volume of the treatment basins. The screened sewage from the mechanicall fine screen will be conveyed to the Grit Distribution Chamber from where electrically operated sluice gates will be provided to facilitate isolation of flow to any one or more grit basins which are square sedimentation tanks in which grit and organic solids are removed collectively. The solids are raked by a rotating mechanism to sump at the side of the tank, from which they are moved up an incline by a reciprocating rake mechanism. The organic solids will then be separated from the grit and fall back into the basin while passing up the incline.

Grit comprises of sand, gravel, food particles or other heavy solid materials that are "heavier")higher specific gravity(than the organic biodegradable solids in the wastewater. Grit and other solids has the potential to cause increased wear and tear of the mechanical equipment, cause pipe blockages, can settle and reduce the effective volume of the treatment basins. The fine screened sewage flows into the grit basins, which are square sedimentation tanks which remove grit and organic solids collectively, working on the velocity principle. The collected solids are raked by a rotating mechanism to sump at the side of the tank, from which they will be moved up an incline by a reciprocating rake mechanism. The organic solids will be separated from the grit using a Detritor and fall back into the basin while passing up the incline. The separated out grit will be disposed off to to a KMDA municipal waste disposal site.

Parshall Flume
A Parshall Flume arrangement will be provided for flow measurement of the raw sewage after de-gritting. The Parshall flume will also act as a velocity control device so that the sewage can pass through the remaining phases of treatment without turbulence. An ultrasonic flow meter will measure the fluctuating liquid depths to give accurate measurement of the average sewage flow. The sewage would then flow further by gravity to the Primary Treatment stage. A bypass arrangement for sewage with an isolation gate will be developed, downstream of the grit chamber prior to the Parshall Flume, to handle a situation when sewage flow to the STP may need to be stopped and the STP shut down for emergency maintenance activities. In the case the sewage would need to be bypassed, it will flow

directly to the Chlorine contact tank effluent chamber for disnfection, before being discharged from the STP. The Bypass arrangement is only an emergency provision and is not operated during normal flow conditions. During any abnormal scenarios or when there is excess storm water or if when the inlet flow is higher than peak flow, the excess flow shall be bypassed so as to prevent any overflow events in the plant and to avoid any MLSS washout from the biological system.

2.5.5.2 Primary Treatment

This section receives the screened and de-gritted sewage. In this part of treatment plant, substantial amount of influent suspended solids and a portion of influent BOD are removed in the Primary Clarifier.

This section comprises of the following units:

Primary Clarifier Distribution Chamber

The de-gritted sewage is conveyed to the Primary Distribution Chamber through a conveying channel. Excess Sludge from the secondary clarifiers, overflow from the digesters, centrate from dewatering centrifuges and supernatant from the centrifuge feed sump are transferred to this Distribution Chamber for further treatment along with the main stream. A rectangular shaped distribution chamber is provided to equally divide and distribute flow received from the Parshall flume to the primary clarifiers. Uniform flow distribution to individual primary clarifiers is achieved by overflow weirs and individual isolation gates provided. CI foot rests are fixed inside the chamber, to provide access for maintenance purposes. Drain arrangement is provided with necessary valve for draining the unit to next stages of treatment process.

Primary Clarifier

Clarification is a physical treatment process in which gravity settling of particles takes place in tanks. The purpose of the primary clarifier is to remove substantial portion of the settleable solids from the untreated wastewater thereby resulting in a decrease in solids content of sewage flowing into the biological unit. Two Nos. Inclined Plate type Primary Clarifiers with integral thickener are constructed as square concrete structures.

In addition to the above, the other key advantages of providing primary treatment include:

- Primary sludge is major contributor to gas generation due to its rich VSS content.
- Reduction in inorganics load to biological treatment which has escaped screening and grit treatment
- Reduction in organics load to the biological treatment
- Reduction in power required for biological treatment
- Reduction in downstream sludge treatment unit sizing due to high sludge consistency
- Reduction in carryover of inert to biological treatment section.

In addition to above, co-settling of waste activated sludge from biological treatment is also considered in Primary sedimentation units. This will be a recirculation system for feedstock from biologically treated activated sludge from treatment process. Primary settling units are also provided with integral thickening mechanism to improve the thickening of the sludge and the resultant thickened sludge is fed to anaerobic digestion. Considering land availability and space saving requirements, plate type lamella sedimentation tanks with integral thickener scrapper mechanism is provided.

The degritted sewage will enter the clarifiers through openings on the sides of the clarifier. The main feature of this primary clarifier is that inclined plates would be provided for increasing the settling area for sludge particles thus reducing its footprint. The Primary Clarifier will have a square configuration with bottom of circular configuration suitable for picket fence sludge scraper mechanism to scrap the settled sludge. Each of the clarifiers will be provided with adequate number of plates arranged in rows with overflow launders. The inclined plates will be spaced in such a way that the flow through the plates shall be laminar and ensuring that the projected area of settling is much higher than conventional clarifiers. The Plates will be so arranged that the incoming solids would be distributed between the plate rows evenly whereby the solids leave the plates in the lower portion and the clarified water overflow take place over adjustable overflow launders to be located in the periphery of the clarifier. The scum generated from the Primary Clarifier will be skimmed by radial scum skimmer and diverted to the Secondary Treatment stage to be part of the treatment process.

2.5.5.3 Secondary Treatment Section

The principle of biological treatment is to convert soluble or dispersed organic wastewater constituents, which cannot be removed from the wastewater by preliminary treatment, into biomass. Thus, the pollutants are converted into a settle-able form, which in turn can be removed from the wastewater by a final sedimentation step.

The process implemented here is Conventional Activated Sludge process with carbonaceous BOD Removal. To ensure that the biological processes be carried out rapidly, the wastewater must be brought into close contact with the microorganisms and sufficient oxygen must be supplied at any time. The biological treatment stage would comprise of activated sludge tanks and secondary clarifiers. In the activated sludge tank, the microorganisms (bacteria) would be supplied with oxygen. The bacteria use the wastewater constituents as nutrients for their metabolism cleaning the wastewater at the same time. After aeration, the pollutants trasnform into biomass the mixed liquor is passed to the final clarifier, wherein it is separated from the cleaned wastewater. The settled biomass will be continuously recycled to the aeration tanks (return sludge) in order to maintain sufficient biomass concentration in the aeration tanks and in order to maintain an optimal sludge age.

Secondary treatment section would comprise of the following units:

Aeration Distribution Chamber

Aeration Distribution Chamber will be designed to recieve the primary treated sewage and also the return activated sludge and distribute sewage to the Aeration Tank. The sludge from the secondary clarifier will be conveyed to the inlet of the Aeration Tank distribution structure as Return Activated Sludge by pumping in order to maintain the MLSS level in aeration tank. The primary treated sewage from Primary clarifiers will be received by gravity through channel connecting to the Aeration Distribution Chamber. The Aeration Tank distribution chamber will be provided with sluice gates for isolation purpose.

Aeration Tank

Two Aeration Tanks will be provided as a means for efficient oxidation of BOD and the design will be based on Central Public Health and Environmental Engineering Organisation (CPHEEO) Manual for Sewage and Sewerage Treatment. The biological processes for decomposition of the organic matter would require the supply of considerable quantity of oxygen. The aeration system will be based on fixed type fine bubble Aeration Tank Diffusers. The mixed liquor will flow into a common drop chamber from the outlet weir of the aeration tank, from where it will be conveyed to the secondary clarifier through pipes. The recirculation sludge will be fed to aeration tanks with the help of Return Activated Sludge Pumps to maintain the concentration of MLSS in aeration tank within the desired range. The capacity of blowers will be adjusted so as to maintain optimal DO level at the outlet of each tank which is in the range of 1 mg/L. Separate air pipe headers will be provided for each aeration tank. The air blower header will be so designed that outlet of the total three (3) (2W + 1S) nos. blowers, one blower will be dedicated for each aeration tank with suitable interconnection valve between common standby blower and the dedicated blower. An Online DO Analyzer will be provided at outlet of each Aeration Tank for monitoring the Dissolved Oxygen (DO) level.

Secondary Distribution Chamber & Clarifier

The mixed liquor from the outlet channel of aeration tanks will be distributed to secondary clarifiers through a Secondary Clarifier Drop Chamber. The distribution chamber will be of RCC construction and provided with sluice gates for isolation of the Secondary Clarifier from the flow during maintenance.

In the next step, the major task of the secondary clarifier will be to separate the activated sludge from the treated wastewater, producing an effluent with an acceptable concentration of suspended solids and BOD. In addition, the settled activated sludge will be efficiently thickened and moved to a central sludge hopper by the final clarifier scraper. The design and operation of the clarifier will account for minimisation of short-circuit in the return sludge flow.

2 Nos. Secondary Clarifiers will be constructed as circular concrete structures and of radial flow type. A central drive unit will move the bridge and the Secondary Clarifier Scrapper Mechanisms will be fixed to the drive head through a central cage. The scraper blades would aid the transport of the settled sludge to the central hopper. The design of the clarifiers will ensure that uniform sludge draw-off would occur to a well sized sludge pit leading the sludge towards the center. The settled sludge will be withdrawn from the sludge hopper of each clarifier and transferred to return activated sludge sump by gravity. The sewage will flow through opening at the top and move radially towards the periphery. The entry ports would remain submerged below the water surface. The flow at the periphery of the clarifier will pass through a weir and will be collected in a RCC launder along the outer periphery of the clarifier. The effluent weir along with baffles provided along the outer periphery will comprise of adjustable ‘ V ‘ notch weir plates for uniform withdrawal of flows. The clarified sewage from the launder of clarifier will be taken into RCC channel leading to Chlorine contact tank. The floor of the clarifier will be in the shape of hopper sloping radially towards the center having a slope of 1:12. The sludge settling on the floor of the clarifier will be scrapped to a central pit from where it will be withdrawn into the return activated sludge sump under hydraulic pressure.

Return Activated Sludge Sump

In order to provide for continuous sludge withdrawal from each clarifier, a Return Activated Sludge (RAS) Sump will be provided to receive the secondary activated sludge (bio sludge) from the secondary clarifiers. The sump will house 3 No.’s of return activated sludge pumps (2W+1S) with capacities designed to pump the RAS flow to aeration tank and excess sludge to primary clarifier. The RAS pumps will discharge flow to the aeration tank on a continuous basis. A tapping in the RAS header line will be provided to facilitate excess sludge bleeding, which will be made to flow back to the Primary Clarifier where it will be thickened along with primary sludge. An electromagnetic type flow transmitter will be provided in the excess sludge line for monitoring the discharge quantity.

Process Air Blower Area

The process air blowers will be located adjacent to the Aeration tanks in the Process air blower area. 3 Nos. (2W+1S) Aeration Blowers would cater to the requirements of aeration tank. The blower capacities will be designed to keep the minimum oxygen concentration in the aeration tanks at 1 mg/L. The blowers would calibrated to operate automatically based on a pre-set oxygen value monitored in the aeration tanks.

2.5.5.4 Disinfection and Disposal Section

The Secondary Treatment Section will be followed by a disinfection system based on Chlorination to reduce coliforms levels present in the treated sewage to desired levels. After disinfection, the sewage will disposed to the Udaypur Khal through a drainage channel. This treatment stage will comprise of the following units:

Chlorine Mixing & Contact Tanks

The output from secondary treatment stage will be mixed with Chlorine Solution in the Chlorine Mixing Tank and Diffusers will be provided in the Tank for effective diffusion of Chlorine solution with the secondary clarified sewage. The treated water would then subsequently move via an inline vacuum ejector and would received at Chlorine Contact Tank, through bottom mounted perforated pipe (chlorine diffuser pipe). The Chlorine Contact Tank will be designed to provide effective contact time between Chlorine gas and secondary treated Sewage for effective disinfection and would comrpise of 1 No. Chlorine Contact Tank of RCC construction along with provision for required number of RCC baffles to allow for proper mixing of Chlorine solution with treated effluent. A Residual Chlorine analyzer is provided at the outlet end of Chlorine Contact Tank to measure the free residual chlorine

Gas Chlorination System

Chlorine gas will used as a disinfectant and will be delivered to the STP facllity in form of cyclindrical Tonners and system would be housed in the Chlorine building. The Chlorination system would consist of a Chlorinator, which will dose Chlorine in aqueous form into the Chlorine Contact Tank. 2 Nos. of Vacuum operated type Chlorinator (1W+1S) suitable for floor mounting, each complete with a remote mounted ejector to give aqueous solution output, will be provided. The chlorinators would be designed for output control proportional to the flow measured upstream of the dosing point and for residual control. Adequate connections and tonner isolating valves will be provided to enable the drums to be connected in two banks, each to an automatic drum changeover device so that one bank of drums are on duty and the other bank of drums remains on standby. Automatic changeover of tonners from duty to standby banks will be initiated by low pressure measured by a pressure switch on the common gas header.

Control Measures

Considering the toxic property of Chorine gas, should an accidental release occurs, several safeguards would be considered to be an integral part of the Chlorination system and will conform to Indian Standard IS 10553, Part I – General Guidelines for Chlorination Plants including handling, storage and safety of Chlorine drums. These would include:

- ***Chlorine Leak Absorption System***: An air extraction system connected to a Leak Absorption System will be provided for the tonner room and chlorinator room to remove chlorine in contaminated air, in case of Chlorine leak in these rooms. The extraction system will consist of extractor fans 2 Nos. (1W+1S) withdrawing air from these areas separately by a system of low level ducts through a chlorine absorber and discharging chlorine free air to the atmosphere. The ductwork will be arranged to extract from the rooms and provided at floor level connected to the absorber. The scrubber exhaust rate will be designed to maintain negative pressure in the tonner room and Chlorinator building during a leak. In the chlorine scrubber tower, the chlorine gas will be neutralized with absorbent (Caustic) solution. The pH of the spent absorbent (caustic) will be checked at the outlet of the scrubber. If the pH is found to be high, then absorbent will be neutralised with water in a neutralisation pit. This activity would be triggered only in case of an accidental release of Chlorine which has a probability of less than 1 event in less than 100 years. If such an instance occurs, the neutralised water from the pit would be recycled back to the Clarifier and will be treated through the STP system, before being discharged along with treated sewage water.
- ***Absorbent Tank***: The absorbent to be used for Chlorine would be Caustic (NaOH) solution. The concentration of caustic used in the absorber will be selected such that it can limit the temperature rise during the absorption process to 10^{o}C. One (1) no, Caustic solution cum recirculation tank adequate to neutralize the content of One (1) Chlorine drum will be provided for this purpose. The tank will also be provided with dilution water supply.
- ***Caustic Solution Recirculation Pump***: Two (2) Nos. Horizontal Centrifugal Type Caustic Solution Pumps (1W+1S) will be provided to transfer the NaOH solution required for neutralizing

the contents of one chlorine drum (1000 kg), from the storage tank to the scrubber. These pumps will also be used for loading the Absorbent Holding / Recirculation tank with fresh caustic solution.

- ***Chlorine Leak Blower***: Extraction fans will be mounted on the downstream side of the absorber to induce an upward draft of contaminated air through the absorber. Two Centrifugal Blowers (1W+1S) each of capacity adequate to provide the required number of air changes per hour will be provided.
- Vacuum regulating/pressure relief valves will be provided on each line to Chlorinator.
- Chlorine Booster pumps will be provided with isolating valves, non-return valves and pressure gauges

2.5.5.5 Sludge Handling Section

- ***Digester Feed Sump***

The function of the Digester Feed Sump will be to balance the intermittent sludge discharges from the primary clarifiers and therein provide a well-mixed uniform sludge feed to the digesters as well as act as a sump for the digester feed pumps that will feed the anaerobic sludge digester. The tanks will be sized to balance the intermittent flow with sludge being withdrawn at a steady rate and concentration to the digesters.

A low speed mixing agitator will be provided in the digester feed Sump to keep the solids in suspension and to avoid any settling. Three (3) Nos. (2W+1S) Digester Feed Pumps of Horizontal Centrifugal Non-clog type Pumps will be provided for transferring the sludge to the Anaerobic Sludge Digester. An Ultrasonic type level transmitter will be provided in the Thickened Sludge sump to monitor the level in the sump and to protect the pumps from any dry run. In addition, a magnetic type flow transmitter with a totalizer will be provided to measure the flow of Thickened Sludge to each Digester, at each of the header lines that would be feeding into the Sludge Digester.

Anaerobic Sludge Digester

Anaerobic sludge stabilization will be undertaken as a part of the treatment process in order to reduce organic content of sludge through anaerobic digestion and recovering energy from sludge in form of Biogas. During anaerobic stabilization process, organic substances in the sludge will be decomposed to a considerable level in order to get digested sludge that is in a biologically stable condition i.e. maximum decomposition of organics, reduction in generation of odors, and having proper dewatering characteristics.

The Anaerobic Sludge Digesters would have a fixed cover with facility for heating and mixing. Mixing will be achieved by recirculation of sludge using Sludge mixing pumps. The thickened sludge will be fed into the digester and undergo anaerobic decomposition in absence of air (oxygen) at mesophilic conditions of about 35 °C and with a retention time of a minimum 10 days being maintained. Decomposition would take place in several transitional phases. As a result of this process, Biogas will be produced with a composition of about 65 % (by volume) of Methane.

Two (2) Nos. of Anaerobic Sludge Digesters would be developed for thickened sludge digestion using mesophilic single stage and single phase process. The digesters would be of RCC construction and would be designed as cylindrical tanks. The base will be constructed with a slope to the centre in order to evacuate the sludge. The sludge withdrawal pipeline will start from the bottom portion of vertical face of the digester and join the main header line feeding the sludge dewatering unit. One number sluice valve with ‘Y’ shape tee connection having blank flanges will also be provided in the sludge withdrawal pipe line for each digester for back pressure application / rodding for opening of chokages etc. Main sludge withdrawal pipeline will terminate into the Digested sludge sump. In order to have homogenous conditions inside the digesters and to avoid scum accumulation on the sludge surface, high efficiency sludge mixing will be provided. Effective mixing will be performed by using three (3) Nos. (2W+1S) Digester Mixing Pumps Sludge mixing pumps. The Gas line from each Digester will be provided with a thermal mass flow meter, to measure the amount of biogas generated from each Digester. In order to maintain the temperature of the digesters at a constant level of about 35 °C the content of each digester will be circulated by external circulation pumps via a sludge heat exchanger. Four (4) Nos. (2W+2S) Sludge Recirculation Pumps of Horizontal Centrifugal type will be provided for sludge recirculation. In addition, two (2) Nos. (2 W) pipe-in-pipe Type Sludge Heat Exchangers will be provided for Sludge Heating. Temperature gauge will be provided at the inlet of each heat exchanger in the Sludge Feed Line.

The Digesters will be gas tight. Gas line on the top of digester will be connected to a common header pipeline leading to the gas holder. The pipe lines will be provided with moisture/drip traps at suitable places. To prevent building up of excessive gas pressure inside the digester, provision be made for hydrostatic pressure relief and gas ventilating arrangements. The arrangement will also consist of a water seal and connecting pipe line. A pressure safety valve with an inbuilt flame arrestor will be provided on the dome of each digester. The pressure safety valve will protect against overpressure and also prevent the occurrence of a vacuum condition, by letting in atmospheric air when required. An in-built-flame arrestor will prevent the ingress of any external source of heat into the digester.

The expected quantity of digested sluge and treated sludge generation at the proposed Arupara STP will be 380 m^3/d (6% DS) and 100 m^3/d (20% DS) respectively. Prior to digestion, the sludge will have a consistency of about 6% dry solids. Digestion process is designed to destruct 50% volatile suspended solids. After digestion, the consistency will be slightly less than 6%.

Digested Sludge Sump

Digested Sludge from Sludge Digesters will be transferred to the Digested Sludge Sump by gravity. A low speed agitator will be provided in the Digested Sludge sump and will prevent the settling of solids in this sump. The digested sludge will be transferred into Sludge dewatering unit by Centrifuge Feed Pumps.

Centrifuge

Solid bowl type Centrifuges will be used to dewater digested sludge of sewage treatment plant. The Centrifuge units will be installed in a Centrifuge Platform which will be designed to permit dewatered sludge being directly loaded onto disposal containers (1 No. for each centrifuge), placed just beneath the platform. The top of the platform will comprise of a RCC slab and all associated machineries will be supported over suitable foundation. A RCC staircase with hand-railing will be constructed to have access to the platform from foundation level.

The solid bowl centrifuge operation concept will be based upon sedimentation assisted by centrifugal force. The cylindrical bowl, with a conical end, rotates at rpm’s depending on the application. Inside the solid bowl will be a conveyor having a spiral drive spinning in the same direction as the bowl, but at lower speeds. The digested sludge will enter the bowl near the center of the cylinder and undergo sedimentation due to the centrifugal force. The liquid will drain out of the bowl through openings at the cylindrical end. The conveyor will then push the solid material to the conical end of the bowl where the dewatering process continues. The separated solids will be pushed out of the conical end of the bowl and discharged into the collection channel. The settling speed will be determined by particle size, particle shape and difference in density between solids and liquids in addition to viscosity of the material. The geometry of the bowl, relation with length and diameter would be adapted to suit the application.

2 Nos. (1W+1S) Sludge Dewatering Machine (Centrifuges) will be provided to dewater the digested sludge from the anaerobic sludge digesters and to be installed in the Sludge Dewatering Building. The Sludge Dewatering Building will be provided with an electrically operated overhead crane (Y-16) for installation and service requirements. Polyelectrolyte dosing will be provided independently for each Centrifuge. Provision will be made to dose polyelectrolyte along with dilution water arrangement in order to adjust the desired dosage.

Polymer Dosing System

Polymer will be used for conditioning of the sludge and will be prepared in a polymer dosing tank. The tank will have a slow speed polymer dosing tank agitator to enable mixing of the polymer solution in the tank. The polymer will be dosed by means of 2 No's (1W+1S) of diaphragm type dosing pumps. Rotameter type flow meters will be provided at the dilution water line to be used for online dilution of the solution.

As per KMDA's requirement, the dewatered sludge will be disposed off to a site identified by KMDA, which will be suitable for disposal of dewatered sludge without any further treatment. Composting or any further treatment is not envisaged as part of the governing Concession Agreement for GSPPL.

Biogas Handling Section

Biogas generated from anaerobic sludge digester with approx. 65% methane concentration, would be used as an alternative source of energy. The following sections describe the facilities planned to handle the generated Biogas from the Plant and recover energy from the Biogas.

Gas Holder

Biogas production during anaerobic stabilization will be a continuous process. However, there would be some variations in the inlet load, based on which there will be fluctuations in the production of the Biogas. To overcome these differences and to provide continuous supply of biogas to the gas engines, one number (1 no.) of 2150 m3 storage capacity for the biogas produced from the plant will be considered.

The gas holder primarily would be of double membrane type and have an internal and an external membrane made of polyester. The internal membrane would hold the biogas and the external membrane provide protection to the internal membrane and is always in inflated condition. The internal pressure in between the internal and external membrane will be maintained by support air blowers. The gas holder will be equipped with a hydraulic safety device in order to protect against overpressure. The biogas generated by the anaerobic digestion process will be used in a co-generation plant in order to produce heat and electrical energy. In cases of emergency, when the CHP unit fails, the excess biogas will be flared off through a flaring system.

An ultrasonic type level transmitter will be provided in the Gas Holder which will monitor the level of filling in the gas Holder. If the biogas level in the holder touches the high level, the valve controlling the pilot burner in the biogas flare will be opened and the gas flow will be diverted for flaring of the excess gas. During normal conditions, the biogas will be scrubbed in the biogas scrubber and sent to the biogas engine. A Thermal mass type flow meter will be provided in the scrubbed biogas header line from biogas scrubber leading to Biogas Engines. Drip trap will be provided in biogas lines in appropriate locations to remove the moisture from the saturated biogas. The moisture will be drained out through a baffling arrangement in the drip trap.

Biogas Scrubber

Hydrogen Sulphide (H2S) which is present as an impurity in the biogas has to be removed because of its corrosive characteristic. The presence of H2S causes corrosion, especially in pressure regulators, gas flow meters, valves and steel parts of equipment. Also, SO2, which is the combustion product of H2S, when combined with water vapour can lead to corrosion in gas engines. Lubricating periods become shorter and maintenance needs increase as a result of corrosion and wearing in gas engines.

Two (2) Nos. (1W+1S) Biogas blowers of twin lobe type will be provided for transferring the Biogas at the required pressure to the Biogas scrubber followed by Biogas Engine Units. Each discharge line will be provided with a Pressure gauge and Pressure Safety valve. Variable speed drives will be provided for Gas Blowers, to control the required gas flow to the Gas Engine. The biological type Biogas scrubber plant will be designed for an average daily digested gas volume production and for a reduction of H2S content to meet the requirement of Biogas Engine. Caustic Soda solution will be used for biogas scrubbing so as to reduce the H2S present in the biogas. The spent caustic will be regenerated in a Biological Aerobic Reactor and recycled back to the scrubbing process.

Biogas Flare

Gas burner with drip trap, pressure regulator and pilot burner will be provided with capacity adequate to burn the biogas produced from the treatment plant, under emergency conditions. Two (2) Nos. (1W+1S) Gas flares designed for 120% of gas generated from the plant, will be provided for this purpose. The burner will be mounted conveniently on a steel flare stack structure at a minimum height 10 m above fixed ground level (FGL)[4]. Aspirator type Gas flare with auto ignition through pilot burner is provided. Biogas will be used as a pilot fuel. and the pilot flame generated with the help of spark ignition system will propagate through the flare unit to ignite the main biogas stream. Flare control system involving control panel, ignition transformer, low pressure switch etc. Will be provisioned for as a part of the flaring arrangement. Adequate retention time, depending on temperature of the flare, would be arranged to ensure efficient combustion of Biogas stream.

To prevent the movement of flame in the pipeline and other associated areas, flame arrestors (one each on pilot burner and the main burner) will be provided for the Gas Flare system. Moisture content present in the Biogas may impact the efficiency and performance of the Gas flaring system. One (1) No. Moisture separator will be provided at the Biogas feed line to the Gas Flare. Water collected due to separation of moisture will be sent back to the clarifier.

The biogas flare will be a vendor package and the actual specification will be confirmed after vendor finalisation. Tentative details for the biogas flare system will include the following:

- Type: Self Aspirating type
- Retention Time: Not Applicable
- Flare height from ground level: 12m
- Design capacity: 120% of design biogas production/day
- Combustion temperature: Details would be provided at later stage after equipment finalization
- Emission standards: Details would be provided at later stage after equipment finalization

Biogas Engine

The biogas generated by the anaerobic digestion process will be used in a co-generation plant in order to produce heat and electrical energy. Electrical energy requirement of the STP will be supplied from the electrical energy produced via the CHP unit. This will help in countering global warming and climate change impacts from the STP's operation besides it reducing withdrawal of power from grid.

One (1) No. of Biogas Engine (rated capacity 800 kWe) will provided for generation of electricity from Biogas. The type of engine proposed is a Single Fuel type biogas engine. A Co-generation system will be provided inside the Gas Engine Building. Heat Recovery units, Cooling system and Ventilation system for Biogas Engine will be housed in the Biogas Engine Building. Biogas engine to be supplied will be complete with required Exhaust ducting, HT radiator, Wet Ventilation System, Fresh and used lube oil system, Cooling water circuit for HT and LT system and Cooling water filling system.To provide makeup water for the cooling system, a fresh water storage tank along with Water Softener will be provided. The soft water from Softener (activated carbon filter) will be transferred by the Utility Water Pump as Make-up water for Cooling Water Circuit of Gas engine and the Waste Heat recovery

[4] Niether the general WB EHS Gudieline or Sector Specific Guidelines (Water & Sanitation) provide any specification for minimum height from the ground level for the gas burner system of a flare burning CH_4/Biogas. There are however specific guidelines on retention time in the gas burner which is related to the temperature necessary to achieve highly efficient combustion of Methane gas ranging from 0.6-1.0 seconds at 850 degrees Celsius to 0.3 seconds at 1000 degrees Celsius for enclosed flares.

system. Biogas engine and the associated utilities to be installed with the biogas engine will be a vendor package and the corresponding technical specification will be confirmed at a later stage after vendor finalisation.

The proposed bio gas engine will be a lean burn engine and produces emissions with NOx < 500 mg/m^3.

The stack of the Gas Engine would be designed as per good industry practice (IFC: General EHS Guidelines) with height being determined by the following formula:

H_{Stack} = H + 1.5L; where

H_{Stack} - Gas Engine Stack height measured from the ground level elevation at the base of the stack

H - Height of nearby structure(s) above the base of the stack.

L - Lesser dimension, height (h) or width (w), of nearby structures

“Nearby structures” - Structures within/touching a radius of 5L but less than 800 m.

The exact height of the stack required would be determined at the detailed engineering design stage after the other structures around the Gas Engine are planned out.

2.5.5.6 Heat Recovery Section

A seasonal temperature variation in the incoming raw sewage is expected during winter and summer season. However, the maximum temperature range of the incoming raw sewage is expected to be around 30 oC considering geographical location of the project. As per the treatment scheme for the STP, sludge feed for the Anaerobic Sludge Digester will be made from the primary clarifier of the STP where the temperature of the sewage water/sludge will be in the same range of 30 oC. In the context of ensuring optimum performance of the Anaerobic Sludge Digester, the temperature will need to be maintained in the range of 35°C to facilitate the biological decomposition of the suldge. Therefore, to maintain the optimum temperature condition, incoming sludge to digester will be required to be heated to 35 oC throughout the year.

The heat requirement for the heating purpose will be extracted from the wasteheat of Bio-gas engine flue gas. Soft water will be used as the heat carrying media in plate type heat exchangers and water softner unit will be installed as an auxillary uint of the Bio-gas engine. The softener of an approx. capacity 5 m^3/h shall be installed. Softener system is a vendor based package that consists of a single FRP vessel packed with ion exchange resins that aids in reduction of hardness present in water. There will be no PSF/ACF in the softener package. Design specification of water softner will available after the finalization of order for the Bio-Gas engine at a latter date.

- ***Hot Water Tank and Hot Water Pumps***

A Hot Water Tank will be provisioned to collect the Hot Water Return from Sludge Heat Exchanger and then recirculate back the same to Sludge Heat Exchanger as Hot Water Supply through the Heat Recovery units, at required pressure. Hot Water Recirculation Pumps will be provided to develop the require pressure for passing the Hot Water through these heat recovery units and Sludge Heat Exchanger. The Hot Water Tank will also act as a buffer for compensating any occasional water losses.

One (1) No. Hot Water Tank will be provided, above the Gas Engine utility room, as Buffer tank to collect the return water from Sludge Heat Exchanger and supply back to Sludge Heat Exchanger. The tank will have requisite insulation to prevent any heat loss to the atmosphere. The tank will have nozzles for receiving hot water supply, hot water recirculation line, make up water line, suction for hot water pump, drain, vent and overflow. The tank will also have a ladder and an access platform to access the top of the tank for maintenance purposes and to reach the nozzles provided on the top of the tank. Two (2) Nos. (1W+1S) Horizontal Centrifugal Type Hot Water Recirculation Pumps will be provided for circulating the water from the Hot Water Tank through the Jacket Water Waste Heat recovery unit, Exhaust Gas Waste Heat Recovery Unit, Sludge Heat Exchanger and back to Hot Water Tank. A facility for recirculating the Hot Water back to the Hot Water Tank will also provided.

Jacket Water Waste Heat Recovery Unit

The Gas Engine would have an inbuilt HT circuit, will exchange heat with a Radiator, where the heat will be lost to the atmosphere. To recover the heat from this circuit, a HT Heat Recovery unit will be provided. The hot fluid from the Gas engine will exchange heat with the water circulated from the Hot water circulation pumps through a Plate type Heat Exchanger. All necessary pipelines, valves for isolation and required instruments for monitoring will be provided for this circuit. Whenever there is no requirement for heating of sludge, this circuit shall be bypassed and the normal circuit to Radiator will be made online.

Exhaust Gas Waste Heat Recovery Unit

The Exhaust Gas Waste Heat Recovery Unit will recover heat from exhaust gas of the Gas Engine. The exhaust gas from gas engine will be discharged at a temperature above 400 oC. This will be emitted into the atmosphere through a stack arrangement, with stack height conforming to statutory requirements. The waste heat from this exhaust gas will be used as additional heat source required for heating the sludge in the Sludge Heat Exchanger. The gas engine will have an independent Waste Recovery Unit.

One (1) No. Exhaust Gas Heat Recovery Unit (H-02) will be provided for exchanging heat with the exhaust gas from Gas Engine. The exhaust gas from the gas engine will exchange heat with the water circulated from the Hot water pumps through this Heat Exchanger. The heat recovery units will allow for recovery of heat, which will be sufficient to meet the sludge heating requirement in the Anaerobic Digester. The estimated total heat recovery from the units for the Arupara STP is estimated to be 700 kW. However, value as stated is tentative and will be subject to equipment specification.

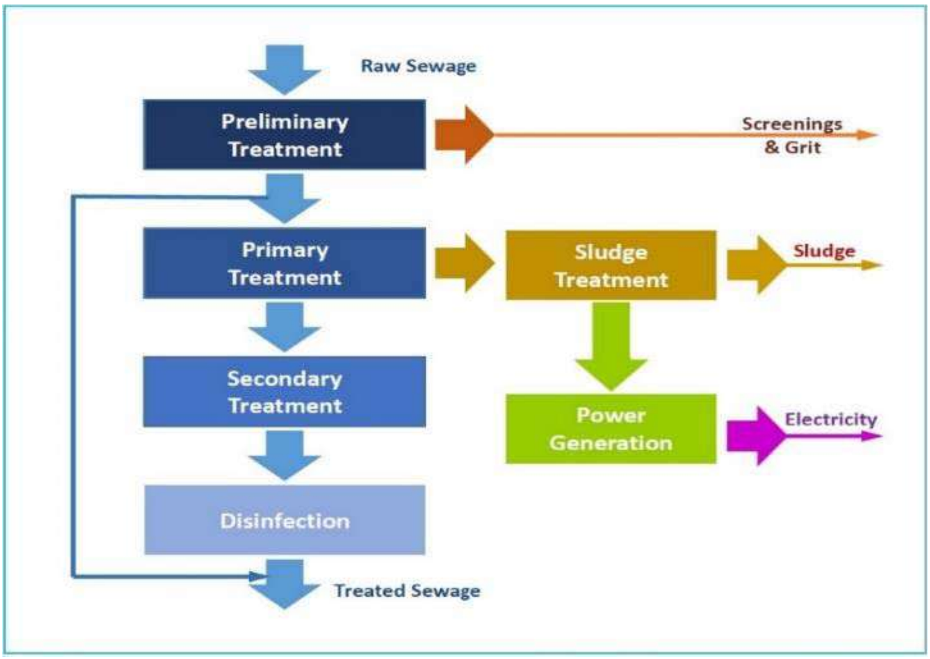
All necessary pipelines, valves for isolation will be provided for this circuit. An electrically operated modulating Three Way Diverter Dampener will be provided in the Exhaust Gas line from the Gas Engine to the stack arrangement. Whenever there will be no requirement for heating of sludge, this diverter valve would ensure that this circuit is bypassed and the normal circuit to flare stack will be made online. Exhaust Gas after exchanging heat with the cold fluid, will be released to the atmosphere through the same stack arrangement.

2.5.5.7 Process Monitoring

Online analyzers will be provided at the following points for effective monitoring of the plant.

- Ultrasonic Flow Meter at the Parshall Flume and Chlorine Contact Tank Outlet
- TSS Analyser at Grit Distribution Chamber and Chlorine Contact Tank Outlet
- COD Analyser at Grit Distribution Chamber and Chlorine Contact Tank Outlet
- BOD Analyser at Grit Distribution Chamber and Chlorine Contact Tank Outlet
- Conductivity Analyser at Grit Distribution Chamber and Chlorine Contact Tank Outlet
- pH Analyser at Grit Distribution Chamber and Chlorine Contact Tank Outlet
- Residual Chlorine Analyser at Chlorine Contact Tank Outlet
- DO Analyser at each Aeration Tank

Figure 2.9 Proposed Treatment Scheme



Source: Adopted from Wabag DPR (Process Design Basis Sewage Treatment Plant)

Figure 2.10 Proposed Site Layout of Arupara STP

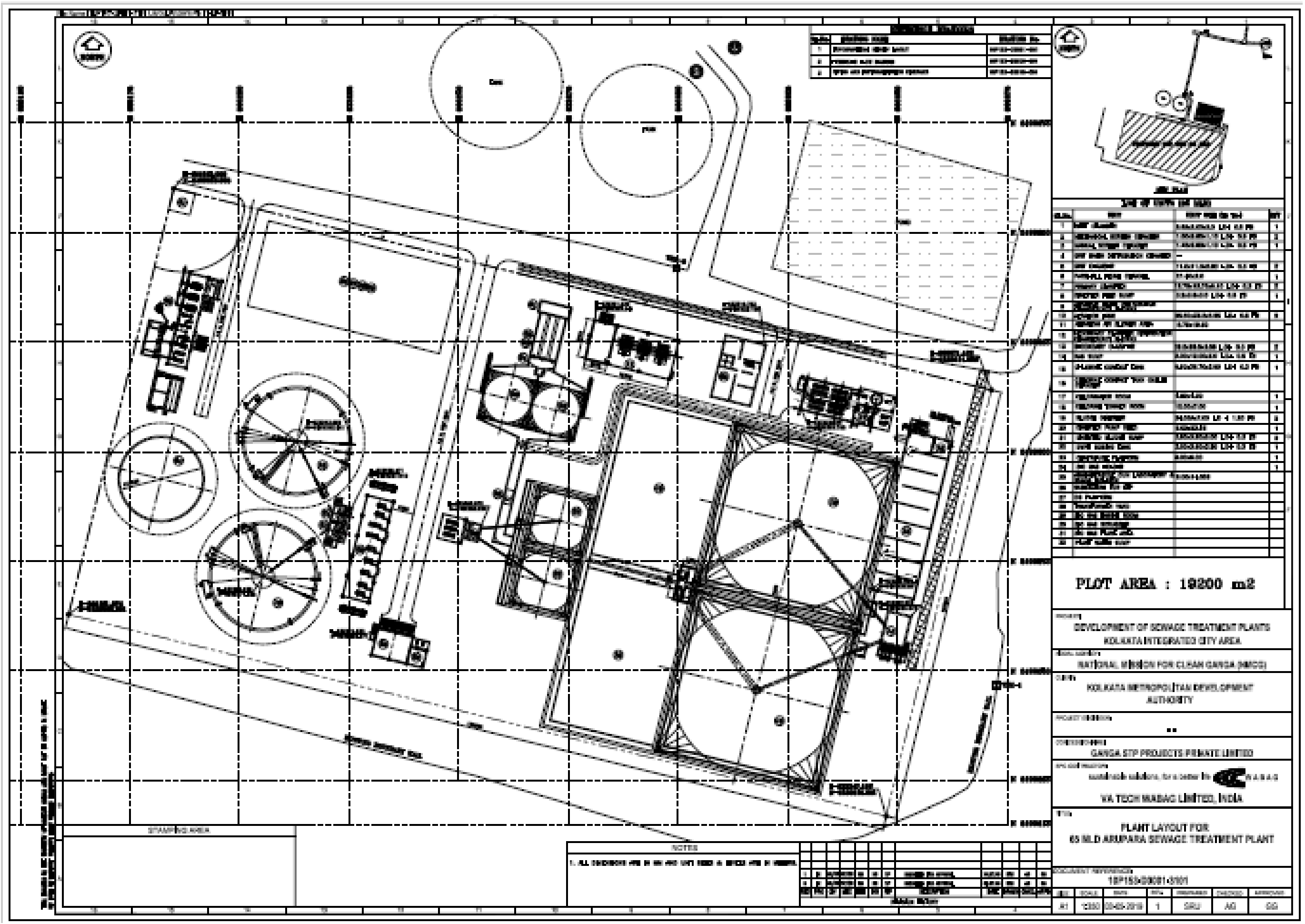
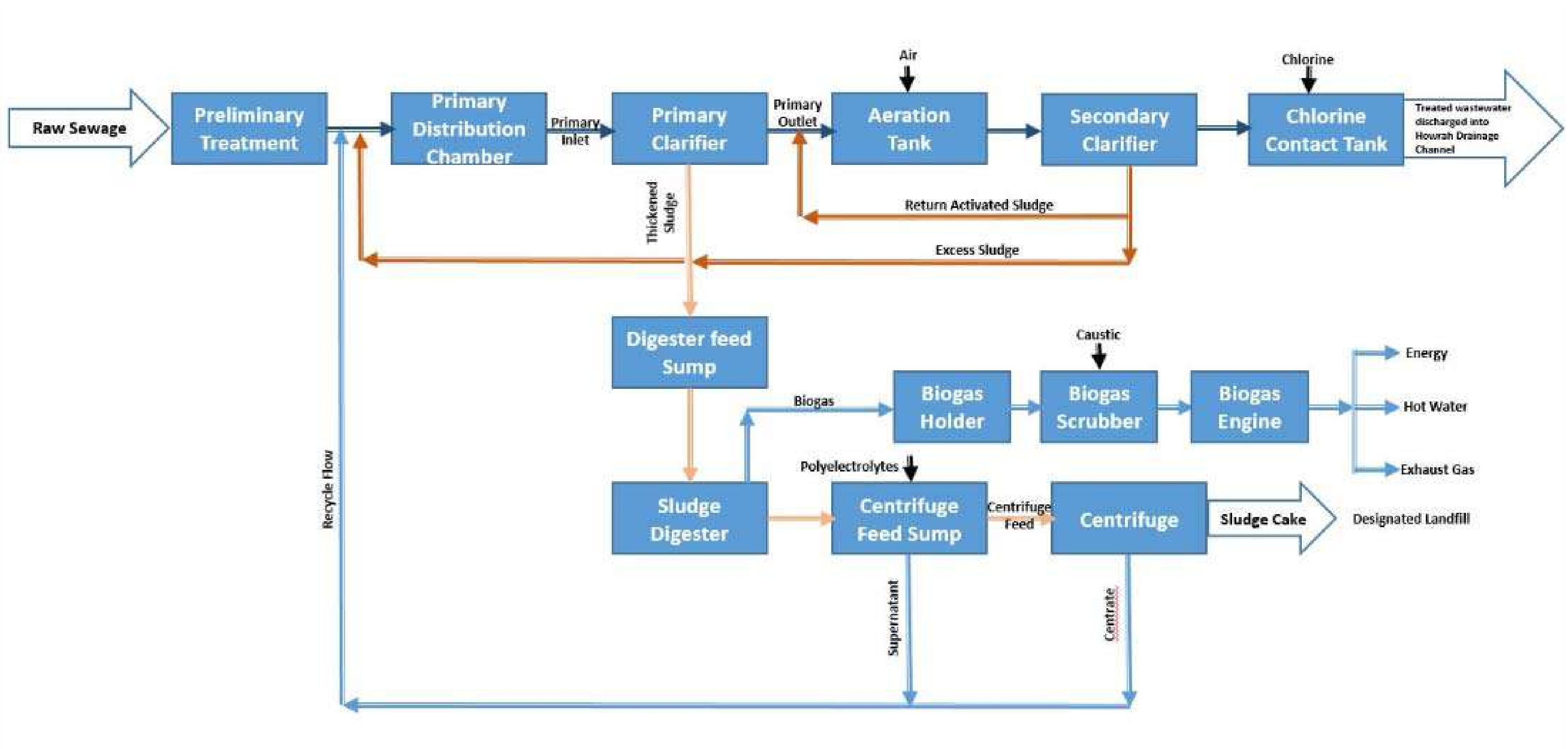


Figure 2.11 Proposed Site layout of Arupara STP structure on Existing Facility

LIST OF UNITS (65 MLD)			
SL.No.	UNIT	UNIT SIZE (in m.)	QTY
1	INLET CHAMBER	5.65x2.00x2.0 LD+ 0.5 FB	1
2	MECHANICAL SCREEN CHAMBER	1.50x9.80x1.10 LD+ 0.5 FB	2
3	MANUAL SCREEN CHAMBER	1.45x9.80x1.10 LD+ 0.5 FB	1
4	GRIT BASIN DISTRIBUTION CHAMBER	--	
5	GRIT CHAMBER	11.0x11.0x0.80 LD+ 0.3 FB	2
6	PARSHALL FLUME CHANNEL	21.40x2.0	1
7	PRIMARY CLARIFIER	13.70x13.70x6.10 LD+ 0.3 FB	2
8	DIGESTER FEED SUMP	3.2x3.6x3.0 LD+ 0.5 FB	1
9	AERATION BASIN DISTRIBUTION CHAMBER(NOT SHOWN)		
10	AERATION TANK	25.50x38.5x5.65 LD+ 0.5 FB	2
11	AERATION AIR BLOWER AREA	8.75x19.60	
12	SECONDARY CLARIFIER DISTRIBUTION CHAMBER(NOT SHOWN)		
13	SECONDARY CLARIFIER	38.5x38.5x3.50 LD+ 0.3 FB	2
14	RAS SUMP	5.00x10.00x3.0 LD+ 0.5 FB	1
15	CHLORINE CONTACT TANK	6.90x36.70x3.90 LD+ 0.3 FB	1
16	CHLORINE CONTACT TANK OUTLET CHAMBER		
17	CHLORINATOR ROOM	4.00x4.00	1
18	CHLORINE TONNER ROOM	12.00x7.00	1
19	SLUDGE DIGESTER	24.00øx7.00 LD + 1.20 FB	2
20	DIGESTER PUMP SHED	8.00x23.45	1
21	DIGESTED SLUDGE SUMP	3.80x3.80x5.00 LD+ 0.3 FB	2
22	DWPE DOSING TANK	3.60x3.60x3.20 LD+ 0.3 FB	1
23	CENTRIFUGE PLATFORM	8.00x6.00	1
24	BIO GAS HOLDER		1
25	ADMINISTARTIVE CUM LABORATORY & SCADA BUILDING	9.00x14.050	
26	SUBSTATION FOR STP		
27	DG PLATFORM		
28	TRANSFORMER YARD		
29	BIO GAS ENGINE ROOM		
30	BIO GAS SCRUBBER		
31	BIO GAS FLARE AREA		
32	PLANT WATER SUMP		

Figure 2.12 Process Block Diagram of Proposed Arupara STP



2.5.5.8 Adequacy Assessment of STP Project

The STP was designed to treat 65MLD of sewage as described earlier. The raw sewage parameters based on which treatment consideration was made is given in the **Table 2.1:** Influent Sewage Characteristics

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Table 2.1: Influent Sewage Characteristics

Parameter	Value
pH	6.5-8.0
TSS, mg/L	600
VSS, mg/L	360
BOD, mg/L	80-250
COD, mg/L	450-600
Faecal coliform, MPN/100ml	10^7-10^8

Source: Wabag, Process Description Document (10P153 – B0012 – 201)

The treated effluent characteristics and digested sludge characteristics are given in **Table 2.2** and **Table** 2.3 respectively.

Table 2.2: Treated Effluent Characteristics

Parameter	Treated Value as per Concessionaire Agreement[5]	Environment (Protection) Amendment Rules, 2017[6]
pH	6.5-9.0	6.5-9.0
TSS, mg/L	< 50	< 50
VSS, mg/L	-	-
BOD, mg/L[7]	< 20	30
COD, mg/L	< 100	< 100
Faecal coliform, MPN/100ml	< 1000	< 1000

Source: Wabag, Process Description Document (10P153 – B0012 – 201)

[5] Project output performance will be governed by the stipulated Indian regulatory standard as specified under Concessionaire Agreement

[6] Traceability: http://www.indiaenvironmentportal.org.in/files/file/Sewage%20Treatment%20Plants_2.pdf (last accessed on 24/03/2020)

[7] The refered Indian standard has not specified testing period for this BOD limit. In general, mostly other Indian standards for BOD limit are prescribed in terms of 5 days at 20ºC.

Table 2.3: Treated Sludge CakeCharacteristics

Parameter	Value
Outlet concentration of dewatered sludge, %	≥20
Faecal Coliform Limit, MPN/ g TS	≤20,00,000

Source: Wabag, Process Description Document (10P153 – B0012 – 201)

As per the condition of governing Concessionaire Agreement, the project designing specification shall follow guidelines provided under “Manual on Sewerage and Sewage Treatment Systems – 2013”[8] as issued by Central Public Health & Environmental Engineering Organisation (CPHEEO), Ministry of Housing and Urban Affairs, Government of India.

The project design consideration has adopted treated effluent water quality compliance with the national effluent discharge standards[9] for sewage treatment plant. Further the sludge generated from the treatment plant is anaerobically digested to produce Biogas which in turn will be used for generation of power from the gas engines. Biogas generated from anaerobic sludge digester with approx. 65% methane, could be used as an alternative source of energy. After energy recovery from sludge, the remaining waste material will be disposed to the KMDA designated site near the STP facility.

2.5.6 Septage Plant

2.5.6.1 Design Standard

Process design for the septage management facility is generally done considering the following documents, as applicable:

− CPHEEO Manual on Sewerage and Sewage Treatment

2.5.6.2 Capacity

The proposed facility has been designed as to handle 150m^3/day of septage in accordance to tender document issued by KMDA.

2.5.6.3 Septage Characteristics

The facility is designed considering the following septage characteristics:

Table 2.4: Inflow Septage Characteristics

Parameters	Units	Values
COD	Mg/L	< 15000
COD/BOD	-	5:1 to 10:1
NH_4-N	Mg/L	< 1000
TS	%	< 3

[8] http://cpheeo.gov.in/cms/manual-on-sewerage-and-sewage-treatment.php

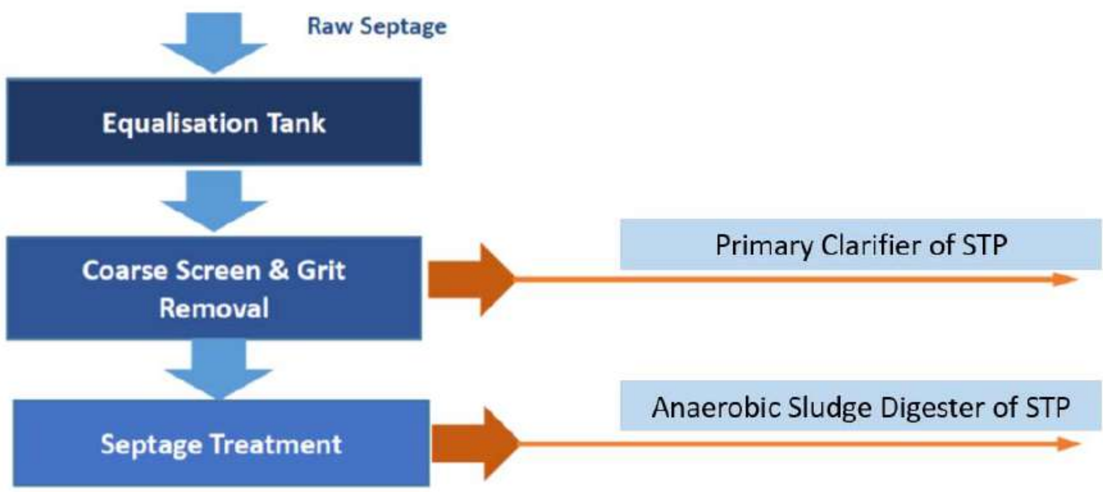
[9] http://www.indiaenvironmentportal.org.in/files/file/Sewage%20Treatment%20Plants_2.pdf

Parameters	Units	Values
SS	Mg/L	7000 (approx.).
Helminth eggs	Nos	4000 (approx.).

Table 2.5: Outflow Septage Characteristics

Parameters	Units	Values
Outlet concentration of dewatered sludge	%	≥ 20
Faecal coliforms	MPN/g	≤ 1000
Salmonella	MPN/4g	≤ 3
Viruses	FPU/4g	≤ 1
Helminth egg	No/4 g	≤ 1

Figure 2.13 Septage Treatment Process Flow



2.5.6.4 Septage Treatment Process

- ***Equalization Tank:*** The septage from tankers is unloaded in this tank. This acts as a flow balancing tank before the septage is treated further. The retention time in this tank is 24 hours.This tank is completely closed and transfer of septage from tankers to equalization tank shall take place through closed pipelines.
- ***Screening and De-gritting***: The septage is screened to remove large floating particles. A manual screen with 10 mm bar spacing is provided for this purpose. This is followed by manual de-gritting chamber. In this chamber, fine particles of grit and sand settles. The purpose of pre-

treatment is to ensure removal of floating solids as they may hinder further treatment processes.As reported the rejects from this chamber shall be feedback to clarifier of STP process.

- ***Lime stabilization (pre-dewatering):*** The pre-treated septage is mixed with lime to increase pH and maintained and higher pH for a stipulated period of time. This is followed by mechanical dewatering, to increase the consistency to 20% DS.
- ***Thermal treatment:*** The pre-treatment sewage is maintained a higher temperature for a recommended time period. This helps removes pathogens from the sludge. Heat treatment is then followed by mechanical dewatering in order to achieve the sludge guarantee of > 20% DS.The dewatered sludge will be processed through anaerobic sludge digester of Arupara STP. The wastewater generated from the process will be feedback to thickener for further purification purpose.

2.5.7 Outlet Pipeline

The treated water from the STP is shall be discharged in Howrah Drainage Channel through electrical driven pumps from the Arupara MPS within the STP complex. The existing outlet line shall be used to discharge the treated sewage water through bircksewer line passing along the Kamardanga Road.

2.6 Details of Plant Machinery

Details of all plant machinery and equipment have been attached in **Appendix B** in the Wabag Process Design Specifications document.

2.7 Resource Requirement

The resource required for the project are given below:

2.7.1 Land

The proposed project will utilize the existing land and infrastructure. The total area available for the proposed STP facility is 19,200 m^2. The existing Arupara STP site is located on the western bank of river Ganga in Dashnagar area at a distance of 4.77 km west of Howrah Station near Howrah – Santragachi railway line within Howrah Improvement Trust (H.I.T) area. Reportedly the land for the proposed STP is under the jurisdiction of the Kolkata Municipal Development Authority (KMDA). The land area of existing STP is 4.97 hectare. Along with STP land specification, the trunk sewer lines, effluent discharge lines are within the ROW of the public roads under the ownership of PWD (Government of West Bengal) and Municipal roads.

As discussed earlier in **Section 4.2**, the proposed project will utilize the existing land and infrastructure. The renovation work at the MPS and LS will be done within the MPS and LS facility respectively, so land will not be required for proposed activity at MPS. For laying of new pipeline or replacement of existing pipeline, temporarily 60 to 75 m^2 (30m of length and 2 to 2.5 m width) of land will be required. The area requirement may change with the depth of pipeline laying or depth of existing pipelines to be replaced.

The land for the STP and the linked facilities belongs to the KMDA. As reported in the Land Ownership Declaration letter pertaining to KMDA's ownership of the land area for the Arupara STP and linked facilities, there are no land issues or disputes, grievances or court cases raised against the land area for the STP and its linked facilities. Moreover, during execution of the project, if necessary for land acquisition, this will be carried out as per the direction of the Government of West Bengal. The Land Ownership Declaration letter has been attached as **Appendix C.**

2.7.2 Workforce

The existing workforce deployed at the Arupara STP and linked three Lift Stations and Main Pumping Station (MPS) are engaged by KMDA through single contractor agency M/s. Ganga Action Plan Contract Workers Co-operative Society Ltd. for operation and maintenance of sewage pumping station being provisioned for through the Ganga Action Plan (GAP). Based on the information shared by KMDA, there are a total sixty-three (63) contracted workers who are presently deployed belonging to semi-skilled and un-skilled categories.

Information related to the workforce planned to be deployed for the proposed project scenario was not made available by the Concessionaire at this ESIA stage. However reportedly, Concessionaire is in discussion with KMDA to develop a reasonable re-engagement plan for the existing contracted workers in the project.

The O&M and EPC contractor for the project i.e. M/s. VA Tech WABAG has a formalised Occupational Health, Safety and Environmental Policy endorsed by the Managing Director and Group CEO Mr. Rajiv Mittal. A copy of the Occupational Health, Safety and Environmental Policy is attached as an **Appendix A.**

2.7.3 Water

Water will be required for both construction and operational phase. The water requirement and utilization of water in both the phases is given below:

Construction Phase:

The water requirement during the construction phase will be about 50 KLD and would mainly be used for dust suppression and drinking water purpose at the labour camp. During construction phase the amount of water required is not provided to ERM. The source of water during construction phase will be arranged by KMDA through the existing municipal water supply pipeline in the locality.

Operational Phase:

The water will be required for Caustic Soda preparation, Scrubber operation and in Chlorination tank. The water will be also required for drinking purpose for the workers during the operational phase. The main source water is pipe water supply and the amount of required during this phase is 0.5 m^3/day. Another 0.1 m^3/day of water will be required to maintain the present greenbelt within the facility. The source of water during operational phase will be arranged by KMDA through the existing municipal water supply pipeline in the locality.

2.7.4 Power

During construction phase of the project portable back-up Diesel Generator (DG) sets shall be used along with the existing grid as this common practice in India. During operational phase, existing grid will be used as the primary electricity source for STP and linked facilities.Whereas, a back-up DG sets of 800 KVA will also be installed for emergency purpose during the operational phase of the project. As proposed an 800 kWe capacity biogas engine will be installed and the power generated from it will be utilized for day to day operations of STP. Approximate power requirement during construction phase will be 75 KW (47 to 50 KVA, depending upon the varying power factor). The approximate expected total power consumption for the STP operation at design conditions will be 11,000 kWh/day. . The onsite biogas engine generates electricity from biogas produced in the STP. The electricity generated from biogas is used to meet the power demand of the STP to the extent possible.

When there is any shortfall in the generated power, grid power will be utilized to meet the shortfall. Standby DG set is only a provision and will be used in the case of power cut. It is expected that at design conditions, the STP will be self sufficient and the power demand can be met by the power generated by Onsite Biogas Engine alone.

2.7.5 Chemical Requirements

The required chemicals for the treatment of sewage water at the STP are Chlorine, Caustic Solution and Poly-electrolytes. The required chemicals shall be stored in a dedicated area. More specific details of onsite chemical storage area specification can be updated on completion of detailed design engineering for the proposed project.

2.7.5.1 Chlorine Gas:

Chlorine gas will be required for disinfection of secondary treated sewage. The Chlorine as would be procured in the form of tonners and will be stored in the Chlorine Tonner room. A Chlorine leak neutralisation system will be provided to handle in case of any leakage of chlorine. All safety equipment as per regulatory requirements will be provided in the chlorination room (IS 10553 – Part I). The Chlorination room and Tonner room will be provided with adequate ventilation. At a time 12 chlorine tonners each of 900 kg capacity will be present at the site. Details of Chlorination is described in **Section 2.5.5.4**.

2.7.5.2 Poly-electrolytes

Liquid Poly-electrolytes shall be used in the centrifuge system. Monthly requirement will be ~10 kg. Apart from these 6 months stock will be present at a chemical storage space within the STP complex.

2.7.5.3 *Caustic Solution*

Caustic solution shall be used for neutralizing chlorine gas at bio-gas scrubbers. The requirement of caustic solution is 10 KLD and thiswill be stored in a tank at the site. A HDPE lined pit of 300 litre capacity will be constructed at the site for safe disposal of caustic solution in case of leakage. More specific details of onsite chemical storage area specification can be updated on completion detailed design engineering for the project site.

2.8 Project Activity

The activities for the Project can be divided into two (2) phases, namely: a) Construction; and b) Operations and maintenance.The key project activities during these two phases of the Project have been summarised below:

2.8.1 Construction Phase

The construction activity will involve construction of a new 65 MLD STP, renovation of MPS facility, renovation and repairing of lifting stations, laying of gravity sewer line and raising main and construction of Septage Treatment Facility. The construction work will include excavation, pilling, backfilling etc. Construction work shall also encompass desilting of the existing gravity sewer lines. At MPS and lifting stations, replacement and installation of pumps along with electrical works (i.e. wiring, cable dressing, installation of electrical panels etc.) shall also be carried out during construction phase.

2.8.2 Operation and Maintenance Phase

During Operation and Maintenance the sewage water from northern and western part of Howrah municipality will treated at the new STP as per the Central Pollution Control Board (CPCB) prescribed standards. Biogas and sludge will be generated from the treatment of sewerage water. Biogas will be utilised in the bio-gas plant for power generation whereas the dry sludge cakes can be utilised for composting after dewatering of the sludge, though this aspect has not been considered in scope of work for O&M contractor as per Concession Agreement. The treated water will comply with effluent discharge standards set by CPCB and shall be discharged into the Howrah Drainage Channel.

2.9 Pollution Source and Control Measures

a) ***Air Emissions:*** Construction activities will generate emission of fugitive dust caused by construction material handling, on-site excavation and movement of earth materials, contact of construction machinery with bare soil, and exposure of bare soil and soil piles to wind. DG sets will be used during construction period which will generate exhaust gas. Biogas will be generated during the operation phase which may partially require to be flared under certain circumstances resulting in flare combustion products. In addition, STP's of the proposed configuration are expected to emit Bio-aerosols (which may include microorganisms such as viruses, pathogenic bacteria, and fungi) during operations phase and may pose a health risk to STP workers and neighbouring communities.

Embedded Control Measures:

i. Sprinkler systems will be used to supress the fugitive dust emission during construction phase.

ii. The DG sets will be installed with emission standards in compliance with the CPCB guideline

iii. The concessionaire will ensure to maintain the stack height as per the CPCB guideline of $H = h + 0.2 \sqrt{\text{capacity of DG sets in KVA}}$ where H is the total height of the stack in meters and h is the height of the building in meters where the DG set will be installed.

iv. Biogas-scrubber (s) will be used to remove the hydrogen sulphide (H_2S) traces present in the biogas generated during anaerobic digestion process.

v. Appropriate flaring system will be installed to ensure efficient combustion of Bio-gas through flaring burners located 6 m above ground level.

vi. The quantification of health risks from bio-aerosols is difficult to predict and can be better charecterised through monitoring (in terms of colony-forming units per unit volume of air (CFU/m3)) when the STP commences operations.

b) ***Noise Generation:*** During construction activities, noise and vibration will be caused by the operation of pile drivers, earthmoving and excavation equipment, concrete mixers, cranes and the transportation vehicle. During operations phase, noise will be generated from high noise equipment and machineries like hydraulic pumps, mixing pit pump, digestor loading pump, HGV movement, material tipping, air blower and compressor.

Control Measures

i. Necessary noise control equipment such as mufflers will be provided to DG sets with Insertion loss of minimum 25 dB (A) to ensure ambient noise level.

ii. No construction activity will be done during night time to maintain ambient noise quality.

iii. Provision for noise enclosures or barriers for high noise machineries, equipment.

iv. Provision for green belt along boundary walls.

c) ***Wastewater Discharge:*** During Construction Phase, no liquid discharge has been envisaged for the proposed Arupara STP. During the operations phase, the STP will be treating sewage water and discharged into the Howrah Drainage Chanel so that it doesn't cause significant adverse impact to the environment or surrounding community – in fact by discharging treated waste water, the STP is expected to result in a minor improvement of the existing water quality of the receiving surface water stream, the Howrah Drainage Channel. The treated sewage water from the proposed 65 MLD STP operation will be discharged into Howrah Drainage Channel maintaining the stipulated regulatory limits set for STP operation under Environment (Protection) Amendment

Rules, 2017 by Ministry of Environment, Forests and Climate Change, Government of India and stipulated qualitative discharge characteristics as under the Concession Agreement.

d) ***Solid Waste Generation:*** Solid wastes will be generated during construction phase activities i.e. packaging materials, cement bags, ready mix concrete discards, excavated materials, empty barrels etc.These waste can be hazardous and non-hazardous in nature and are categorized as Construction and Demolition (C&D) wastes governed by Construction and Demolition Waste Rules, 2016 for the proposed project site and linked faculties.

During operation phase, periodic maintenance of the sewer line will generate de-silted sludge. De-watered sludge will be generated due to treatment of sewage water. Solid wastes from grit chambers and screens will be generatd at the pumping stations and STP. Used oil and grease and cotton waste (contaminated with oil) generated from maintenance activities at the LS, PS and STP equipment are the sources of hazardous wastes during operation phase.

All non hazardous solid wastes generated will be stored temporarily at respective location and then disposed to designated landfill sites assigned by KMDA as per Concession Agreement.

Approximately 5m^3/day quantity of grit will be generated during operation of the proposed Arupara STP. The estimated quantity of used oil generation due to maintenance of the mechanical equipment at the STP will be available at a later stage after equipment finalization.

Control Measures

i. As reported the C&D waste generated during the construction activities will be stored separately at a designated area within the STP complex.
ii. The concessionaire may reuse a portion of the C&D waste for backfilling activity if required.
iii. The concessionaire will dispose the other solid wastes at a designated landfill site of KMDA near the STP complex as per concession agreement.
iv. Contract with WBPCB approved vendor for disposal of hazardous waste;
v. Disposal of solid waste through municipal waste collection trucks;
vi. Dry sludge will be disposed to landfill site as designated by the KMDA within a radius of 10 km from the relevant Site as per Concession Agreement.

e) ***Hazardous Waste:*** activities may result in the potential for generation of small quantities of petroleum based wastes, such as used oil including lubricants, hydraulic fluids, or fuels during their storage, transfer, or use in equipment. Quantity of the used oil generation due to periodic maintenance of the equipment during the STP operational phase will be estimated at a later stage after equipment finalization.

Control Measures:

i. Making arrangement for proper segregation, storage and disposal of such wastes;
ii. Providing adequate secondary containment for fuel storage tanks and for the temporary storage of other fluids such as lubricating oils and hydraulic fluids;
iii. Using impervious surfaces for refuelling areas and other fluid transfer areas;
iv. Providing portable spill containment and clean-up equipment on site and training in the equipment deployment; and

v. Training workers on the correct transfer and handling of fuels and chemicals and the response to spills.

2.10 Project Schedule

The project schedule is given in **Table 2.6**.

Table 2.6: Project Schedule for Arupara STP Project

Activities/Month	2019			2020												2021												2022	
	M10	M11	M12	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M1	M2
Basic Engineering																													
Detailed Engineering																													
Order Placement																													
Manufacturing & Supply																													
Information Disclosure																													
Stakeholder Engagement & Grievance Redressal																													
Mobilization at Site																													
Civil Work (Construction)																													
Installation Work																													
Final Documentation																													
Commissioning and Trail Run																													

Note: The project is scheduled assuming October, 2019 to be the start date for basic engineering.

2.11 Project Cost

The total cost for STP Arupara is Rs. 185.22 crores including 15 years O&M with an estimated environmental and social management cost being Rs. 12.24 lakhs per annum under a Hybrid Annuity scheme based on PPP mode.

3. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

This section highlights only the relevant environmental and social policies and regulations, IFC guidelines, which are applicable for this project.

- Applicable national and state-specific EHS and Social regulations in India;
- IFC Performance Standards on Social and Environmental Sustainability, 2012 along with IFC General EHS Guidelines (2007) and Industry Sector Guidelines: Water and Sanitation, (10 December 2007);
- National Mission for Clean Ganga Environmnetal and Social Management Framework for Navami Gange Program

3.1 Environment, Health and Safety-related Regulations, Guidelines and Rules in India

The applicable regulations in the context of the project are presented in below table:

Table 3.1: Applicability of Environment, Social, Health and Safety (ESHS) Regulatory Regime

National Legislations	Applicability
■ Prior **environmental clearance** from the concerned regulatory authority for 39 types of projects as stipulated under Schedule of **EIA Notification, 2006** under Rule 5 of the **Environment *(*Protection*)* Rules, 1986** and covers aspects like screening, scoping and evaluation of the upcoming project. The main purpose is to assess impact of the planned project on the environment and people and to try to abate/minimise the same.	Not Applicable The proposed project activity involving renovation and installation of sewage treatment plant and linked sewerage infrastructure which does not fall under ambit of EIA Notification, 2006 as amended and therefore does not require Environmental Clearance.
■ As per requirement of the **Water** (**Prevention & Control of Pollution**) **Act, 1974** (the Water Act); **Air** (**Prevention & Control of Pollution**) **Act, 1981** (the Air Act) it is mandatory to obtain **Consent to Establish** *(*CTE/ NOC*)* from respective State Pollution Control Board before commencement of the construction activities on the site and to obtain a **Consent to Operate** (CTO) from the State Pollution Control Board before initiation of the any commercial operations at the facility.	Applicable The proposed project activity would involve construction, operation and maintenance (O&M) of a newly constructed 65 MLD STP. During the construction phase wastewater generated from activities I.e. mixing of concrete, washing of equipment, waste water from dust suppression etc.will be discharged, and during O&M phase treated sewage water will be discharged into existing drainage channel i.e.Howrah Drainage Channel. As per the regulatory requirements, obtaining CTE/NOC from West Bengal Pollution Control Board (WBPCB) will be mandatory before initiation of any site work and the CTO from WBPCB will be mandatory prior initiation of operations.
■ As per **Environment** (**Protection**) **Act, 1986**, (Section 6) and **Environment *(*Protection*)* Rules, 1986.** Project Proponent is required to ensure all pollutant emissions and effluents discharge during	Applicable The proposed project has two phases, construction of 65 MLD STP along with

<table>
<tr><th>National Legislations</th><th>Applicability</th></tr>
<tr><td>different phases of the project must comply with notified environmental standards;
■ Effluent discharge standards for Sewage Treatment Plants stipulated under Environment (Protection) Amendment Rules, 2017.</td><td>renovation of existing linked sewerage infrastructure i.e. LS, MPS and Sewer network and operation of STP. The project is envisaged to generate dusts, fumes, gaseous emissions, bio-aerosols, bio-solids, solid and hazardous wastes, noise emissions during both construction and operation of the project. Thus, as per regulatory requirement, these potential pollution sources shall require to be maintained within emissions and discharge norms set out by the regulatory authority.
Effluent discharge standards for the sewage treatment plants as stipulated under Environment (Protection) Amendment Rules, 2017:

<table>
<tr><th>Parameter</th><th>Concentration not to exceed</th></tr>
<tr><td>pH</td><td>6.5 – 9.0</td></tr>
<tr><td>Biochemical Oxygen Demand (BOD) (mg/l)</td><td>20</td></tr>
<tr><td>Chemical Oxygen Demand (COD) (mg/l)</td><td>No limit</td></tr>
<tr><td>Total Suspended Solids (TSS) (mg/l)</td><td><50</td></tr>
<tr><td>Total Nitrogen (mg/l)</td><td>No limit</td></tr>
<tr><td>Ammonical Nitrogen (mg/l)</td><td>No limit</td></tr>
<tr><td>Total Phosphorous (mg/l)</td><td>No limit</td></tr>
<tr><td>Faecal Coliform (FC) (MPN/100ml)</td><td><1000</td></tr>
</table></td></tr>
<tr><td>■ As per Environment (Protection) Act, 1986, (Section 5) and West Bengal Ground Water Resources (Management, Control & Regulation) Act, 2005 and Amendment Act 2015. No Objection Certificate for groundwater abstraction through mechanical devices for industrial purpose from District Level Ground Water Resources Development Authority (State Water Investigation Directorate).</td><td>Not Applicable.
As reported water requirement for both construction and operation phase will be sourced from Municipal supply water.</td></tr>
<tr><td>■ As per Solid Waste Management Rules 2016, waste generator need to segregate and store waste as three separate streams i.e. bio-degradable, non-bio-degradable and domestic hazardous waste and dispose them through approved vendors of West Bengal State Pollution Control Board.</td><td>Applicable

The proposed project is envisaged to generate different categories of non-hazardous wastes such as packaging waste, metal scrap, solid wastes mainly plastics, cardboards, miscellaneous grits screened at MPS and LS both during construction and operational phase.</td></tr>
</table>

National Legislations	Applicability
	As per regulatory requirement these wastes have to be segregated and stored as per three specified streams and disposed through vendors approved by West Bengal Pollution Control Board.
■ As per **Construction and Demolition Waste Management Rules, 2016** (Section 4), The waste generator shall prima-facie be responsible for collection, segregation and disposal C&D wastes separately as directed or notified by the concerned local authority and the waste generator who generate more than 20 tons or more in one day or 300 tons per project in a month is required to submit waste management plan and get appropriate approvals from the local authority before commencement of construction or demolition or remodelling work.	Applicable The proposed project activity is envisaged to generate construction i.e. Asphaltic concrete paving, Concrete, Concrete reinforcing steel, Brick, Concrete masonry units, etc., during construction of the STP and renovation of the linked sewerage infrastructure. Thus the provision of this regulation will be applicable for the project.
■ As per **Gas Cylinder Rules,2004** Chlorine tonners are classified as Compressed gas any permanent gas, liquefiable gas or gas dissolved in liquid under pressure or gas mixture which in a closed gas cylinder exercises a pressure either exceeding 2.5 kgf/cm2 abs (1.5 kgf/ cm2 gauge) at +150 C or a pressure exceeding 3kgf/ cm2 abs (2 kgf/ cm2 gauge) at + 500 C or both; Explanation – Hydrogen Fluoride falls within the scope of compressed gas although its vapour pressure at 500 C is 1.7 to 1.8 atmospheric gauge;	Applicable The proposed project involves chlorination for disinfection of treated water and the operational phase of the project will involve storage of chlorine tonners within the STP facility.
■ As per **E-Waste Management Rules , 2016** and Amendment 2018, used for channelization of e-waste from 'end-of-life' products from generator to authorised dismantler or recycler having Authorisation.	Applicable The proposed project will generate electrical wastes i.e. discarded circuit boards, PLC units, during renovation of linked LS and MPS, where all electrical and electronic equipment will be replaced as per Scope of Work for the Concessionaire. Thus, this rule gets triggered and these waste need to be stored separately and disposed through West Bengal Pollution Control Board authorized dismantler or recycler.
■ As per the requirements of the **Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016** (HWR, 2016), any facility which generates, storages, handles, and disposes any type of hazardous wastes listed in Schedule-I of the said Rules, is required to obtain a hazardous waste authorization (HWA) from the State Pollution Control Board.	Applicable The proposed project is envisaged to involve generation and handling of hazardous wastes (used oil, empty chemical containers, used oil containers, fluorescent light tubes, etc.) during renovation of linked facilities and during construction phase as well as in the operation phase of STP.

National Legislations	Applicability
	Thus the provision of this regulation will be applicable for the project activity. The Concessionaire has to maintain the hazardous waste storage, handling and disposal requirements as per the regulatory requirements and to obtain HWA from West Bengal Pollution Control Board prior commencement of the project operation.
■ As per **Manufacture, Storage and Import of Hazardous Chemicals Rules 1989, amended 1994 and 2000** (the Rules provide indicative criteria for hazardous chemicals and require occupiers to identify major accident hazards and prepare on-site and offsite emergency plans).	Applicable The proposed project involves chlorination for disinfection of treated water and the operational phase of the project will involve storage of chlorine tonners at the STP facility. Chlorine is categorized as hazardous chemical under Schedule 1 Part II and Schedule 2 of Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (MSIHC Rules, 1989). Therefore the relevant provision of the MSIHC Rules will be applicable for the proposed project activity and with special emphasis on the specific criteria (isolated storage, approval and notification of Site, safety reports, on-site emergency plan) if the storage quantity of chlorine is equal to or more than the threshold quantity for Chlorine as specified in the Column 3 (10 tonnes) and Column 4 (25 tonnes) of Schedule 2 of the MSIHC Rules, 1989.
■ As per **Public Liability Insurance Act, 1991 and rules thereunder,** any facility involved in handling, storage and transportation of hazardous chemical listed under EPA, 1986 shall issue an insurance policy which is applicable if any incident happens during handling of hazardous chemicals.	Applicable The operation and maintenance of the proposed project facility is envisaged to involve generation and handling of hazardous and non-hazardous wastes (used oil, empty chemical containers, empty chlorine tonners, high sulphur content sludge from Biogas scrubber etc.) as well as hazardous chemical as storage of chlorine tonners for chlorine based disinfection process for treated water. As per MSIHC Rules, 1989 chlorine is classified as hazardous chemicals. Thus this act and its rules are applicable as hazardous chemical handling and storage is involved.
■ As per **Central Electricity Authority *(*Measures relating to Safety and Electric Supply*)* Regulations, 2010** *(*the Rule lays down general safety requirements pertaining to construction,	Applicable The proposed project activity shall involve installation and operation of medium to high voltage electrical installations (transformers,

National Legislations	Applicability
installation, protection, operation and maintenance of electric supply and apparatus).	pumps, DG sets, panels etc.) at the existing LS and MPS as well as in the proposed 60 MLD STP facility. Therefore the relevant regulatory provisions as per Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010 will be applicable for the project activity.
■ The Factories Act, 1948 and the West Bengal Factories Rules,1958 thereunder, (the Act lays down the procedure for approval of plans before setting up a factory, health and safety provisions, welfare provisions, working hours and rendering information- regarding accidents or dangerous occurrences to designated authorities.	Applicable The proposed project's major activity shall entail pumping of sewage and within premise of the facility ten or more workers will be working, on any day and in any part of which a manufacturing process (pumping of sewage) is being carried on with the aid of power. Thus the provision of the Factories Act, 1948 and West Bengal Factories Rules, 1958 will be applicable for the proposed project activity.
■ As per **West Bengal Fire Service Act of 1950** and the **West Bengal Fire Services (Fire License) Rules, 2004** (Outlines legally bindings requirements to ensure that the buildings are built and maintained with adequate safeguards to prevent the occurrence of Fire or to contain Fire occurring in a high risk building as defined under section 2(hb) of the West Bengal Fire Services Act, 1950.)	Applicable, only if the project building to be greater than 14.5 meters in height and buildings as notified in Notification No. 279/DS/FS/0/C-1/FIA-3196 Dated 8th July, 2003 or involves storage of hazardous substances (chlorine tonners) as specified under rule 3 and Schedule I of West Bengal Fire Services (Fire License) Rules, 2004.
■ As per **West Bengal Trees (Protection and Conservation in Non-Forest Areas) Act, 2006**, permission from the Divisional Forest Officer (Utilization Division), Forest Directorate, Government of West Bengal will be required to cut trees for construction. The applicant will also be responsible for plantation of trees (5 times the number of trees to be cut) within the premises.	Not applicable The proposed project activity along the sewage network has no full grown trees, but the proposed STP location has significant green cover and full grown trees, as per KMDA and concessionaire these trees will not be uprooted for the new STP. thus, this regulation is not applicable for this project location for now.If tree felling scenario comes up in later stage then this regulation is applicable and the concessionaire along with KMDA have to take up mandatory regulatory provisions under this national regulation.

Note:

In view of attaining control on the current pollution status of Indian rivers and depletion of aquatic resources, the National Green Tribunal (NGT), Government of India vide their Order dated 30 April 2019 (Original Application No. 1069/2018 (M.A. No. 1792/2018, M.A. No. 1793/2018, I.A. No. 150/2019 & I.A. No. 151/2019)) has emphasised that there is a need of revised effluent discharge standards for STPs. Therefore, based on the recommendation report from the Expert Committee (comprising the nominees from IIT Kanpur, IIT Roorkee, NEERI and CPCB) on the matter, NGT has endorsed the proposed revised discharge standards for STPs, which will apply not only for new STPs but also for existing/ under construction STPs without any delay[10].

Accordingly, NGT has directed Ministry of Environment, Forests & Climate Change (Government of India), which may issue an appropriate Notification in the matter within one month from the date of the concerned NGT Order dated 30 April 2019. The further Notification on any revised effluent discharge standards for STPs is awaited from Ministry of Environment, Forests & Climate Change as on February 2020.

In case the revised effluent discharge standards for STPs as per NGT order come into effect through official gazetted notification from the Ministry of Environment, Forests & Climate Change (Government of India), the Concessionaire needs to take up the matter with KMDA for augmenting the project treatment design and scheme to comply with the new regulatory discharge limit.

3.2 Social related Legislation in India

The major regulation that are applicable for the project life cycle is provided below:

Table 3.2: Applicability of Social Regulatory Regime

National Legislations	Applicability
■ **The Right to Fair Compensation and Transparency in Land Acquisition and Rehabilitation and Resettlement Act, 2013** (provides for a transparent process and just and fair compensation to the affected families whose land is acquired or proposed to be acquired or are affected by such acquisition and provides for rehabilitation and resettlement of the affected families.)	Not Applicable The proposed project does not involve any land acquisition, as the proposed activity will be implemented within the boundary of existing facility. However economic displacement and temporary resettlement due to renovation activity within the existing ROW will be governed through IFC PS 5. Moreover, it may be noted that in 2014, the Government of West Bengal (GoWB) issued a memorandum allowing all state government departments to go in for direct (negotiated) purchase of land for public purpose, mainly involving commissioning of infrastructure projects. [11]
■ **The West Bengal Estates Acquisition Act, 1953 and the West Bengal Land Reforms Act of 1955 and amendments** ■ *(*Outlines land-related laws of the State regulating land holding *(*ceiling*)* for various purposes including change in character and ownership and use of the land and the right of the sharecroppers.*)*	Not Applicable No specific provisions in the Acts that will have a direct bearing on envisaged temporary involuntary resettlement under the Project.
■ **Contract Labour** (**Regulation and Abolition**) **Act, 1970** (the Act provides for certain welfare measures to be provided by the contractor to contract labour);	Applicable The proposed project activity will engage contractual workers during the construction

[10] http://www.indiaenvironmentportal.org.in/files/file/revised-standards-STPs-NGT-Order.pdf

[11] Memorandum No. 3145-LP/1A-03/14 dated 24 November, 2014. It provides for constitution of a Purchase Committee, process of determination of value of land, buildings, and structures. It provides an incentive on the price of land finally determined if land registration is accomplished within defined time frames. GoWB has also exempted the stamp duty for such purchase of land.

National Legislations	Applicability
	phase as well as during the operations and maintenance (O &M) phase of the project. Thus under this act registration for license is necessary before employing workers for any project related activity.
■ **Payment of Wages Act, 1936** and the **West Bengal Payment of Wages Rules, 1958** thereunder *(*it lays down as to by what date the wages are to be paid, when it will be paid and what deductions can be made from the wages of the workers*)*.[12]	Applicable As per section 1(4) and 2(ii) (g) of the Payment of Wages Act, 1936, the Act applies to persons employed in establishments in which any work relating to the construction, development or maintenance of buildings, roads, bridges or canals, or relating to operation connected with navigation, irrigation, development or maintenance of buildings, roads, bridges or mission and distribution of electricity or any other form of power is being carried on. This Act is applicable because the project activities will include construction and operation of the STP. Moreover, during the operation phase, a major activity is pumping of sewage which is considered a manufacturing process and will be carried out with the aid of power.
■ **Minimum Wages Act, 1948 and Minimum Wages Rules, 1950** thereunder (The Minimum Wages Act, 1948 Act applies to persons employed in a factory where scheduled employment is carried out. Schedule employment includes manufacturing processes, the employer is supposed to pay not less than the Minimum Wages fixed by the Government as per provisions of the Act). **Refer footnote No** 9	Applicable The proposed project's major activity is pumping of sewage and within premise of the facility ten or more workers will be working, on any day and in any part of which is being carried on with the aid of power. This qualifies as a manufacturing process (under Section 2K of the Factories Act). The proposed project activity will engage contractual workers during the construction phase as well as during the operations and maintenance (O&M) phase of the project. Thus the regulatory provision under *Minimum Wages Act, 1948* will be applicable for the proposed project related activity.
■ **Employees' State Insurance Act, 1948** *(*The ESI scheme governed by the Act is a self-financed comprehensive social security scheme devised to protect the employees covered under the scheme against financial distress arising out of events of sickness, disablement or death due to employment injuries. The ESI scheme is applicable to all factories	Applicable The proposed project's major activity is pumping of sewage and within premise of the facility ten or more workers will be working, on any day and in any part of which is being carried on with the aid of power. This qualifies as a manufacturing

[12] As of 2nd August, 2019, the Code on Wages, 2019 has been enacted which subsumes the Payment of Wages Act, 1936, the Minimum Wages Act, 1948, the Payment of Bonus Act, 1965 and the Equal Remuneration Act, 1976. However, this is subject to the adoption of the Act by the Government of West Bengal.

National Legislations	Applicability
and other establishments as defined in the Act with 10 or more persons employed in such establishment and the beneficiaries' monthly wage does not exceed Rs 21,000 are covered under the scheme.)	process (under Factories Act). The proposed project activity will engage contractual workers during the construction phase as well as during the operations and maintenance (O&M) phase of the project. Thus the regulatory provision under *Employees' State Insurance Act, 1948* will be applicable for the proposed project related activity.
■ **Employees Provident and Miscellaneous Provisions Act, 1952** and amendments thereafter (As per section 2 *(a)* of the Employees Provident and Miscellaneous Provisions Act, 1952, the Act applies to every establishment which is a factory engaged in any industry specified in Schedule 1 and in which twenty or more persons are employed.)	Applicable The proposed project's major activity is pumping of sewage and within premise of the facility ten or more workers will be working, on any day and in any part of which is being carried on with the aid of power. This qualifies as a manufacturing process (under Factories Act). The proposed project activity will engage contractual workers during the construction phase as well as during the operations and maintenance (O&M) phase of the project. Thus the regulatory provision under *Employees Provident and Miscellaneous Provisions Act, 1952* will be applicable for the proposed project related activity.
■ **Workmen's Compensation Act, 1923** (the Act provides for compensation in case of injury by accident arising out of and during the course of employment).	Applicable As per Section 2 (n) of the Workmen's Compensation Act 1923 applies to workman employed in work related to a manufacturing process as defined in section 2 (k) of the *Factories Act, 1948* which includes pumping of sewage, as well as where electrical power is generated. The Act is thus applicable as the Concessionaire will employ workmen in facilities where pumping of sewage will take place and where electrical power will be generated.
■ **Building and Other Construction Workers** (**Regulation of Employment and Conditions of Service**) **Act, 1996** and the **Cess Act of 1996** (all the establishments who carry on any building or other construction work and employs 10 or more workers are covered under this Act; the employer of the establishment is required to provide safety measures at the building or construction work and other welfare measures, such as canteens, first-aid facilities, ambulance, housing accommodation for Workers near the workplace, etc.).	Applicable The provision of this Act is applicable for the proposed project activity, as the Concessionaire supposedly will be engaging more than ten construction workers during the construction phase of the project.
■ **Inter-State Migrant Workmen's** (**Regulation of Employment and Conditions of Service**) **Act, 1979** (the inter-state migrant workers, in an	Applicable, only if five or more inter- State migrant workmen to be hired from outside the state of West Bengal.

National Legislations	Applicability
establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, traveling expenses from home to the establishment and back, etc.).	
■ **The Child Labour** (**Prohibition and Regulation**) **Act, 1986** (This Act prohibits engagement of children in certain employments and regulates the conditions of work of children in other certain employments)	This act specifies that no child below the age of fourteen years shall be employed to work in any factory or employed in any hazardous work. The act It aims to regulate the hours and the working conditions of child workers and to prohibit child workers from being employed in hazardous industries.
■ The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013	This Act seeks to protect women from sexual harassment at their place of work.
■ National Policy on Corporate Social Responsibility 2013 ■ This act-CSR has been recently notified in section 135 of the Companies Act 2013 by the Ministry of Corporate Affairs, Government of India.	*Under sub section 1 of the section 135, the act mandated companies with a net worth* 500 crore or more or Turnover of 1000 crore or more or Net Profit of INR 5 crore or more shall be covered within the ambit of CSR provisions

3.2.1 National Mission for Clean Ganga Environmneta l and Social Management Framework for Navami Gange Program

The ESMF, an umbrella document for management of environmental and social issues of the river pollution mitigation projects has been developed under the National Ganga River Project (NGRBP). The ESMF has broadly categorise the projects based on the location, size and nature of the project activities that will have a varying impacts on environment. To facilitate effective screening, the portfolio of projects to be implemented under NGRBP, have been grouped into the following two categories, based on the severity of its potential impacts, regulatory requirements of Government of India (GoI) as well as State Governments apart from the safeguard requirements of the World Bank:

- Category I – Sub-Projects requiring Environmental and Social Assessment and development of RAP (Category A as per OP 4.01 of The World Bank)
- Category II – Sub-Projects requiring implementation of safeguard management plans (Category B, as per OP 4.01 of The World Bank)

As per the ESMF categorisation, the proposed project in Baranagar falls under category II. Thus the project required an analysis of environmental and social issues and management measures shall be implemented to mitigate the temporary impacts, mostly anticipated during the construction phase of the project.

The framework also recognises the rights of both the titleholder and non-tittle holders eligible for compensation.

3.3 Lenders' Environmental and Social Safeguard Standards

IFC Performance Standards (2012)

As per IFC's Sustainability Framework, 2012, all investments and advisory clients whose projects go through IFC's initial credit review process after January 1, 2012 is required to comply with IFC's

Environmental and Social Performance Standards for managing their environmental and social risks. IFC's Performance Standards offer a framework for understanding and managing environmental and social risks for high profile, complex, international or potentially high impact project. The IFC Performance Standards help IFC and its clients manage and improve their environmental and social performance through an outcomes-based approach and also provide a solid base from which clients may increase the sustainability of their business operations. IFC's Performance Standards sets out the policy objectives, scope, risk management and principles for eight key Environmental and Social Sustainability areas:

a) Risk Management,
b) Labour,
c) Resource Efficiency,
d) Community,
e) Land Resettlement,
f) Biodiversity,
g) Indigenous People, and
h) Cultural Heritage.

IFC General EHS Guidelines (2007) and Industry Sector Guidelines: Water and Sanitation, (10 December 2007)

The IFC Environmental, Health and Safety Guidelines for Water and Sanitation is a technical reference document with general and industry- specific examples of Good International Industry Practice (GIIP). This document contains relevant information pertaining to the operation and maintenance of (i) potable water treatment and distribution systems, and (ii) collection of sewage in centralized systems, such as piped sewer collection networks or decentralised systems, and treatment of collected sewage at centralised facilities.

3.4 Reference Framework and their Applicability

Based on the review of Project facility and the corresponding operational details, the following IFC Performance Standards (2012) is found to be applicable to the Project in the current scenario:

Table 3.3: IFC Performance Standards

IFC PS	Description	Applicability to the Project
PS 1	**Assessment and Management of Environmental and Social Risks and Impacts** [*This PS aims to assesses the existing social and environmental management systems and to identify the gaps with respect to their functioning, existence and implementation of an environmental and social management plan* (*ESMP*)*, a defined EHS Policy, organization chart with defined roles and responsibilities, risk identification and management procedures as well as processes like stakeholder engagement and grievance management*]	Applicable Considering the proposed project activity being implementation and operation of public utility development project (sewage treatment plant and linked sewerage infrastructure) it is essential to have a defined mechanism towards assessment and management of associated environmental and social risks and impacts. Thus ensuring compliance with PS 1 will be applicable for the Project.
PS 2	**Labour and Working Conditions**	Applicable

IFC PS	Description	Applicability to the Project
	[This PS is guided by a number of international conventions and instruments on labour and workers' rights. It recognises that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of fundamental rights of workers. The PS covers following themes: human resource policy and management, workers' organization, non-discrimination and equal opportunity, retrenchment, protecting the workforce and occupational health and safety. *The requirement set out in this PS have been in part guided by a number of international conventions and instruments.]*	Considering the proposed project activity involving renovation, capacity addition, operation and maintenance of the municipal sewerage treatment plant and the linked sewerage infrastructure, the Concessionaire and the EPC and OM contractor deputed thereunder will be deploying own and subcontracted workforce at the project site during construction and operation of the project. Wherein the labour and working conditions needs to be ensured by the Concessionaire. Thus ensuring compliance with PS 2 will be applicable for the Project.
PS 3	**Resource Efficiency and Pollution Prevention** *[This PS-3 focuses on increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. There is also a growing global consensus that the current and projected atmospheric concentration of greenhouse gases (GHG) threatens the public health and welfare of current and future generations. At the same time, more efficient and effective resource use and pollution prevention2 and GHG emission avoidance and mitigation technologies and practices have become more accessible and achievable in virtually all parts of the world.]*	Applicable The proposed project activity involves overall environmental improvement context through renovation and capacity addition of the municipal sewerage treatment plant and the linked sewerage infrastructure to reduce release of untreated sewage to river Ganga to ensure effective abatement of pollution and conservation of the river Ganga and its tributaries. Therefore no permanent and adverse environmental impact is envisaged due to implementation of the project activity. However, being the developmental project temporary environmental pollution is envisaged during construction and operation of the sewage treatment plant and the linked auxiliary system. Thus ensuring compliance with PS 3 will be applicable for the Project.
PS 4	**Community Health, Safety and Security** *[This PS-4 requires due diligence to anticipate and avoid adverse impacts on the health and safety of the affected community during the project life from both routine and non-routine circumstances. It also requires to ensure that the safeguarding of personnel and*	Applicable The proposed STP is located at Howrah Municipal Corporation area. The linked sewage infrastructures are spread across densely populated municipal of HMC. Both construction and operational phase of the project may involve surrounding community health, safety and security context related to fugitive emissions, faecal coliform contamination, pathogen exposure, odour nuisance, accidental chlorine gas

IFC PS	Description	Applicability to the Project
	property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the affected Communities. Key areas of compliance screened under PS-4 includes: infrastructure/equipment safety, hazardous material safety, natural resource issues, exposure to disease, emergency preparedness and response, and security personnel requirements.]	leakage from chlorine tonner storage and risks posed by its security arrangements. Thus ensuring compliance with PS 4 will be applicable for the project activity.
PS 5	**Land Acquisition and Involuntary Resettlement** [*PS-5 requires project proponents to anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use. The key themes covered under this are: compensation and benefits for displaced persons, consultation and grievance mechanism, resettlement planning and implementation, physical displacement, economic displacement. The PS-5 also prescribes private sector responsibility to supplement government actions and bridge the gap between governments assigned entitlements and procedures and the requirements of PS-5.*]	Applicable The proposed project scenario does not involve land acquisition. However, the Site reconnaissance activity during the current due diligence process revealed that though no physical displacement will take place during project implementation, there is potential for economic displacement in the form of temporary income loss for roadside vendors and kiosks, during the replacement of the sewer pipelines.Therefore, ensuring compliance with PS 5 will be applicable for the Project.
PS 6	**Biodiversity Conservation and Sustainable Management of Living Natural Resources** [*The requirements of this Performance Standard are applied to Project* **(***i***)** *located in modified, natural, and critical habitats;* **(***ii***)** *that potentially impact on or are dependent on ecosystem services over which the client has direct management control or significant influence; or* **(***iii***)** *that include the production of living natural resources* **(***e.g.*, *Agriculture, animal husbandry, fisheries, forestry***)**. *PS-6 screens relevant threats to biodiversity and ecosystem services, especially focusing on habitat loss, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution***.** *The key themes covered*	Not Applicable It is understood based on the site reconnaissance that the existing project STP facility and associate sewerage infrastructure are located in the semi-urban and urban area and does not interfere with any ecologically sensitive and protected areas. The project location does not also involve presence any full grown trees to be impacted during development of new 65 MLD STP. Therefore the proposed project scenario is not envisaged to have any adverse impact on the local biodiversity. Hence, ensuring compliance with PS 6 is not applicable for the project.

IFC PS	Description	Applicability to the Project
	under PS-6 are: *natural habitat, critical habitat, legally protected areas, international introduction of alien species, and living natural resources* (*natural and plantation forest, aquatic resources etc*.) *are sustainably managed*.]	
PS 7	**Indigenous Peoples** [*This Performance Standard applies to communities or groups of Indigenous Peoples who maintain a collective attachment, i.e., whose identity as a group or community is linked, to distinct habitats or ancestral territories and the natural resources therein. PS-7 endeavour to ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples. Key themes covered under PS-7 are: avoidance of adverse impacts, consultation and informed participation, impacts on traditional or customary lands under use, relocation of IPs from traditional or customary lands, and cultural resources.*]	Not Applicable This Performance Standard is not applicable because the project area does not fall under Schedule V and VI areas as defined by the Indian Constitution. Moreover, as per census data the Scheduled Caste and Scheduled Tribe population in HMC only constitutes for 0.3% of the overall population and are a part of the mainstream population. Based on the information provided, the project does not trigger any impact on traditional land, ancestral domain or critical cultural heritage of any communities that are identified as Indigenous Peoples. Thus ensuring compliance with PS 7 will not be applicable for the Project.
PS 8	**Cultural Heritage** [*For the purposes of PS-8, cultural heritage refers to* (*i*) *tangible forms of cultural heritage;* (*ii*) *unique natural features or tangible objects that embody cultural values; and* (*iii*) *certain instances of intangible forms of culture that are proposed to be used for commercial purposes. The requirements of PS-8 apply to cultural heritage regardless of whether or not it has been legally protected or previously disturbed*.]	Not Applicable Review of Google Earth Map and based on the site reconnaissance of the Plant locations did not point towards the presence of any significant cultural heritage site within the vicinity of Project facility as well as the ROW of the linked sewerage infrastructure. Thus ensuring compliance with PS 8 will not be applicable for the Project.

3.4.1 World Bank Group EHS Guidelines and Industry Sector Guidelines

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative. Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility. Capacity of the environment, and other project factors, are taken into account. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment. Applicability of EHS General Guidelines has been discussed in **Table 3.4** below.

Table 3.4: IFC EHS General Guidelines

Guideline Aspect	Description	Applicability
Air Emissions	This guideline applies to facilities or projects that generate emissions to air at any stage of the project life-cycle. It complements the industry-specific emissions guidance presented in the Industry Sector Environmental, Health, and Safety (EHS) Guidelines by providing information about common techniques for emissions management that may be applied to a range of industry sectors. This guideline provides an approach to the management of significant sources of emissions, including specific guidance for assessment and monitoring of impacts. It is also intended to provide additional information on approaches to emissions management in projects located in areas of poor air quality, where it may be necessary to establish project-specific emissions standards.	Applicable and has been detailed out in Section 4.2.6, 5.4.2 and Table 9.1
Energy Conservation	This guideline applies to facilities or projects that consume energy in process heating and cooling; process and auxiliary systems, such as motors, pumps, and fans; compressed air systems and heating, ventilation and air conditioning systems (HVAC); and lighting systems	Applicable and has been detailed out in Section 2.5.5.6
Wastewater and Ambient Water Quality	This guideline applies to projects that have either direct or indirect discharge of process wastewater, wastewater from utility operations or storm water to the environment. This guideline is meant to be complemented by the industry-specific effluent guidelines presented in the Industry Sector Environmental, Health, and Safety (EHS) Guidelines. Projects with the potential to generate process wastewater, sanitary (domestic) sewage, or storm water should incorporate the necessary precautions to avoid, minimize, and control adverse impacts to human health, safety, or the environment.	Applicable. Ambient water quality has detailed out in Section 4.2.9, 4.2.11, 5.4.5, 5.4.6 and Table 2.3.
Hazardous Materials Management	These guidelines apply to projects that use, store, or handle any quantity of hazardous materials (Hazmats), defined as materials that represent a risk to human health, property, or the environment due to their physical or chemical characteristics. Hazmats can be classified according to the hazard as explosives; compressed gases, including toxic or flammable gases; flammable liquids; flammable solids; oxidizing substances; toxic materials; radioactive material; and corrosive substances.	Applicable and has been detailed out in Section 2.8.5 and Section 2.5.5.4

Guideline Aspect	Description	Applicability
Waste Management	These guidelines apply to projects that generate, store, or handle any quantity of waste across a range of industry sectors	Applicable and has been detailed out in Section 2.10 (c, d & e)
Noise	Addresses impacts of noise beyond the property boundary of the facilities	Applicable and has been detailed out in Section 4.2.7 and Section 5.4.3.
Contaminated Land	Management approaches for land contamination due to anthropogenic releases of hazardous materials, wastes, or oil, including naturally occurring substances. Releases of these materials may be the result of historic or current site activities, including, but not limited to, accidents during their handling and storage, or due to their poor management or disposal	Not-Applicable It is not applicable since the wastewater treatment process does not generate any material/ waste that can be categorized as hazardous per the relevant regulatory requirement.
Occupational Health and Safety	Provides guidance and examples of reasonable precautions to implement in managing principal risks to occupational health and safety. Although the focus is placed on the operational phase of projects, much of the guidance also applies to construction activities.	Applicable and has been detailed out in Section 5.4.13

The EHS Guidelines for Water and Sanitation include information relevant to the operation and maintenance of collection of sewage in centralized systems (such as piped sewer collection networks) or decentralized systems (such as septic tanks subsequently serviced by pump trucks) and treatment of collected sewage at centralized facilities. The Sanitation sectoral guideline outlines measures to minimize potential community health risks can be implemented both in the collection and treatment of wastewater and sludge. Applicability of EHS Guidelines for Water and Sanitation has been discussed in Table 3.5 below.

Table 3.5: IFC EHS Guidelines for Water and Sanitation

Sanitation	Description	Applicability to the Project
Liquid Effluents	Treated wastewater effluents are typically discharged to surface water or re-used for irrigation or other purposes. In many cases, direct or indirect human contact with treated wastewater is likely. Therefore, adequate wastewater treatment to remove contaminants and, especially, microorganisms and pathogens, is important not only to prevent adverse environmental impacts, but to protect public health as well.	Applicable
Air Emissions and Odours	Odours from wastewater treatment facilities can be a nuisance to the neighbouring community. Bio aerosols can also carry disease-causing microorganisms. Furthermore, releases of hazardous gases, such as chlorine, could adversely affect nearby residents.	Applicable

Sanitation	Description	Applicability to the Project
	The following measures are recommended to prevent, minimize, and control community exposure to dust and odours from waste management facilities: ■ Provide adequate buffer area, such as trees, or fences, between processing areas and potential receptors; ■ Avoid siting facilities near densely populated neighbourhoods and installations with potentially sensitive receptors, such as hospitals and schools. Site facilities downwind from potential receptors, if possible.	
Physical Hazards	Visitors and trespassers at wastewater treatment facilities may be subject to many of the hazards for site workers. Recommended measures to prevent, minimize, and control physical hazards to the community include: ■ Restrict access to waste management facilities by implementing security procedures, such as: ■ *Perimeter fencing of adequate height and suitable material, with lockable site access gate* ■ *Security cameras at key access points, and security alarms fitted to buildings and storage areas; and* ■ *Use of a site visitor register* ■ Light the site where necessary. As this may cause light nuisance to neighbours, the lighting installations should be selected to minimize ambient light pollution.	Applicable
Land Application	Use of treated wastewater in agriculture can pose public health risks. Hazards associated with crops irrigated with treated wastewater include excreta-related pathogens and toxic chemicals that may be present in the wastewater. The following methods are recommended to protect consumers: ■ Treat wastewater and sludge used for land application in a manner consistent with WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater and applicable national requirements; ■ Stop irrigation with treated wastewater two weeks prior to harvesting; ■ Limit irrigation with treated wastewater to crops that are cooked before eating; ■ Restrict public access to hydraulic structures carrying wastewater and to fields irrigated with treated wastewater.	Not Applicable The treated wastewater from the proposed project STP will be discharged to existing sewerage canal and without any envisaged land application.
Effluent Guidelines	The choice of sanitation technology and design of wastewater treatment begin with a determination of the required level and type of treatment. Project- specific effluent guidelines for sanitation projects should be established based on a clear definition of health objectives and a comprehensive evaluation of alternatives, considering appropriate treatment technologies; quality and quantity of raw wastewater and its variability; available land area for the treatment facility; resources for capital expenditures, training, operation, maintenance, and repair; and availability of skilled operators, maintenance personnel, treatment chemicals, and replacement parts.	Applicable

Sanitation	Description	Applicability to the Project
	The selected approach should achieve effluent water quality consistent with applicable national requirements or internationally accepted standards and with effluent water quality goals based on the assimilative capacity and the most sensitive end use of the receiving water.	
Treated Wastewater Re-use and Sludge Management	Treated wastewater and sludge quality for land application should be consistent with WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater and applicable national requirements. Potential impact on soil, groundwater, and surface water, in the context of protection, conservation and long term sustainability of water and land resources should be assessed when land is used as part of any wastewater treatment system. Sludge from a waste treatment plant needs to be evaluated on a case-by-case basis to establish whether it constitutes a hazardous or a non-hazardous waste and managed accordingly	Applicable
Environmental Monitoring	Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental Monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project.	Applicable
Occupational Health and Safety Monitoring	The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by credentialed professionals experienced in water and sanitation as part of an occupational health and safety monitoring program. Facilities should also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents. Additional guidance on occupational health and safety monitoring programs is provided in the General EHS Guidelines.	Applicable

4. ENVIRONMENTAL AND SOCIAL BASELINE CONDITIONS

4.1 Introduction

This section describes the environmental and social baseline condition prevailing in the study area. The study area include all the components of the projects as discussed in ***Section 2.5***. Data on prevailing baseline conditions of Physical environment, biological environment and socio-economic environment were collected for the study.

4.1.1 Area of Influence

The Area of Influence (AOI) of the Project comprises of the Project Site and the surrounding area, where influence of the Project activities are anticipated. The AOI with respect to the environmental and social resources was considered based on the following reach[13] of impacts:

- Air Quality: Gaseous pollutants)e.g. NOx and SO2(and fine particulate matter)PM10 and PM2.5(–typically up to 1 km from projects site during construction and operational phase.
- Noise: Noise impact area)defined as the area over which an increase in environmental noise levels due to the project can be detected(–typically 500 m from project site.
- Water: Groundwater will be contaminated through leaching of pollutants from the project site depending on the geology)soil cover(of the area. Groundwater impact will be within 1 km of the project footprint)as the velocity is very slow almost imperceptible(.
- Flora and Fauna)Terrestrial and Aquatic(: The project area is a part of urban environmental setting. There is no natural forests in the entire study area. If any significant impact is identified near the project site, the area of influence will not exceed 1 km.
- Socio-economic: The direct footprint of the project and its linked facilities, including sewage line and MPS. This is based on the understanding that most of the interactions from the project will be limited to project site and 50 m of sewage pipeline replacement work.

Based on the above the AOI for environmental and social studies is limited to 1 km from the Project site and 50 m, for the sewage pipeline. New laying of pipelines or repairing of existing pipelines will be a localized activity on roads and lanes. The proposed pipeline work expected to cover 25 m per day. So the work is temporary for a particular place.

4.1.2 Study Area

Study area has been considered based on the area of influence, which includes all the components of the project. Study area includes a one (1) km buffer zone around the STP facility and one hundred meter area around the proposed sewer network line (50m on both side of the sewer network line). The study also include MPS facility. The study area was selected based on the AOI of the project.

4.1.1 Study Period

The baseline study was conducted between June-August, 2019 for collecting information on physical environment, biological environment and socio-economic environment. Mitra SK Pvt. Ltd., a NABL (National Accreditation Board for Testing and Calibration Laboratories) certified laboratory was engaged for collecting primary monitoring data of physical environment (Ambient Air, Noise, Surface Water and Ground Water) for the study. As per the provided study timeline for the project (June-September), only one season i.e. Monsoon period data collection was possible.

Note:

[13] Distance based on ERM's experience with similar projects

The ESIA scope accounts to limited primary baseline data collection and accounting for the timeline of the study, over a single season. There are no representative data for different environmental dimensions available in public domain for pre-monsoon and post-monsoon for the project location, except for air quality. Ambient Aiir quality data within 10 km from the proposed project location as referred from the public domain has been included in the report (**Refer Section 4.2.6**) for better correlation.

4.1.2 Approach and Methodology

The approach and methodology adopted for collection of baseline data on Physical, Biological and Socio-economic environment are discussed below:

a) The methodology followed for baseline data collection on Physical Environment are given below:

- Review of existing ESMP report of the STP facility. The relevant data are incorporated in this report.
- Selection of primary data collection location as per scope of work discussed in ***Section 1.5***.
- Primary monitoring of key environmental parameters like air, noise, soil, sediment, surface water, ground water and traffic. Primary baseline monitoring data collection was conducted by Mitra S. K. Pvt. Ltd.
- Information about geology, hydrology, prevailing natural hazards like floods, earthquakes etc. have been collected from literature reviews and authenticated information made available by government departments.

b) The methodology followed for baseline data collection on Biological Environment are given below:

- Review of secondary data
- Primary survey data collection by ERM team

c) The methodology followed for baseline data collection on Socio-economic Environment are given below:

- Review and collection of Secondary data including the Census data 2011
- Primary data collection through consultation

4.2 Physical Environment

4.2.1 Topography

The study area is a part of lower gangetic deltaic plain and the entire district has flat topography with average elevation from MSL (mean sea level) varies from 7 to 11m. The overall slope of the district is toward south. The rivers within the district flow from North to South which again indicate the general slope of the district is toward south.

4.2.2 Geology

The study area is a part of lower Gangetic Deltaic plain of Bengal basin. Presently, the configuration of Bengal basin can be inferred by the presence of Gangetic-Brahmaputra delta system in the north and the Bengal Deep Sea Fan on the south[14]. The study area is characterized by thick quaternary alluvium deposit, laid down by Bhagirathi-Hooghly River system. The alluvial sediments in the form of flood plain deposits consist of the sands of various grades, silt and clay with occasional gravel beds.

[14] Alam M., Alam M.M., Curray J.R., Chowdhury M.L.R. (2003), An overview of the sedimentary geology of the Bengal Basin in relation to the regional tectonic framework and basin-fill history. Sedimentary Geology, 155; 179-208.

Immediately below the land surface a thick layer of sticky clay ranging in thickness between 30-70 m. exploratory drilling carried out by CGWB in parts of the district revealed the presence of clay layer around a depth of 300mbgl which continues beyond 548 mbgl[15].

The STP area is located at an aerial distance of 4.79 km from the Hooghly River. The Arupara area is situated in the eastern part of the district. The area is characterized by loose sediment deposits of middle to late Holocene age. The area has alternate layers of fine sand, silt and clay. The clay layer present in the area characterized by dark grey colour and plastic nature. Grain size of the sand varies from fine to coarse and in some places the gravel is also found mixed with the sand. The thickness of the top-clay layer is very thin as depicted from the Hydrogeological map of the area given in **Figure 4.24**.

4.2.3 Land use

The study area is located in the urban settings. The broad land use classes identified in the study area are water bodies, drainage channels, settlements, vacant land and green cover. The green cover is relatively small in this area. The land use map of STP and its surrounding 1 km area is given in the **Figure 4.1** and **Table 4.1.** The land use map of sewer line network and its surrounding 100 m area is given in The **Figure 4.2** to **Figure** 4.5 and **Table 4.2.** The sewer pipeline network passes through the main load with settlements on both side of the road.

[15] CGWB district report of Howrah.

Figure 4.1 Land Use Map of Arupara STP and its surrounding 1 km area

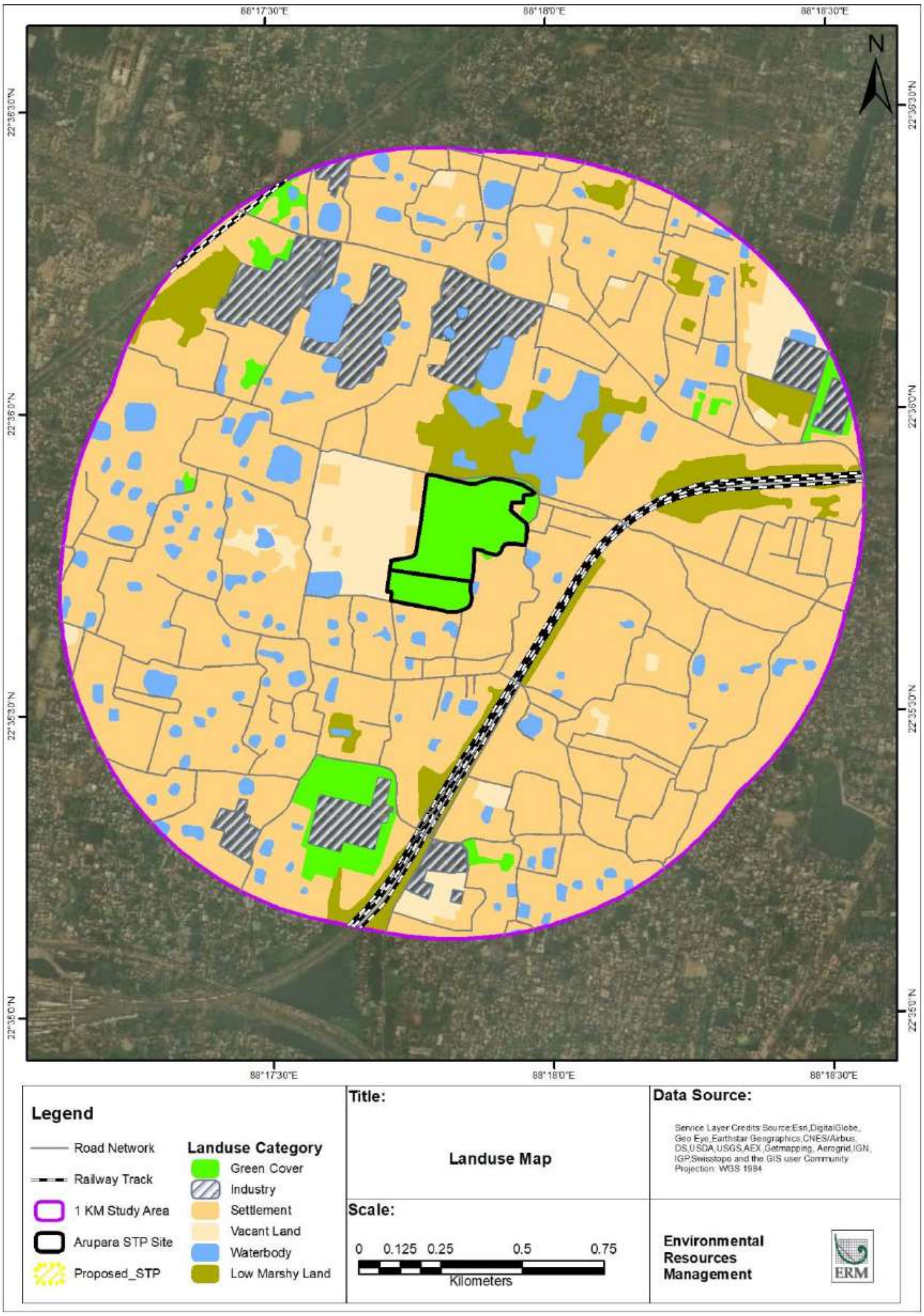


Table 4.1: Total Area Covered by Various Land Use Classes around the STP Area

Landuse Category	Area SqM	Area SqKM	Percentage
Green Cover	212449.49	0.21	4.53
Industry	280330.06	0.28	5.98
Railway Track	65458.89	0.07	1.40
Road Network	190413.05	0.19	4.06
Settlement	3139773.42	3.14	66.93
Vacant Land	209209.95	0.21	4.46
Waterbody	315717.89	0.32	6.73
Low Marshy Land	277880.92	0.28	5.92
Total	4691233.67	4.69	100.00

Source: ERM Primary Monitoring

The major land use classes present in the area include, settlements (66.93%), water bodies (6.73%), industry area (5.98%) and low marshy land (5.92%). A significant portion of the area is part of low-lying marshy land. Dense vegetation is present within this marshy land. Road network and railway tracks constitute 4.06% and 1.40% of the study area respectively. The land use of existing STP area is shown as green cover due to presence of wild vegetation within the STP facility along with other existing STP structures and internal roads. Due to lack of maintenance of the site premises, the naturally overgrown wild vegetation canopy observed covering the existing STP structures. The internal access roads are covered with wild vegetation and proposed STP area within the Arupara STP facility is also covered with wild vegetation hence, the land use pattern in **Figure 4.1** shows green cover for the STP site.

Figure 4.2 Land Use Map of Existing Sewer Network and Raising main

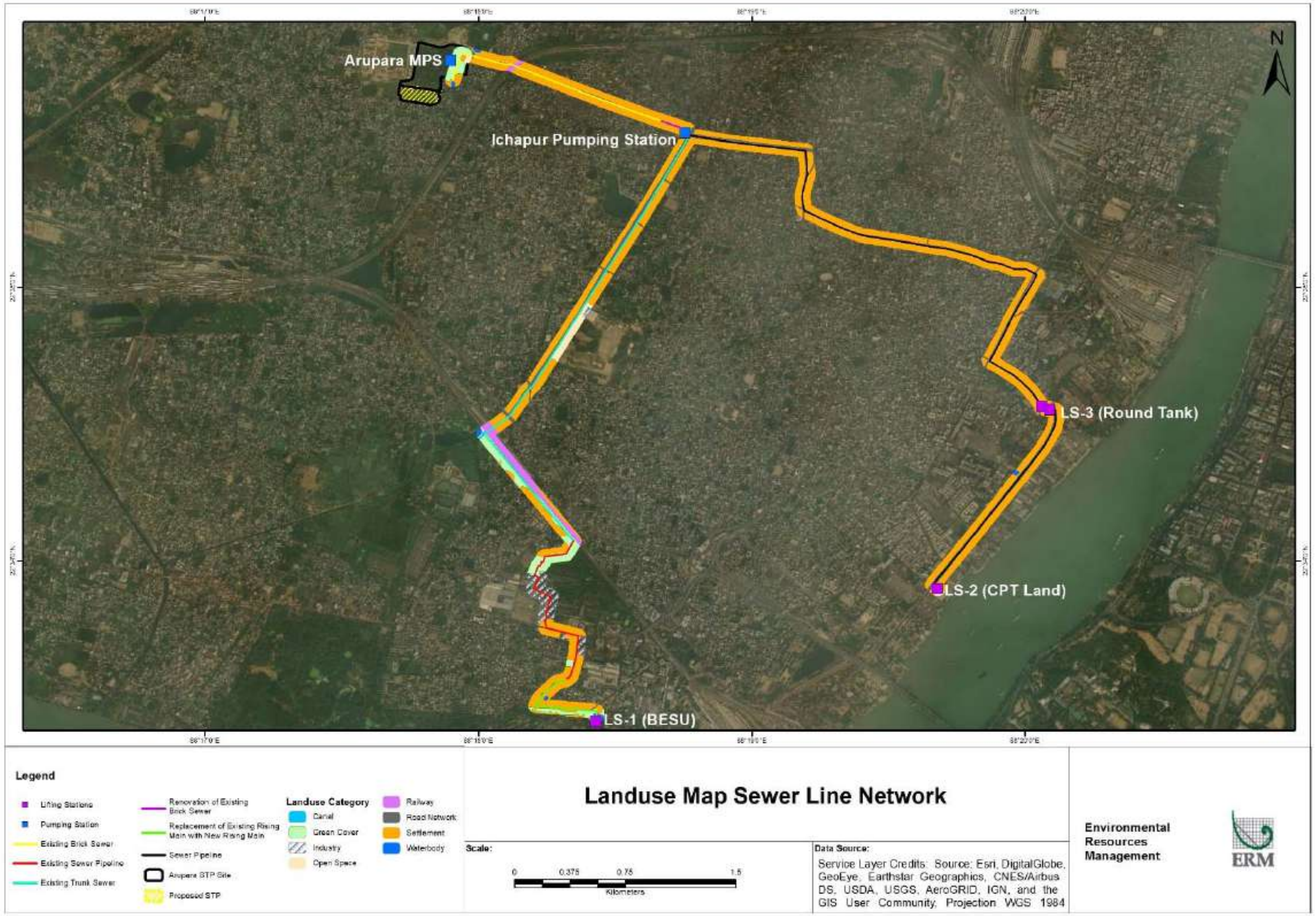


Figure 4.3 Land Use Map of Existing Gravity Sewer Network

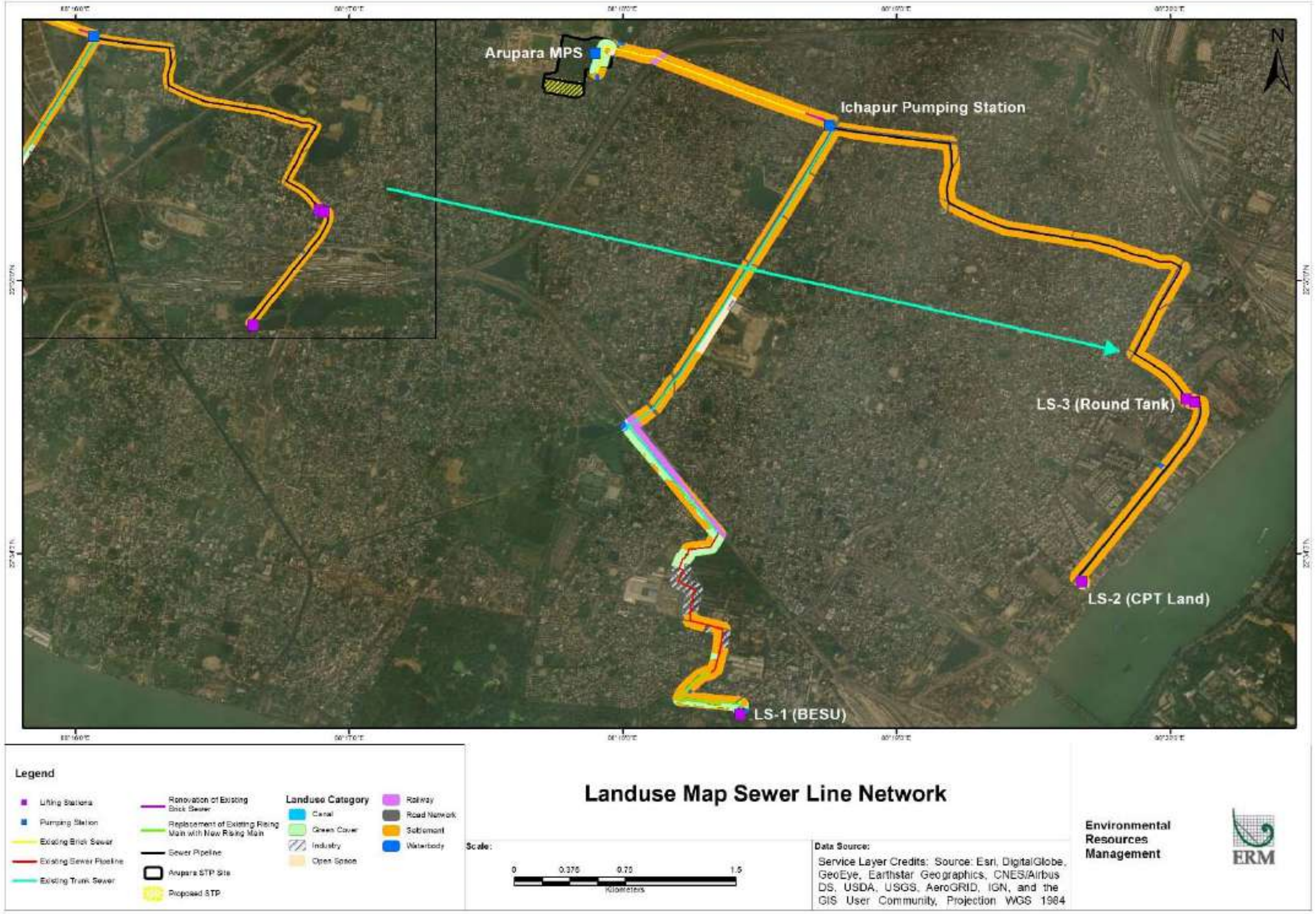


Figure 4.4 Land Use Map of Existing Gravity Sewer Line Network near BESU LS

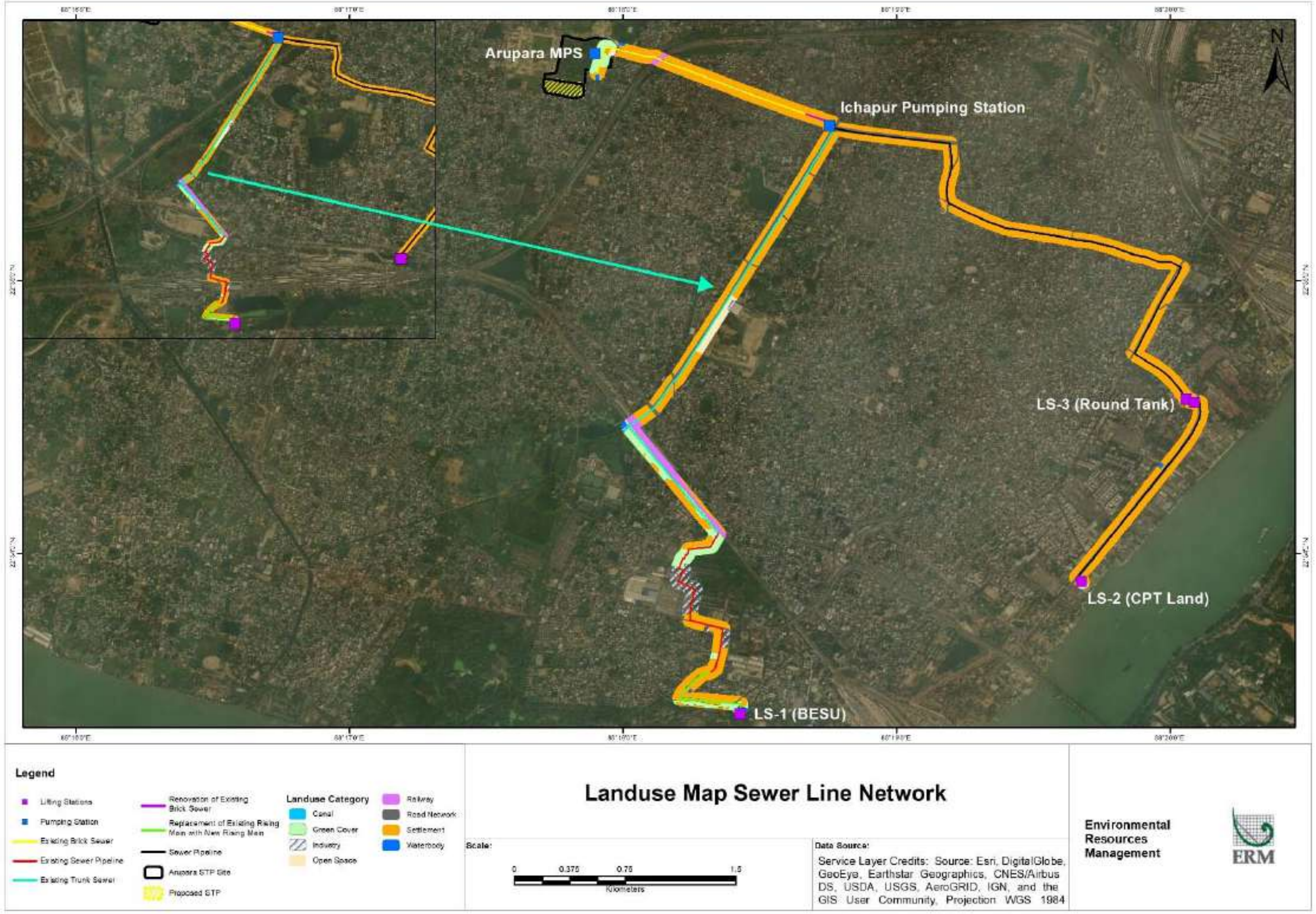


Figure 4.5 Land Use Map of Existing Raising Main

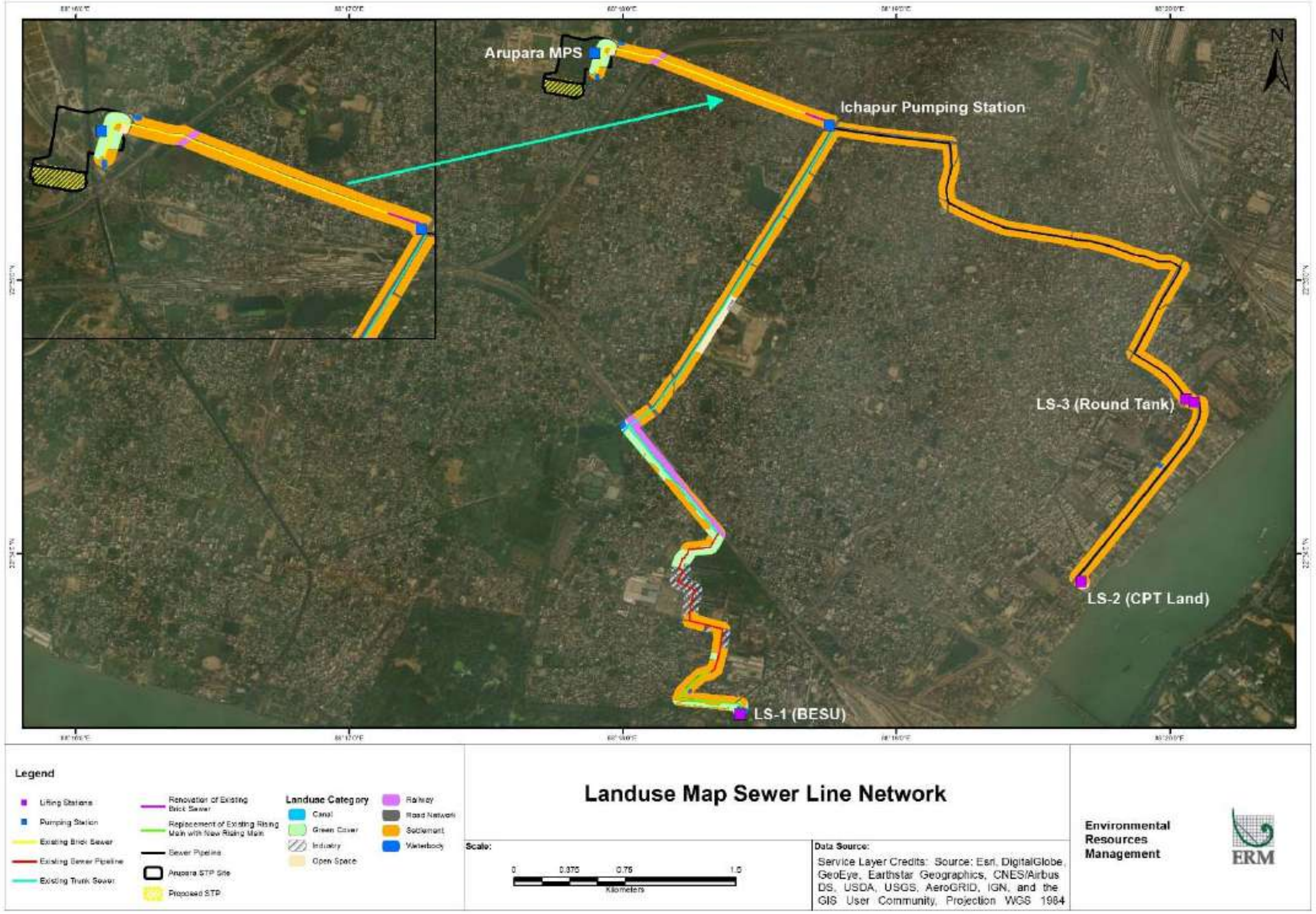


Table 4.2: Total Area Covered by Various Land Use Classes around the Sewer Line Network

Landuse Category	Area Sq.M	Area Sq.KM	Percentage
Canal	980.77	0.00	0.08
Green Cover	97855.44	0.10	7.86
Industry	48568.59	0.05	3.90
Open Space	23067.74	0.02	1.85
Railway	38336.67	0.04	3.08
Road Network	169021.16	0.17	13.58
Settlement	857721.04	0.86	68.94
Waterbody	8651.75	0.01	0.70
Total	**1244203.17**	**1.24**	**100.00**

4.2.4 Soil Quality

The district of Howrah falls within the new alluvium sub-region of the lower Gangetic Plain and is considered being most fertile for crop production. The prominent soil in the Howrah district falls under the new alluvial and old alluvial agro-climatic zone of West Bengal. The pH in soils ranges from 3.0 to 8.30 with a mean value of 5.75 and organic carbon content in soils ranges from 0.18 to 1.21% with a mean value of 0.55%[16]. Soils of the area are taxonomically classified into three orders i.e. Alfisol, Inceptisols and Entisols[17].

4.2.4.1 Primary Soil Monitoring

Soil quality was monitored at two (2) different locations within the Arupara area. The soil samples were collected from the top-soil within 15cm depth from the surface. The soil samples are collected and analysed to estimate the extent of soil pollution due to previous operation of STP. One sample as collected within the Arupara facility and another sample was collected outside the STP facility area to estimate the baseline condition and the difference in the quality of the soil sample. The details of the soil monitoring locations are provided in **Table 4.3** and the soil locations have been shown in **Figure 4.6** .[18] The detailed results are given in **Appendix D**.

[16] Rahul Kumar, Gora Chand Hazra, Ruma Das, Shyam Prasad Majumdar and Amal Chandra Das (2019). Nutrient Index of Available S in Soils of Howrah and South Dinajpur Districts of West Bengal, India. International Journal of Current Microbiology and Applied Sciences, Volume 8.

[17] https://slusi.dacnet.nic.in/srm/srmabstracts/SRM_113_Howrah.pdf

[18] Historically disposed sludge at the existing sludge drying bed having a thickness of about 1m overlain on the natural soil. Thus the surficial soil layer is not accessible as collection of natural soil samples from this existing sludge drying bed area required removal overlain sludge layer.

Table 4.3: Soil Monitoring Locations in Study Area

S. No.	Monitoring Location	Station Number	Land Use	Latitude	Longitude	Rationale for Selection
1.	Arupara STP Plant	S-1	Marshy land	22° 35' 49.40" N	88° 17' 56.19" E	The area was previously used for dumping of screened solid waste (including plastics) collected from Arupara MPS grit chambers.
2.	Near Arupara STP Plant	S-2	Marshy land	22° 35' 51.57" N	88° 17' 58.31" E	Existing and proposed outlet of treated sewerage line passes through this area.

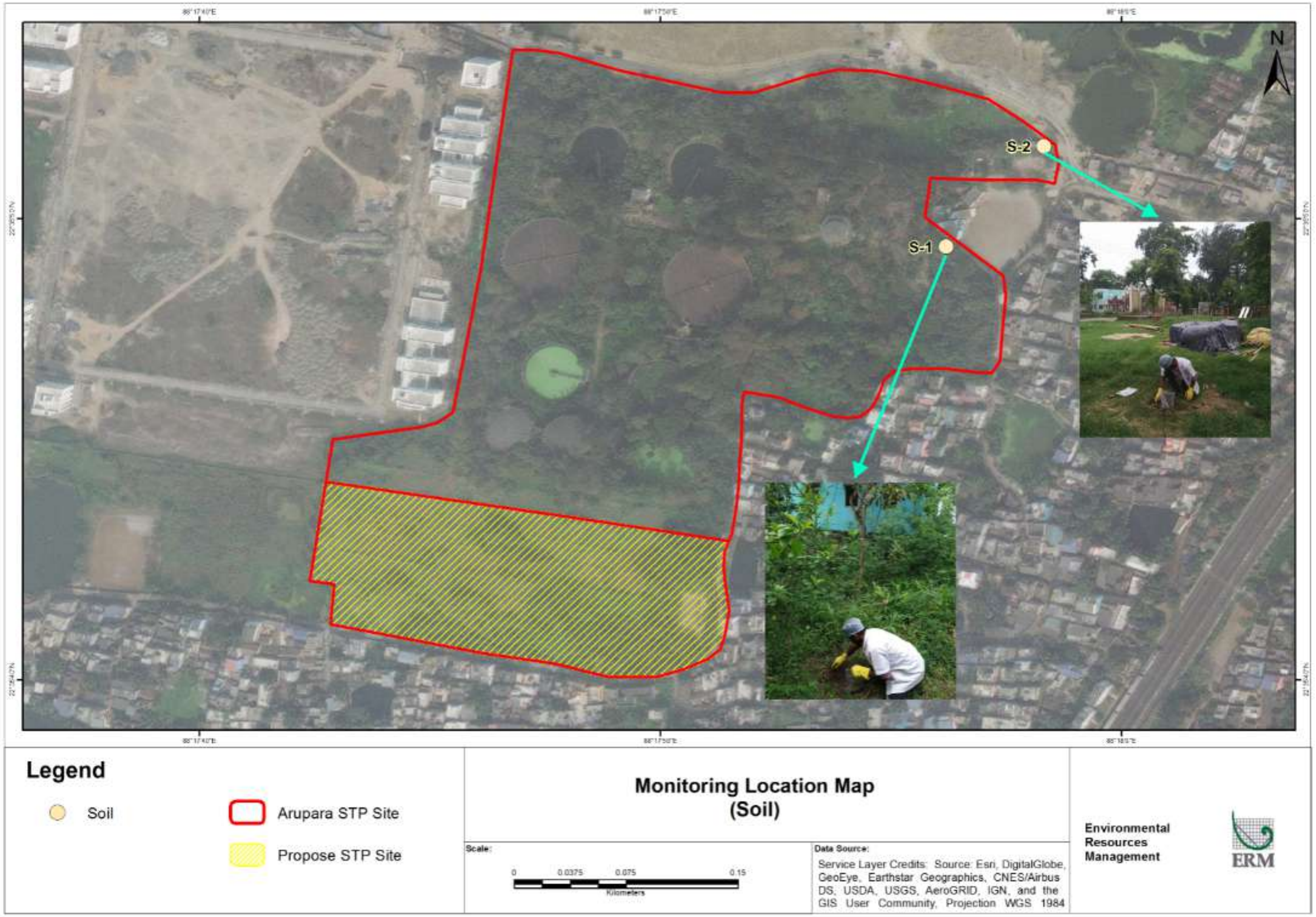
Table 4.4: Results of Soil Monitoring

Parameters	Location	Within Arupara STP	Near Arupara STP Plant
	Sample Id	*SS1*	*SS2*
Texture	-	Clay loam	Clay Loam
Particle Size Distribution	%	Sand 40% silt 26% clay 34%	Sand 38% silt 26% Clay 36%
Specific gravity	-	2.43	2.44
Permeability	Cm/hr	1.2	1
Water Holding capacity	%	30	34
Porosity	%	43.3	49.6
Bulk Density	gm/cc	1.38	1.23
Moisture	%	19	16
Infiltration Capacity	Mm/hrs	9.1	7.8
pH value	-	7.87 (1:2.5) at 25^0C	7.89 (1:2) at 25°C
Boron (as B)	mg/kg	19	21
Calcium (as Ca)	mg/kg	5850	5700
Chloride (as Cl)	mg/kg	430	270
Sulphate (as SO_4)	mg/kg	<15	<15
Alkalinity (as $CaCO_3$)	mg/kg	400	380
Arsenic(as As)	mg/kg	4.6	5.3
Available Nitrogen (as N)	mg/kg	326	200
Sodium (as Na)	mg/kg	426	276
Electrical conductivity	us/cm	871 (1:2) at 25 deg C	664 (1:2) at 25 deg C
Available Potassium (as K)	mg/kg	184	402
Sodium Adsorption Ration (as SAR)	-	1.48	0.98
Available Phosphorus (as P)	mg/kg	5.3	14

Parameters	Location	Within Arupara STP	Near Arupara STP Plant
	Sample Id	***SS1***	***SS2***
Cation Exchange Capacity	meq/100 gm	38	37
Hexavalent Chromium (as Cr+6)	mg/kg	<2.0	<2.0
Acidity	mg/kg	NIL	NIL
Carbonate as CO3	mg/kg	NIL	NIL
Copper (as Cu)	mg/kg	14	27
Iron (as Fe)	mg/kg	1.4	2.0
Magnesium (as Mg)	mg/kg	480	660
Manganese (as Mn)	mg/kg	361	321
Cadmium (as Cd)	mg/kg	<2.0	<2
Lead (as Pb)	mg/kg	12	15
Mercury (as Hg)	mg/kg	<0.1	<0.1
Nickel (as Ni)	mg/kg	16	21
Zinc (as Zn)	mg/kg	44	69
Total Chromium (as Cr)	mg/kg	17	24

Source*:* Primary monitoring conducted through WBPCB recognised laboratory during this ESIA study

Figure 4.6 Soil Sampling Location Map



4.2.4.2 Soil monitoring results interpretation

The results of the primary soil monitoring are discussed below:

Texture

Texture is an expression to indicate the coarseness or fineness of the soil as determined by the relative proportion of the various sized primary particles in the soil mass. The textures of the collected soil samples were found to be clay loam.

Particle Size Distribution

The particle distribution in the soil samples collected from STP and residential area have greater sand concentration than silt and clay. Although in S-2 sample, the proportion of sand and clay is almost equal. The high sand content in the soil increase the permeability of the soil and indicate light soil.

Porosity

The porosity of the soils are 43.3% and 49.6% respectively for S1 and S2. These high value of porosity of soil indicates sandy clay.

Permeability

The permeability of the soils are 1.2 and 1 cm/hr respectively for S-1 and S-2. Soil permeability is the property of the soil to transmit water and air. Ponds built in high permeable soil will lose water through seepage. The permeability value of the soil samples indicate clay loam to loam for SS2[19].

pH

pH values in soils were 7.87 and 7.89 respectively for SS1 and SS2. pH values in both the soil samples indicate moderately alkaline soil.

Electrical Conductivity

The EC values for the soils monitored at the study area were 871 and 664 µs/cm for S-1 and S-2 respectively. For a productive soil, the electrical conductance (EC) should be < 1000µs/cm.

Macronutrients

Nutrient status of the soil samples can be determined from the concentration of N, P, K and organic carbon in soil samples. Standard rating chart for soil nutrients is provided in Table 4.4. Nitrogen contents in the soil samples were 326 and 200 mg/kg (145.22 and 89.09 kg/ha), phosphorus content in the soil samples were 5.3 and 14 mg/kg (2.36 and 6.24 kg/ha) and potassium contents ranges between 184 and 402 mg/kg (81.96 and 179.07 kg/ha) for S-1 and S-2 respectively. With comparison to the rating chart nitrogen status was less to good, phosphorus status was very less and potassium status was very less to less. The variarion of available nitrogen concentration in soil is due to the fact that the soils were sampled from different locations.

[19] http://www.fao.org/tempref/FI/CDrom/FAO_Training/FAO_Training/General/x6706e/x6706e09.htm

Table 4.5 Soil Monitoring Locations in Study Area

S.N.	Soil Test Parameters	Classification
1	pH	<4.5 Extremely acidic 4.51-5.00 Very strongly acidic 5.00-5.50 slightly acidic 5.51-6.0 moderately acidic 6.01-6.50 slightly acidic 6.51-7.30 Neutral 7.31-7.80 slightly alkaline 7.81-8.50 moderately alkaline 8.51-9.0 strongly alkaline 9.01 very strongly alkaline
2	Salinity Electrical Conductivity (mmhos/cm) (1 ppm = 640 mhos/cm)	Upto 1.00 Average 1.01-2.00 harmful to germination 2.01-3.00 harmful to crops (sensitive to salts)
3	Nitrogen (kg/ha)	Upto 50 very less 51-100 less 101-150 good 151-300 Better >300 sufficient
4	Phosphorus (kg/ha)	Upto 15 very less 16-30 less 31-50 medium, 51-65 on an average sufficient 66-80 sufficient >80 more than sufficient
5	Potash (kg/ha)	0-120 very less 120-180 less 181-240 medium 241-300 average 301-360 better >360 more than sufficient

Source: Handbook of Agriculture; Indian Council of Agricultural Research, New Delhi, 2015

Metals

a) **Cooper:** Copper concentration of the soil samples are 14 and 27 mg/kg respectively for S-1 and S-2. The concentration of copper in the soil samples are much below the soil remediation intervention values of 190 mg/kg specified in Dutch Soil Remediation Circular (Refer **Appendix D**).

b) **Lead:** Lead concentration of the soil samples are 12 and 15 mg/kg respectively for S-1 and S-2. The concentration of lead in the soil samples are much below the soil remediation intervention values of 530 mg/kg specified in Dutch Soil Remediation Circular.

c) **Zinc:** Zinc concentration of the soil samples are 44 and 69 mg/kg respectively for S-1 and S-2. The concentration of zinc in the soil samples are much below the soil remediation intervention values of 720 mg/kg specified in Dutch Soil Remediation Circular.

d) **Iron:** Iron concentration of the soil samples are 1.4 and 2.0 mg/kg respectively for S-1 and S-2.

e) **Magnesium:** Magnesium concentration of the soil samples are 480 and 660 mg/kg respectively for S-1 and S-2.

f) **Manganese:** Manganese concentration of the soil samples are 361 and 321 mg/kg respectively for S-1 and S-2.

g) **Cadmium** (<2.0 mg/kg) and **Mercury** (<0.1mg/kg) concentrations were found to be below detectable.

The variarion of heavy metal concentration in soil is due to the fact that the soils were sampled from different locations.

Sodium Absorption Ratio (SAR)

Sodium absorption ratio for the soil samples were 1.48 and 0.98 respective for S-1 and S-2.

4.2.5 Climate and Meteorology

Howrah district is located next to Kolkata. Due to location of the two (2) districts, the districts have same climate and weather condition throughout the year. The climate of Howrah district is tropical, like the rest of the Gangetic West Bengal. It is characterised by hot summer, high humidity nearly all around the year and well distributed monsoon season. The winter season starts from December and continues till end of February, followed by the summer from March to May. Rainfall occurs primarily during the south-west monsoon months i.e. June to September and constitutes of more than 70% of the total annual rainfall. Some rainfall, mostly as thunder showers, is received in the latter half of the summer season and in October. Sometimes a bit of shower takes places in summer accompanied by dusty violent winds, which are called 'Kal Baisakhi' by the local people.

The following are the well-defined seasons of the region:

- Summer: March-May
- Monsoon: June- September
- Post-Monsoon: October –November
- Winter: December – February

Temperature

January is observed as the coldest month with mean minimum temperature of 11 ºC. Mean temperature for most period of the year besides winter season remains around 24.1 to 30.4 ºC with May being the hottest at 38 ºC (mean maximum temperature). The monthly mean minimum and maximum temperatures are shown in **Figure 4.7**.

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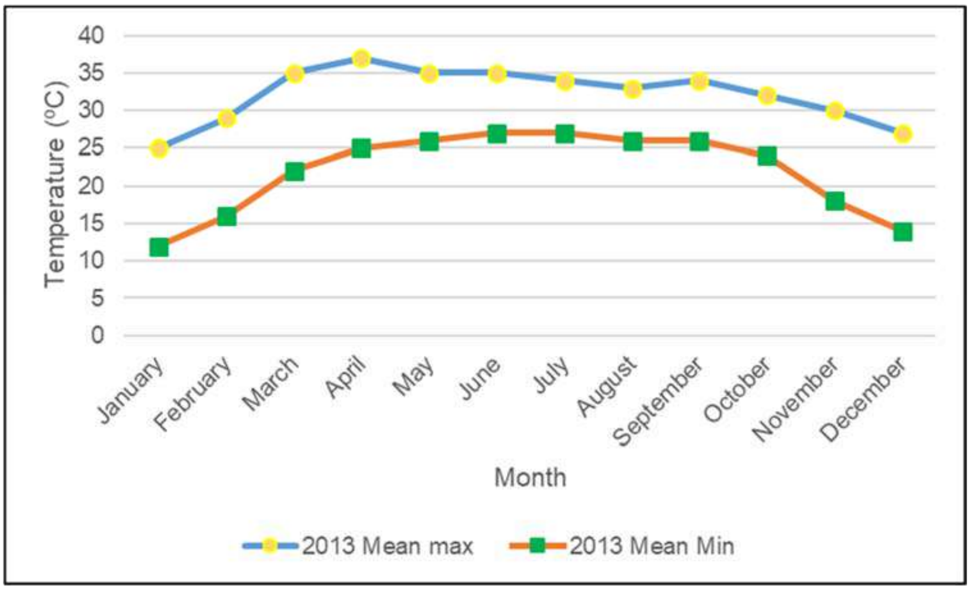
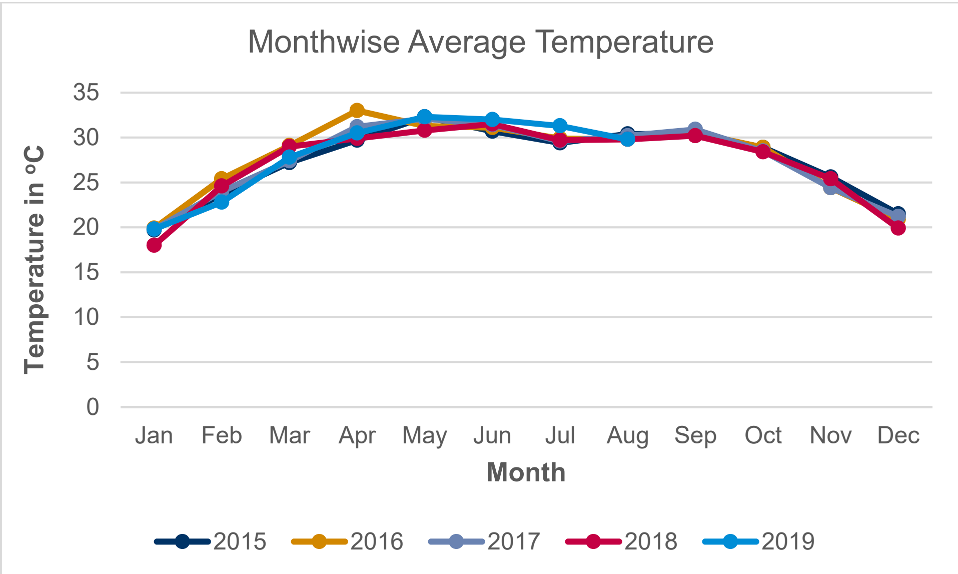
Figure 4.7 Monthly Mean Minimum and Maximum Temperature Variations



Source: District Statistical Handbook of North 24 Parganas, 2013

Monthly average temperature data from 2015 to 2019 was colected from Weather -Online[20]. The monthwise average temperature data is given in **Figure 4.8**. Highest average temperature occur in the month May.

Figure 4.8 Monthly Average Temperature Data from 2016 to 2019



Relative Humidity

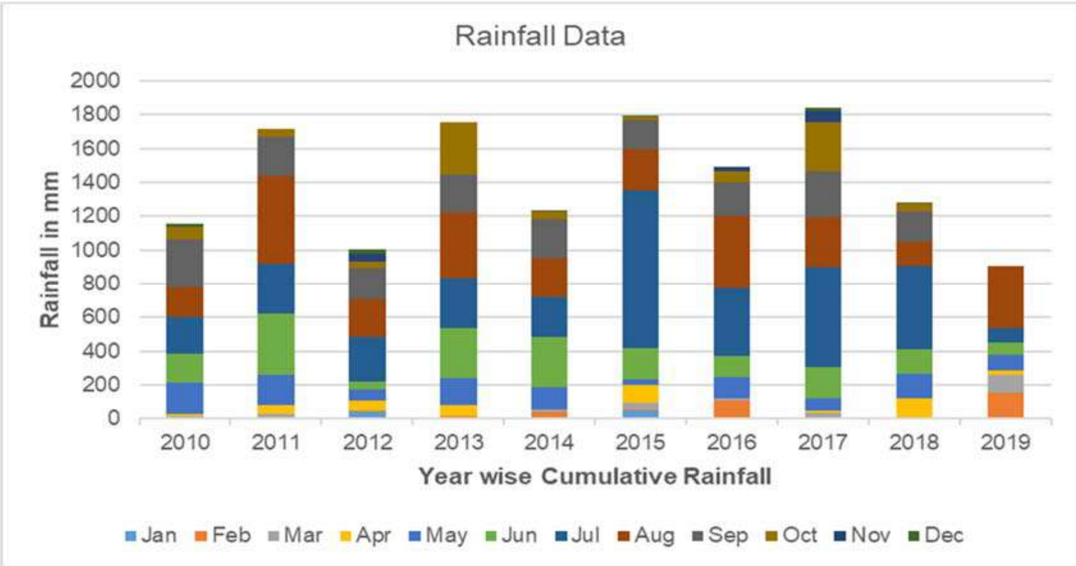
The relative humidity of Howrah district is reported to be high (71% to 85%) throughout the year.

[20] https://www.weatheronline.in/weather/maps/city?FMM=1&FYY=2019&LMM=8&LYY=2019&WMO=42809&CONT=inin&REGION=0024&LAND=II&ART=PRE&R=0&NOREGION=0&LEVEL=162&LANG=in&MOD=tab

Rainfall

The period between Junes to September is the monsoon season. The average annual rainfall of the district is about 1579 mm[21]. The downpour is the maximum in the month of August. Monthly cumulative rainfall data from 2010 to 2019 was collected from Weather-Online to estimate the rainfall pattern of the area. The yearwise cumulative rainfall data is given in ***Figure***4 .10. It was found from the analysis of the decadal data that highest rainfall occur in the month of July. The annual average rainfall was 1473.84 mm. The highest rainfall occured in 2017.

Figure 4.9 Cumulative year-wise Rainfall Data



Wind Speed and Direction:

The average hourly wind speed in the study area shows significant seasonal variation over the course of the year. The windier part of the year lasts for 5.3 months, from March 25 to September 2, with average wind speeds of more than 7.4 miles per hour. Whereas, the calmer time of year lasts for 6.7 months, from September 2 to March 25.[22]

The wind is most often from the west for the time period of 1.2 months, from February 13 to March 20. The wind is most often from the south for 6.6 months, from March 20 to October 9. The wind is most often from the north for 4.1 months, from October 9 to February 13.[11]

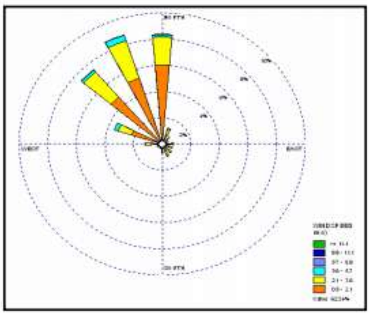
Wind Rose

The wind rose diagram of Kolkata which is located close to the Study area is used to predict the predominant wind direction within the area given in Figure 4.10. Wind roses for the months of January to December as an average of 1998 to 2007 are given in Figure 4.10Figure 4.11. Analysis of monthly wind rose data reveals that from March to September, the predominant wind direction is from S or SSE direction. From November to February, the wind direction is predominantly between NW-N Sector. During the month of October variation in the wind direction is observed to be large it varies from N to S through E. The maximum wind speed observed during April to November (5.7 m/s).

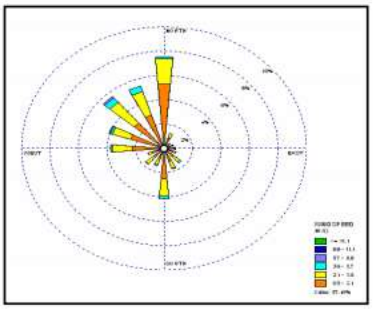
[21] Disaster Management Plan- Howrah -2018

[22] https://weatherspark.com/y/111532/Average-Weather-in-Kolkata-India-Year-Round

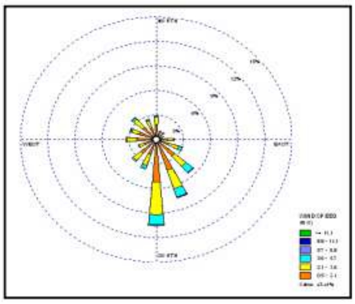
Figure 4.10 Annual Monthly Wind Rose Diagram



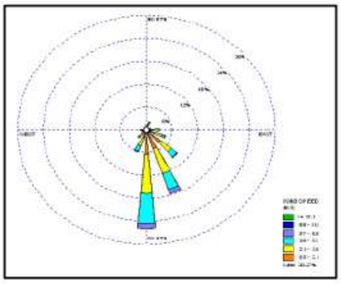
January



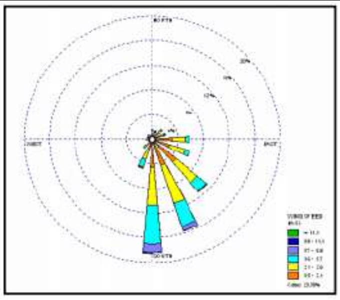
February



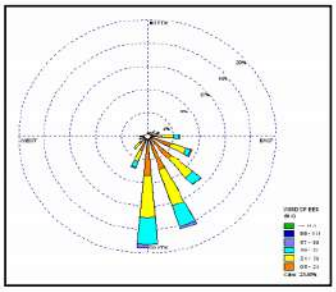
March



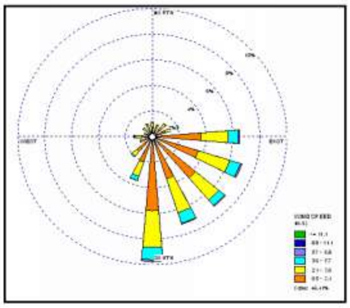
April



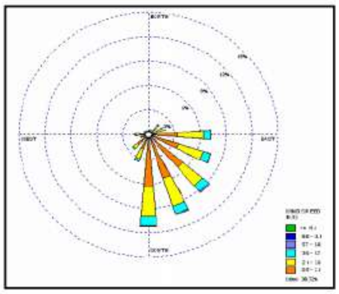
May



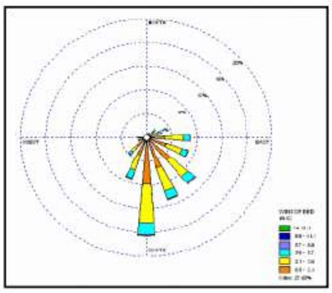
June



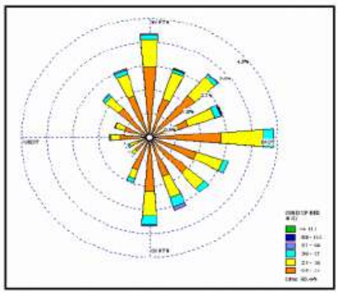
July



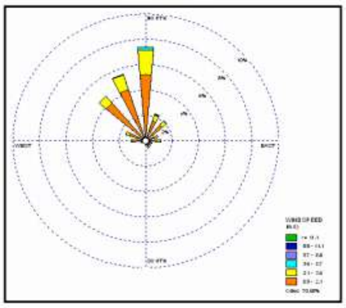
August



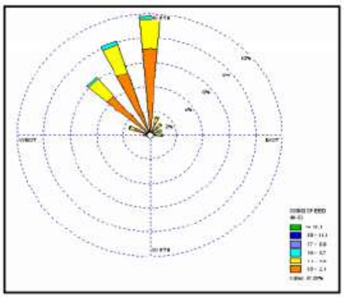
September



October



November



December

Source*:* Study of Urban Air Quality in Kolkata for Source Identification and Estimation of Ozone, Carbonyls, NOx and VOC Emissions- CPCB*:* August, 2010 *(*http://164.100.107.13/upload/NewItems/NewItem_160_cups.pdf*)*

4.2.6 Ambient Air Quality

The study area is situated in the municipality area and exhibits moderate air quality and moderate air quality index. The major emission sources within the study area are vehicular emission from the road and industries present adjacent to the site. The major sources of air emissions due to the proposed project activity includes fugitive dust generation from construction activity, vehicular emission due to vehicle movement and emissions from DG sets during construction phase, and biogas flaring during operational phase.

Daily air quality data of 2019 from automated continuous monitoring stations (Sankrail, Belurmath, Bauria, Ghusuri and Padmapukur) located within Howrah district are available in WBPCB (West Bengal Pollution Control Board) website which is collected and analysed to estimate the baseline condition of the district. Padmapukur automated monitoring station was located at an aerial distance of 3.2 km from the STP site. The air quality monitoring data from WBPCB automated stations are available only for PM_{10}, $PM_{2.5}$, NO_2 and SO_2 pollutants. The data was referred for 8 months from January, 2019 to August, 2019. The monthly average, min and max values of PM_{10}, $PM_{2.5}$, NO_2 and SO_2 is given in **Table 4.6**.

Table 4.6: Air Quality Monitoring Data for Howrah District

Month	PM2.5 (µg/m3)			PM10 (µg/m3)			NO2 (µg/m3)			SO2 (µg/m3)		
	Monthly			Monthly			Monthly			Monthly		
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Jan	121.21	75.88	194.33	212.26	136.60	304.96	46.41	30.36	71.88	23.69	16.76	37.59
Feb	84.01	25.82	120.46	170.53	50.14	228.85	41.67	25.69	60.65	18.72	9.47	30.97
Mar	48.40	23.43	88.09	112.25	55.47	184.70	30.97	21.74	38.95	15.30	9.37	24.84
Apr	29.86	15.23	55.66	80.75	33.60	143.89	28.65	16.21	38.01	10.39	4.85	18.39
May	35.17	13.08	135.83	78.68	43.61	188.78	28.57	19.44	49.66	7.87	4.20	10.58
June	29.38	15.45	53.71	67.45	41.95	116.92	29.67	20.77	40.85	7.00	4.24	9.99
July	31.71	13.83	50.13	70.97	35.58	107.34	30.61	21.79	39.53	7.99	3.91	13.22
Aug	28.75	15.05	54.50	70.42	37.22	118.13	28.44	21.90	38.64	7.97	6.10	14.07

Month	PM2.5 (µg/m3)			PM10 (µg/m3)			NO2 (µg/m3)			SO2 (µg/m3)		
	Monthly			Monthly			Monthly			Monthly		
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
8 Month Average	**51.06**			**107.91**			**33.12**			**12.37**		

Source: WBPCB

It was found that the 8 month average concentration of PM_{10} for Howrah district exceeds NAAQS value of 100 µg/m3. The 8 month average concentration of $PM_{2.5}$ is below the NAAQS value of 60 µg/m3. Higher concentration of PM_{10} and $PM_{2.5}$ values were recorded during winter and pre-monsoon season as reflected in the above dataset. The concentration of air pollutants in ambient air is governed by the meteorological parameters such as atmospheric wind speed, wind direction, relative humidity, and temperature. The concentration of particulate pollutants during winter usually remain higher than that in other seasons, irrespective of the monitoring sites at urban region of Kolkata (India) and its nearby areas like Howrah, Hooghly, North 24 Parganas, South 24 Parganas etc., because of the longer residence time of particulates in the atmosphere during winter due to low winds and low mixing height[23]. The 8 month average concentration NO_2 and SO_2 was below the NAAQS value.

4.2.6.1 Primary Air Quality Monitoring

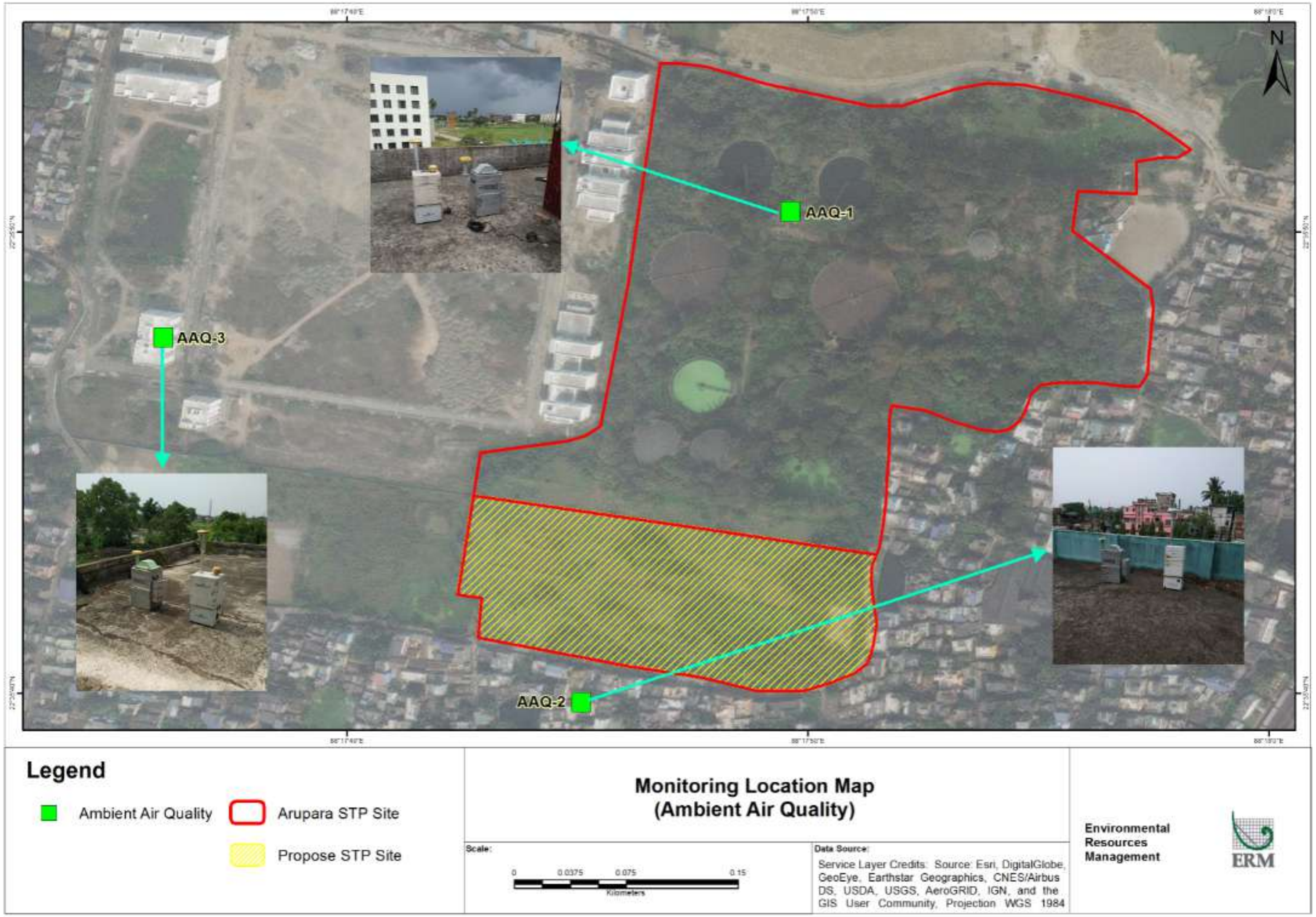
Ambient air quality was monitored at three (3) locations across the study area from 18th June to 27th June, 2019. The parameters studied were Particulate Matter (PM10 and PM2.5), Oxides of Nitrogen (NOx), Sulphur dioxide (SO2), Carbon Monoxide (CO), Ammonia (NH3), Hydrocarbon and H2S. Air quality monitoring locations were selected in residential areas surrounding Arupara STP. The monitoring locations were Upwind, downwind and crosswind direction with respect to the proposed STP location to understand the baseline air environment in the study area. The monitoring location details are given in **Table 4.7**. The air monitoring locations have been provided in **Figure 4.11**. The detailed results are given in **Appendix E**.

Table 4.7: Ambient Air Quality Monitoring Locations

Sl No	Monitoring Location Number	Geo-coordinates		Rationale for Selection
AAQ1	Within the STP facility	22° 35' 50.45” N	88° 17' 49.62” E	The location is within existing STP facility. The point is Upwind with respect to proposed STP location
AAQ2	Hatpukur Para	22° 35' 49.73" N	88° 17' 59.06” E	Downwind with respect to proposed STP location
AAQ3	Police Training Ground	22° 35' 46.15" N	88° 17' 44.49" E	Cross-wind with respect to proposed STP location

[23] https://www.hindawi.com/journals/ijas/2013/264046/

Figure 4.11 Ambient Air Quality Monitoring Location Map



The result of the parameters monitored has been discussed in context of compliance to National Ambient Air Quality Standards (NAAQS) of residential, commercial and industrial area. The station wise summary results are ***Table 4.8***.

Table 4.8: Summary of Ambient Air Quality Monitoring

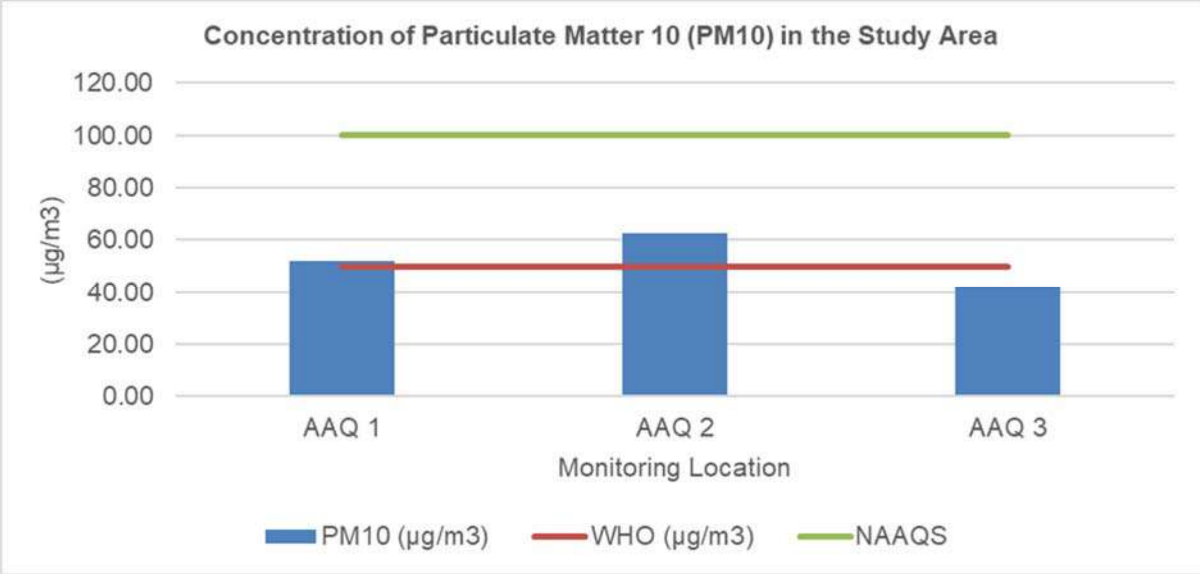
	PM_{10} (µg/m³) (24 hours)	$PM_{2.5}$ (µg/m³) (24 hours)	SO_2 (µg/m³) (24 hours)	NO_2 (µg/m³) (24 hours)	CO (mg/m³) (8 hours)	NH_3 (mg/m³) (24 hours)	Hydrocarbon (as Methane) ppm (24 hours)	H_2S (µg/m³) (24 hours)
Within the STP facility								
Average	51.80	29.00	6.83	29.20	0.59	15.70	1.70	<10.0
Max	70.2	41.8	7.8	38.5	0.82	22.5	2.23	<10.0
Min	39.4	21.3	6	22.8	0.36	<10	1.38	<10.0
98th Percentile	69.22	41.08	7.76	38.01	0.81	22.34	2.20	-
Hatpukur Para								
Average	62.5	36.5	7.1	35	0.75	17.5	1.5	<10.0
Max	71.7	41.4	7.6	41.6	0.82	21.5	1.72	<10.0
Min	51.4	30.9	6.5	28.8	0.67	13.8	1.19	<10.0
98th Percentile	71.4	41.2	7.6	41.3	0.8	21.3	1.7	-
Police Training Ground								
Average	41.93	25.77	6.27	25.97	0.46	16.30	2.24	<10.0
Max	52.6	30.1	6.8	30.7	0.63	16.3	2.94	<10.0
Min	30.8	18.4	6	21.9	0.27	16.3	1.73	<10.0
98th Percentile	52.2	30.0	6.8	30.5	0.6	16.3	2.9	-

Source*:* ERM Primary Monitoring

Particulate Matter (PM_{10})

The average concentration of PM_{10} in the Study Area ranged between 41.93 and 62.50 µg/m3. The average concentration of PM_{10} values in all the monitoring stations were found to be in compliance to the NAAQS value of 100 µg/m3. PM_{10} concentration at Hutpukur Para was in compliance with the WHO air quality guideline value of 50 µg/m^3 whereas, PM_{10} concentration in other 2 sites were exceeding the WHO air quality guideline value. Variation of PM_{10} values at the monitoring stations are presented in the **Figure 4.12**.

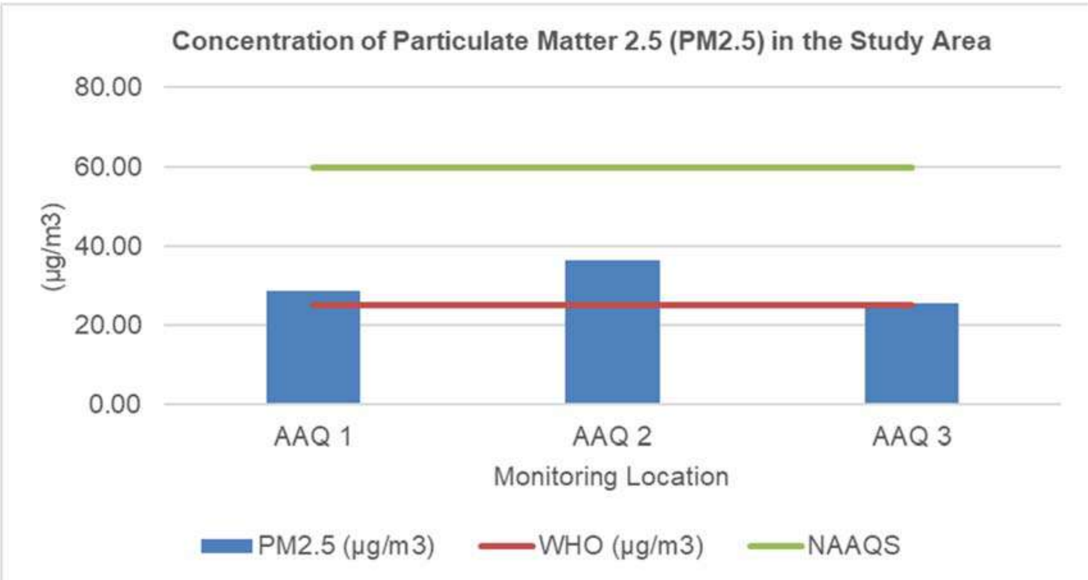
Figure 4.12 Concentration of Particulate Matter (PM10) in the Study Area



Particulate Matter ($PM_{2.5}$)

The average concentration of Particulate Matter ($PM_{2.5}$) in the study area ranged between 25.77 and 36.50 µg/m3. The average concentration in all the monitoring stations were in compliance with NAAQS standard of 60 µg/m3 but the average concentrations were exceeding the WHO Air quality guideline values of 25 µg/m^3. Variation of $PM_{2.5}$ values at the monitoring stations are presented in the **Figure 4.13.**

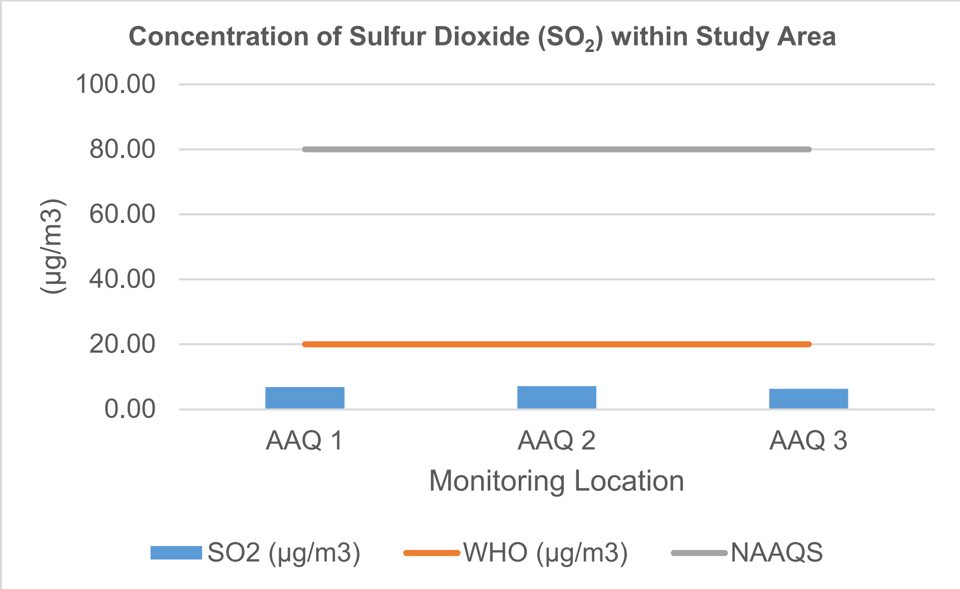
Figure 4.13 Concentration of Particulate Matter 2.5 (PM2.5) in the Study Area



Sulphur Dioxide (SO_2)

The average concentration of Sulphur Dioxide (SO_2) in the study area ranged between 6.27 and 7.10 µg/m^3. The average concentration reported across all the three (3) monitoring locations were in compliance with NAAQS value of 80 µg/m^3 and WHO air quality guideline values of 20 µg/m^3. Variation of SO_2 values at the monitoring stations are presented in the **Figure 4.14.**

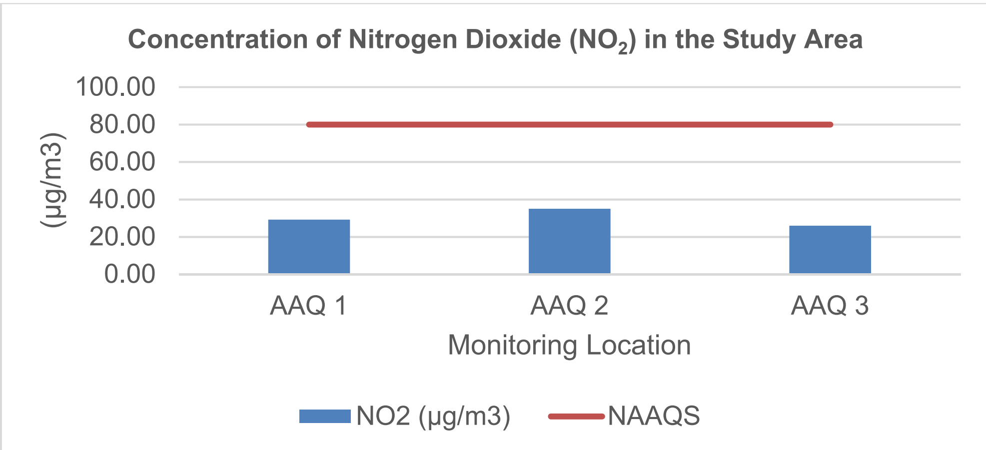
Figure 4.14 Concentration of Sulphur Dioxide (SO_2) in the Study Area



Nitrogen Dioxide (NO_2)

The average concentration of NOx in the study area ranged between 25.97 and 35 µg/m3. The average concentration reported across all the three (3) monitoring locations were below the NAAQS value of 80µg/m3WHO air quality guidelines values for NO_2 is 40 µg/m^3 annual mean and 200 µg/m^3 1-hour mean whereas the primary monitoring results were given in 24 hour mean. So, the NO_2 values can not be comparable with WHO air quality guideline values. Variation of NO_2 values at the monitoring stations are presented in the **Figure 4.15**.

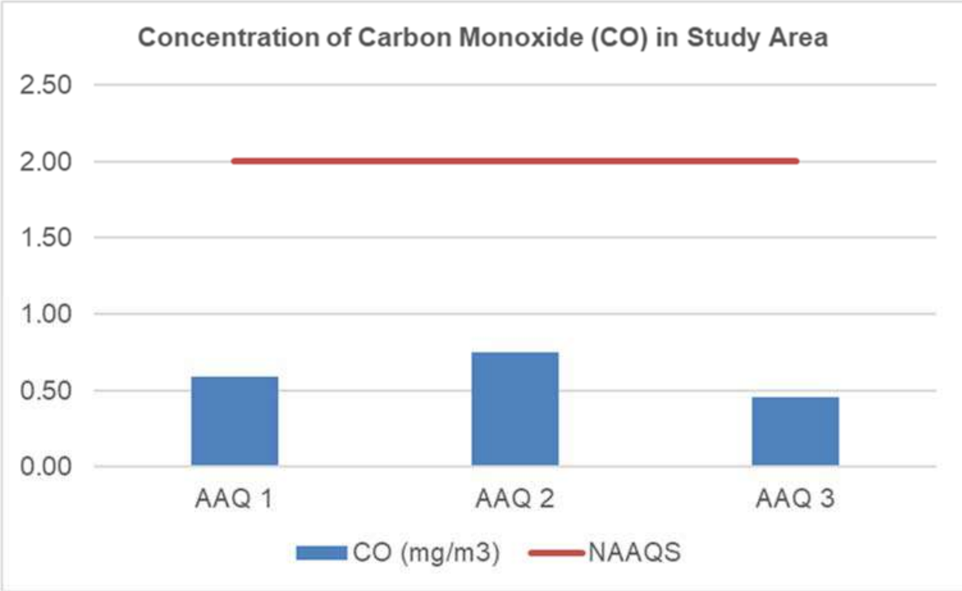
Figure 4.15 Concentration of Nitrogen Dioxide (NO_X) in the Study Area



Carbon Monoxide (CO)

The 8 hour average concentration of Carbon Monoxide in the study area ranged between 0.46 and 0.75 mg/m^3. The average concentration of CO reported across monitoring locations were in compliance the NAAQS value of 2mg/m^3. Variations of CO values in at the monitoring stations are presented in the **Figure 4.16**.

Figure 4.16 Concentration of Carbon Monoxide (CO) in the Study Area



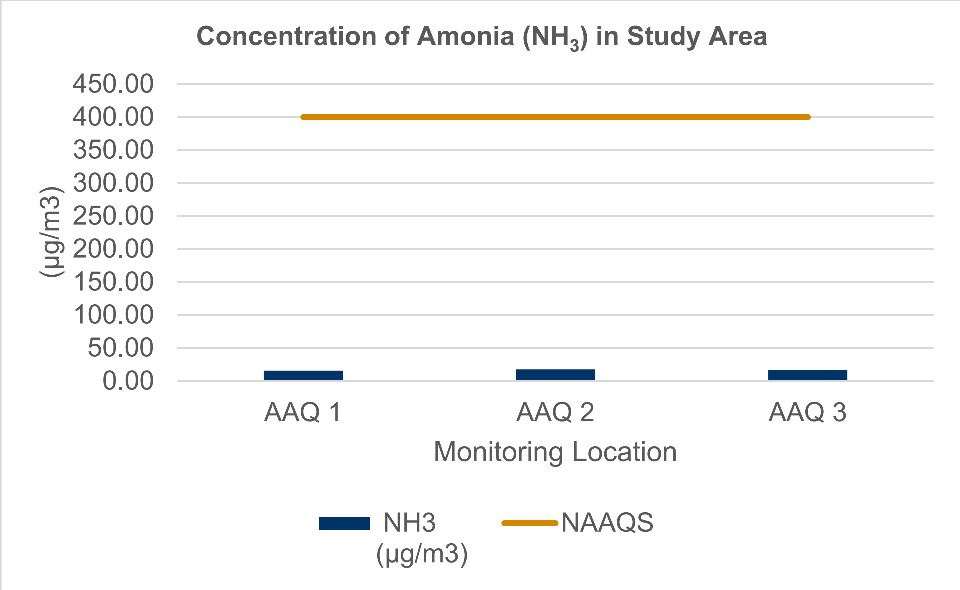
Hydrocarbons

The average methane concentration in the study area ranged between 1.50 and 2.24 ppm. There is no standard value for Methane in NAAQS.

Ammonia

The concentrations of ammonia concentration in the study area ranged between 15.70 and 17.5 µg/m^3. The average concentration of NH_3 reported across monitoring locations were in compliance the NAAQS value of 400 µg/m^3. Variations of CO values in at the monitoring stations are presented in the **Figure 4.17**.

Figure 4.17 Concentration of Ammonia (NH_3) in Study Area



Hydrogen Sulphide (H_2S)

The concentrations of H_2S in the study area were recorded to be less than 10 µg/m3.

The study area represents urban environmental setting and the main source of emission to air is vehicles in the roads within the study area. All the values of pollutants were in compliance with the National Ambient Air Quality Standards. The secondary data available from Howrah air quality station indicates that the concentration of PM_{10}, $PM_{2.5}$, NO_2 and SO_2 concentration found in June, 2019 were nearly similar with the data recorded during the primary monitoring.

4.2.6.2 Odour

The source of odour within the site are from clarifiers and solid waste disposal areas. As a common practice solid waste generated at the grit chambers are disposed within the site near the north-west corner and behind the existing pumping station within the STP premises. The odour producing compounds are mainly Hydrogen Sulphide (H_2S) and Volatile Organic Compounds potentially arising from a combination of sources. During site visits, it was observed that a strong and discernible H_2S like odour could be felt in the area upto 300 m radius from the source.

There is no possibility of odour generation from cogen plant (i.e. Biogas Engine), since the biogas feeding for the gas engine will be looped in after the biogas scrubber. Flue gas from the biogas engine after heat exchanger will be emitted through stack as the air pollution control measure. Stack height and diameter will be maintained following relevant Indian regulatory requirements/standards (CPCB) as well as IFC General EHS Guideline, as has been noted in Section 2.5.5. The Concessionaire should also refer to WBG EHS General Guideline Good International Industry Practice (GIIP) Stack Height requirements specified in Annex 1.1.3[24].

4.2.7 Noise Quality

Ambient noise monitoring was conducted at four (4) stations within the study area. The noise levels have been monitored at residential zones to assess and evaluate the impact on ambient noise environment. The location of NQ-1 is selected within the facility to predict the noise level prior to

[24] Traceability: https://www.ifc.org/wps/wcm/connect/29f5137d-6e17-4660-b1f9-02bf561935e5/Final%2B-%2BGeneral%2BEHS%2BGuidelines.pdf?MOD=AJPERES&CVID=jOWim3p

project activity. This data will also help to assess the impact on noise environment due to project activity. The location NQ2 is selected near Arupara road as this road will be used during construction period. The baseline data of these areas will help to estimate the possible effects of extra load during construction will have on the ambient noise quality of the area. The location of NQ4 is selected close to the proposed STP location to estimate the noise environment in the vicinity. The Location NQ3 is selected within the Police Training ground to estimate the noise environment in the area as this area is a sensitive area. The location of the noise monitoring stations have been presented in **Table 4.9** and depicted in **Figure 4.18** for reference.

Table 4.9: Ambient Noise Monitoring Locations

Sl. No	Monitoring Location	Station Number	Geographical Coordinates		Date of Monitoring	Category of Area/Zone
			Latitude	Longitude		
1.	Within the STP Facility	NQ-1	22° 35' 50.5716" N	88° 17' 49.7292" E	23.06.2019	Residential
2.	At the gate of STP near Arupara Road	NQ-2	22° 35' 49.902" N	88° 17' 56.634" E	24.06.2019	Residential
3.	Police Training Facility	NQ-3	22° 35' 54.2688" N	88° 17' 46.212" E	27.06.2019	Residential
4.	Hatpukur Para	NQ-4	22° 35' 43.8684" N	88° 17' 57.6204" E	28.06.2019	Residential

The 24-hour baseline noise monitoring was conducted by using the portable sound meter (Lutron, SL-0423SD, unit: dB(A). Noise level (LAeq) were measured and recorded at a one hour interval and averaged at a daily (i.e. 24-hour) interval using the following formula:

LAeq = 10*Log 10 (Average (10^ ((X)/10))) where X is measured noise in dB(A). Sound pressure level (SPL) measurements in dB(A) was recorded for 24 hours with the equivalent noise values computed as Leq (Daytime) and Leq (Night time) for each location. Daytime is considered between 06:00 to 22:00 hours and night from 22:00 hours to 06:00 hours. The results so obtained were compared with ambient noise standards specified for respective category under the Noise Pollution (Regulation & Control) Rules, 2000. The summary of noise quality results is presented in **Figure 4.19** below.

Figure 4.18 Ambient Noise Monitoring Location Map

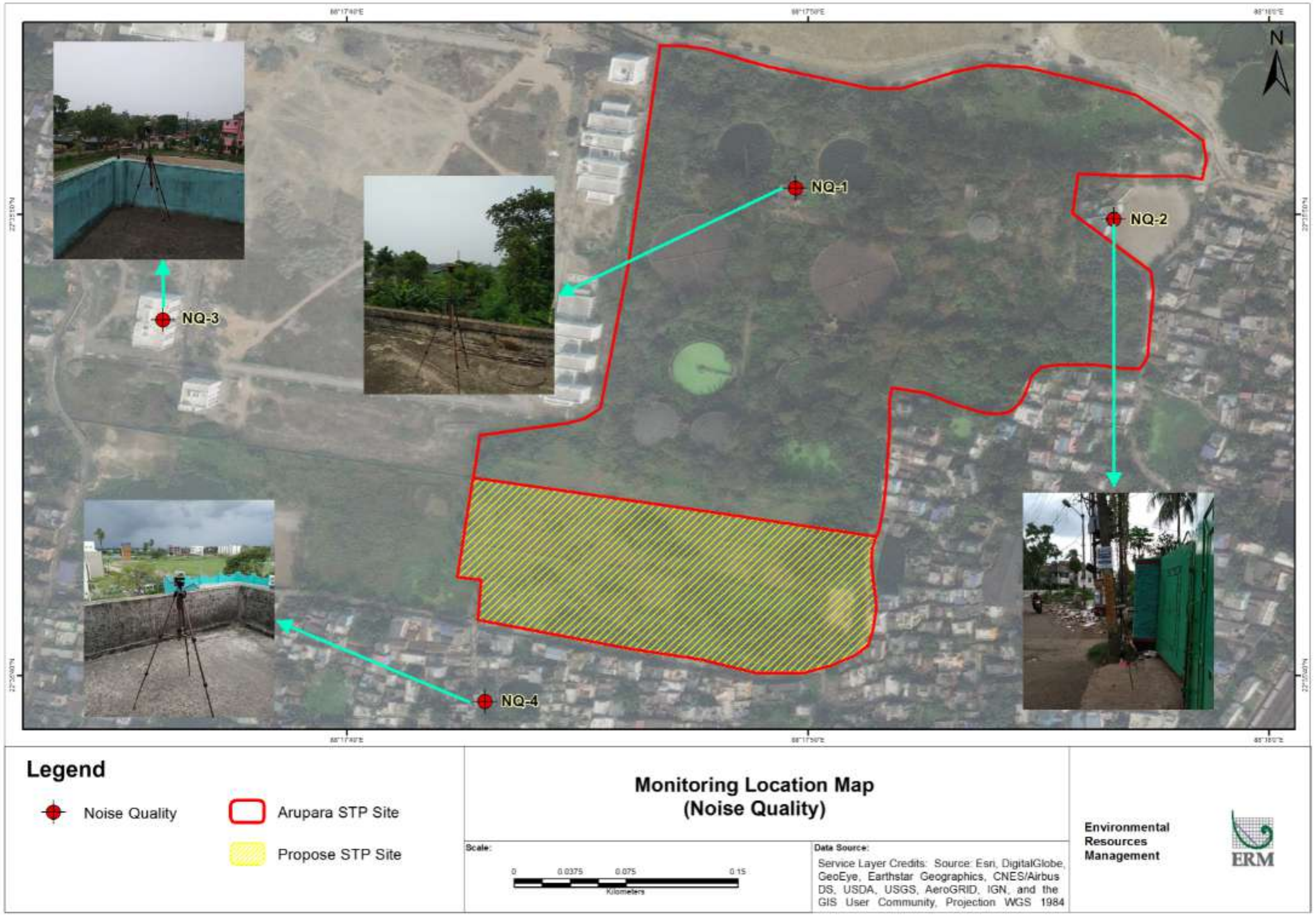
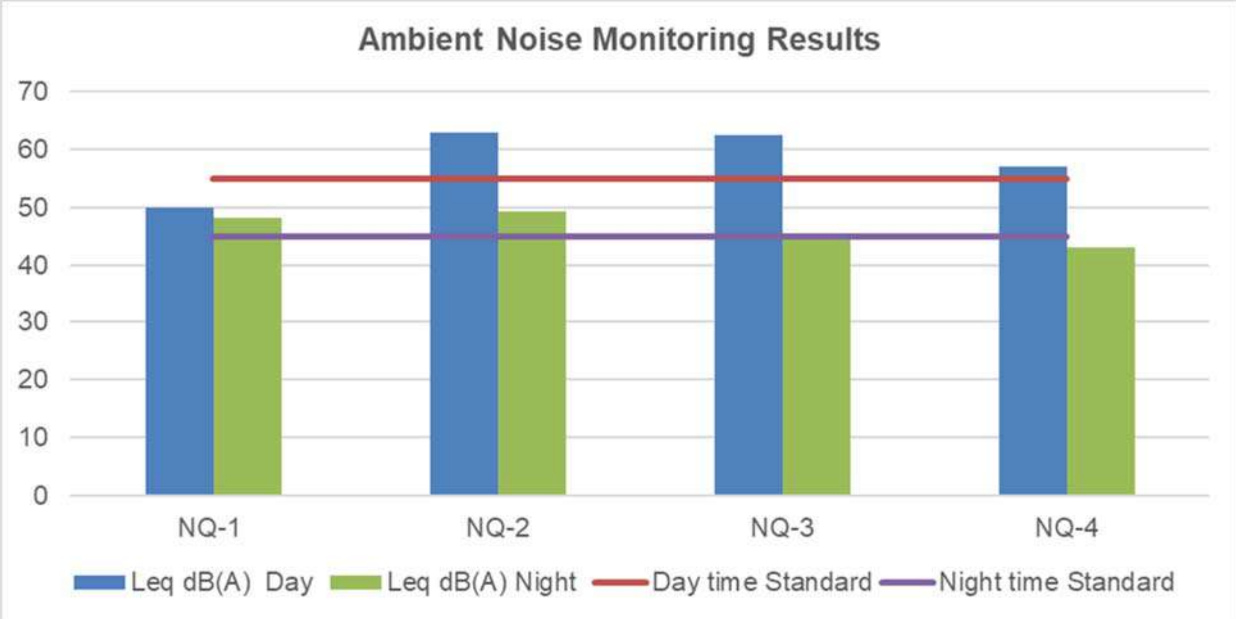


Figure 4.19 Ambient Noise Monitoring Results



Source: ERM Primary Monitoring

4.2.7.1 Interpretation of Primary Noise Monitoring Results

The equivalent noise level as measured at the residential areas range between 50 -62.8 dB(A) at day time and between 43.2-49.3 dB(A) at night time. The equivalent day time noise values in all the locations (Near the Arupara Road, Police Training Facility, Hatpukur Para) except the location within the facility were exceed the day time CPCB standard of 55 dB(A) for residential areas and WHO day time standard of 55 dB(A) for outdoor living area. The equivalent night time noise values in two (2) locations (with the site and Arupara road) were exceed the night time CPCB standard of 45 dB(A) for residential areas but all station comply with WHO night time standard of 50 dB(A) for outdoor living area. The noise monitoring stations were close to the Das Nagar railway station and other communication roads. The vehicles in the roads and sound from railways are the major source of day-time Noise in the area. The major source in night-time are the insect-roar within the facility along with railways. The detailed results are given in **Appendix F**.

4.2.8 Drainage

The main rivers of Howrah district are Rupnarayan River, Mundeswari River, Bhagirathi and Hooghly River. The boundaries of the district are naturally defined by these three (3) rivers - Rupnarayan River flows along the West and South-west part of the district; Bhagirathi-Hooghly River flows along East and South-east part of the district and Damodar River flows from north-west boundary of the district. Apart from rivers there is an artificial canal called Bally Khal present along the north-eastern boundary of the district. The Bally Khal meets the Hooghly River at the North-eastern part of the district. In addition to Bally Khal, there are so many *khals* and channel like, Howrah Drainage Channel, Mahishdhara khal, Barjola khal, Rajapur khal, Medinipur Main khal, Champa khal, Rampur khal, Gaighata khal etc. which play very important role in respect to flood and irrigation control. Besides the above, other small rivers like Saraswati, Maza Damodar, Kana Damodar etc. serves drainage purpose in the district[25].

Howrah Drainage Channel flows from the eastern side of the STP facility. The channel drains gravitational flows from its basin area. Howrah drainage channel flows in south direction before it

[25] West Bengal Disaster Management Plan for Howrah District-2018

meet the Hooghly River at Mourigram. The Howrah drainage channel covers almost entire district through its distributary channels. The entire drainage load of the channel is discharged into the Hooghly River. The channel is used to drain both storm and sewage water from its basin area. The drainage system of the study area is controlled by the Howrah Drainage Channel. HowrahDrainage Channel is a covered drainage channel in most of its course.

Micro-Drainage: The STP site is located at a low-lying area. In the present site setting, the slope of surface within the STP facility is towards the Howrah Drainage Channel. The drainage map of the study area is given in **Figure 4.20** and **Figure 4.21.**

Figure 4.20 Drainage Map

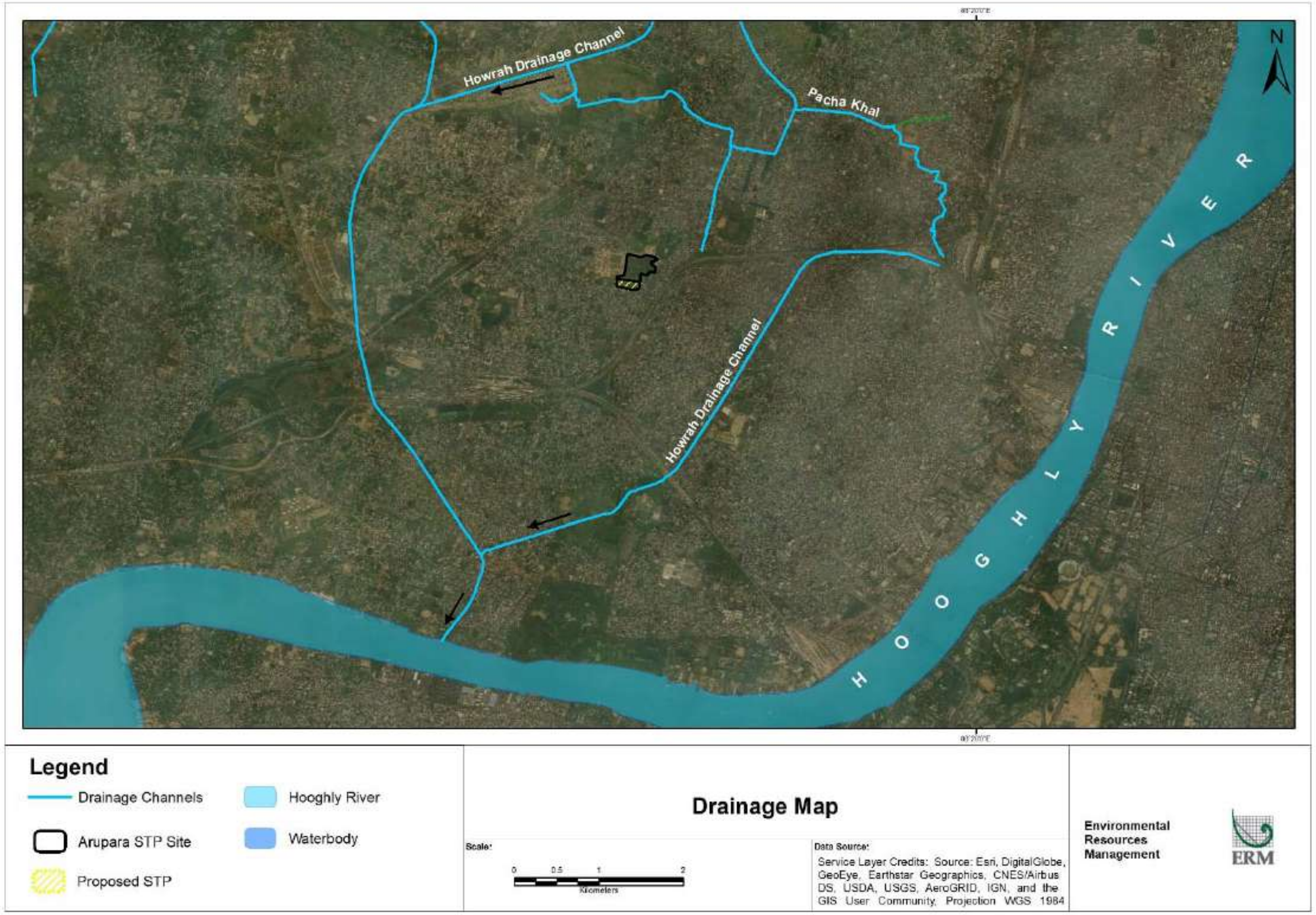
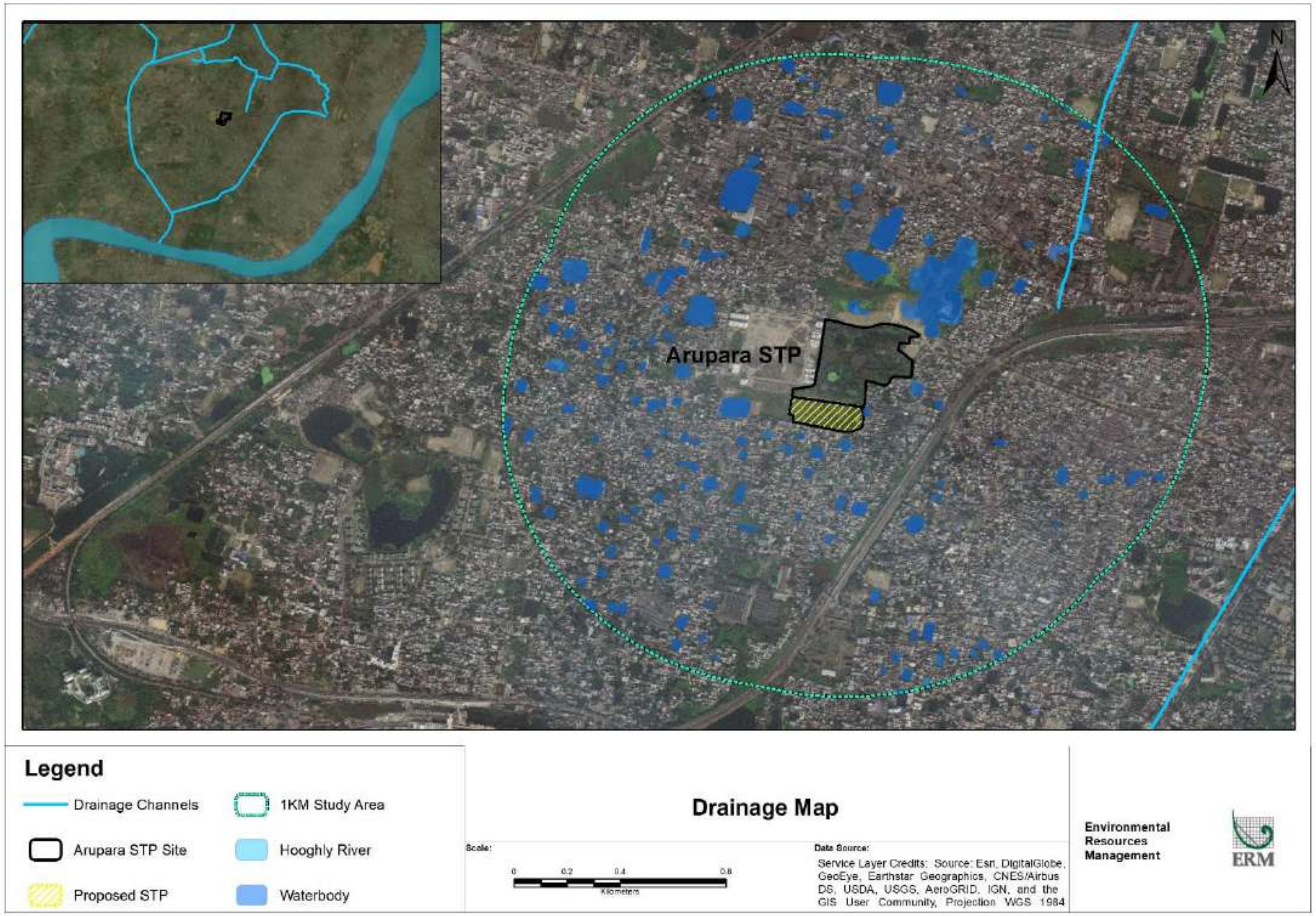


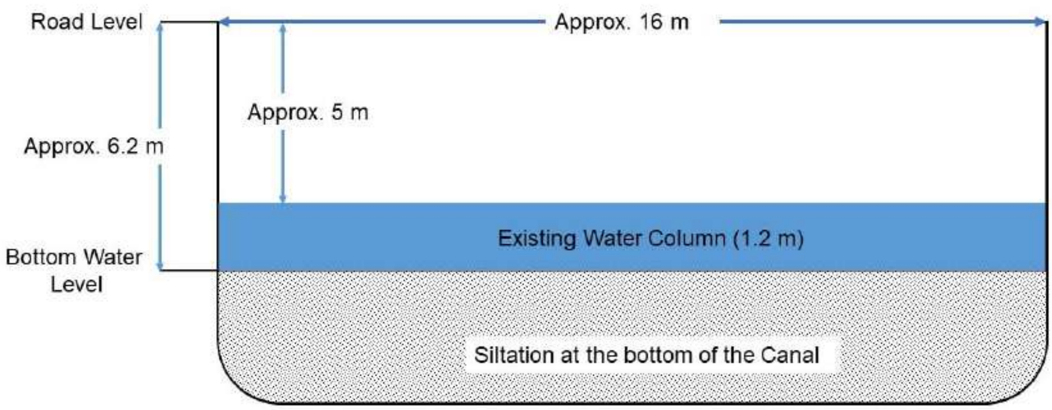
Figure 4.21 Drainage Map within 1 km of Arupara STP



4.2.8.1 Primary Study of Howrah Drainage Channel

The initial depth of the channel is not known. During initial assessment it was found that the channel was heavily silted. The thickness of the silt bed at the bottom was not known. The effective depth of the channel was estimated to be approximately 6.2 m below the road level and the current (post-monsoon) height of water column in the canal was estimated to be approximately 1.2 m. It was visually observed that the flow of water in the channel was quite high. The velocity of the channel near Ichapur MPS was estimated to be approximately 4.15 km/hour. The approximate features of the cross sectional area of the canal is outlined in **Figure 4.22**.

Figure 4.22 Cross-sectional Area of Howrah Drainage Channel



In present scenario the carrying capacity of the channel with existing siltation at the bottom is estimated to be 4,11,680 m^3/hour based on the primary monitoring data. Presently, the channel is approximately carrying 79,680 m^3/hour of untreated water, thus approximately carrying capacity 3,32,000 m^3/hour will be available for accommodating additional discharge of treated water from the Arupara STP and flood water discharge.

As discussed in **Section** 2.1, the capacity of the proposed STP will be 65 MLD. The present carrying capacity of the canal is 3, 32,000 m^3/hour or 7968000 m^3/day or 7968 MLD. Therefore, the available carrying capacity of Howrah Drainage Channel will be approximately 7903 MLD after accommodating the peak design flow from STP.

4.2.9 Surface Water Quality

Surface water has been monitored at four locations within the study area. The sampling locations have been designed to capture the water quality of the existing ponds within the study area that could be impacted due to the operation of STP. The distribution of sampling ponds are selected surrounding the STP area. Sampling exercise was conducted on 28th June, 2019 during monsoon season. The receiving body i.e. Howrah Drainage Channel is a covered and underground wastewater drainage channel as discussed in **Section 4.2.8**. The sampling at Howrah Drainage Channel is not possible as the intermediate openings are not suitable for sampling. The surface water monitoring locations in detail has been provided in **Table 4.10** and the locations are shown in **Figure 4.23.**

Table 4.10: Surface Water Monitoring Locations

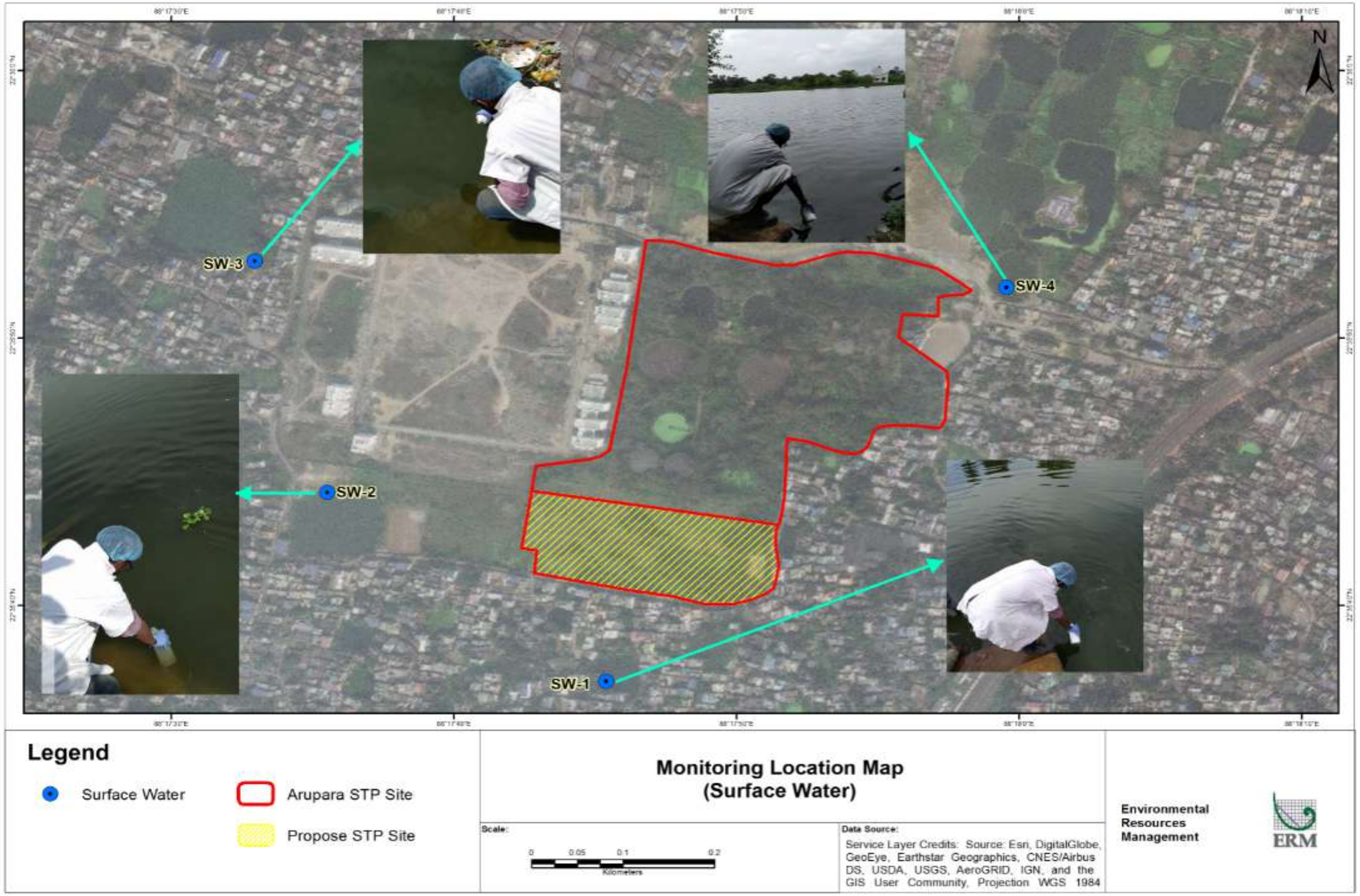
Sl No	Location	Station No	Latitude	Longitude
1	Hatpukur Para	SW 1	22°35'37.07" N	88°17'45.33" E
2	Dharsa Chowdhury Para	SW 2	22° 35' 44.24" N	88° 17' 35.49" E

Sl No	Location	Station No	Latitude	Longitude
3	Dharsa Panchanantala Puea Pukur	SW 3	22° 35' 52.89" N	88° 17' 32.94" E
4	Near STP facility gate	SW 4	22°35'51.74" N	88°17'59.36" E

Water sampling and analysis[26] was done during June 2019 following the CPCB standard guidelines for physical, chemical and bacteriological parameters. Field parameters viz. temperature, pH, dissolved oxygen were analysed at the site. The samples are collected from ponds present surrounding the proposed STP location to estimate possible condition of the ponds which are used for fishing. The pond at Hatpukur para is the nearest location to the proposed STP location. The results of the samples collected from the surface water bodies in the study area have been discussed below with respect to the CPCB's Water Use Criteria and classified as A, B and C category (as provided in **Appendix G**).

[26] http://www.cpcb.nic.in/latest/guidelines-water.doc

Figure 4.23 Surface Water Quality Monitoring Station Location Map



4.2.9.1 Surface water Monitoring Results

The surface water primary monitoring results have been provided in **Table 4.11.**

Table 4.11: Surface Water Monitoring Results

Sl No.	Parameter	Location	Hatpukur Para	Dharsa Chowdhury Para	Dharsa Panchanantala Puea Pukur	Near STP facility gate
		Sample Code	SW 1	SW 2	SW 3	SW 4
1	pH value	-	6.94 at 25 degree C	7.11 at 25 degree C	6.93 at 25 degree C	7.89 at 25 degree C
2	Turbidity	N.T.U.	4.8	1.5	2.3	<1.0
3	Chloride (as Cl)	mg/l	528	604	760	634
4	Copper (as Cu)	mg/l	<0.02	<0.02	<0.02	<0.02
5	Fluoride (as F)	mg/l	0.43	0.31	0.34	0.44
6	Iron (as Fe)	mg/l	13	12	6.9	2.0
7	Manganese (as Mn)	mg/l	0.13	<0.02	<0.02	<0.02
8	Nitrate (as NO3)	mg/l	18	13	20	18
9	Sulphate (as SO4)	mg/l	24	16	9.6	14
10	Total Hardness (as CaCO3)	mg/l	543	438	555	489
11	Cadmium (as Cd)	mg/l	<0.001	<0.001	<0.001	<0.001
12	Lead (as Pb)	mg/l	<0.005	<0.005	<0.005	<0.005
13	Mercury (as Hg)	mg/l	<0.001	<0.001	<0.001	<0.001
14	Nickel (as Ni)	mg/l	<0.02	<0.02	<0.02	<0.02
15	Arsenic(as As)	mg/l	<0.005	<0.005	<0.005	<0.005
16	Sodium (as Na)	mg/l	370	224	297	272
17	Electrical conductivity	us/cm	3520	2990	3080	3210
18	Potassium (as K)	mg/l	20	16	21	18
19	Total Nitrogen (as N)	mg/l	4.1	6.6	8.6	9.0
20	Zinc (as Zn)	mg/l	<0.02	<0.02	<0.02	<0.02
21	Hexavalent Chromium (as Cr+6)	mg/l	<0.01	<0.01	<0.01	<0.01
22	Temperature	°C	25	25	25	25
23	Dissolved Oxygen	mg/l	5.1	5.5	5.4	5.3
24	Biochemical Oxygen Demand (as BOD)	mg/l	28	5.6	6.6	12
25	Chemical Oxygen Demand (COD)	mg/l	90	20	27	48

Sl No.	Parameter	Location	Hatpukur Para	Dharsa Chowdhury Para	Dharsa Panchanantala Puea Pukur	Near STP facility gate
		Sample Code	SW 1	SW 2	SW 3	SW 4
26	Salinity	-	2.2 In respect to KCl equivalent salinity 35.	1.3 In respect to KCl equivalent salinity 35.	1.8 In respect to KCl equivalent salinity 35.	1.5 In respect to KCl equivalent salinity 35.
27	Phenol	mg/l	<0.001	<0.001	<0.001	<0.001
28	Total Alkalinity (as CaCO3)	mg/l	304	242	354	394
29	Total Phosphorous	mg/l	0.40	0.06	1.8	0.13
30	Faecal coliform	MPN/100ml	22	4.5	27	7.8
31	Total coliform	MPN/100ml	2800	33	11000	490

4.2.9.2 Interpretation of Surface Water Monitoring Results

Results of the water quality sampled from the ponds located near STP facility gate, Dharsa Chowdhury Para, Dharsa Panchanantala Pukur and Shibtala are discussed below:

- ***pH*** – The range of pH value of the samples collected from 4 locations was 6.93 to 7.89. pH values of the SW-2 and SW-4 indicate slightly alkaline water whereas pH values of the SW-1 and SW-3 indicate slightly acidic water.
- ***Dissolved Oxygen (DO)***–DO concentrations of the water samples varies from 5.1 mg/l to 5.5 mg/l.
- ***Biochemical Oxygen Demand (BOD)*** – The concentration of BOD for surface water samples varied from 5.6 mg/l to 28 mg/l. The lowest BOD value was found in the sample taken from Dharsa Chowdhury Para Pond whereas highest BOD value found in the sample taken from the pond near STP facility gate. The variation of BOD value in surface water samples is attributed to the different sources where from the samples were collected.
- ***Chemical Oxygen Demand (COD)*** – The concentration of COD for surface water samples varied from 20 mg/l to 90 mg/l. The lowest COD value was found in the sample taken from Dharsa Chowdhury Para Pond whereas highest COD value found in the sample taken from the pond near STP facility gate. The variation of COD value in surface water samples is attributed to the different sources where from the samples were collected.
- ***Faecal Coliform***– Faecal Coliform is present in all the sample. The concentration of faecal coliform in samples are varied from 4.5 to 27 MPN/100ml. The lowest concentration of Faecal Coliform was found in the sample taken from Dharsa Chowdhury Para Pond whereas highest concentration found in the sample taken from the pond near STP facility gate.
- ***Total Coliform***- The range of the total coliform values found in the sample was 33 to 11000 MPN/100ml. The lowest concentration of Total Coliform was found in the sample taken from Dharsa Chowdhury Para Pond whereas highest concentration found in the sample taken from the pond near STP facility gate. The variation of Total Coliform concentration in surface water samples is attributed to the different sources where from the samples were collected.
- ***Salinity***-Salinity values in the samples ranges from 1.3 to 2.2 in respect to KCl equivalent salinity 35.

- ***Turbidity***- turbidity values in the samples were varied from <1.0 to 4.8 N.T.U. The lowest value of turbidity was found in the pond near Shibtala.
- The concentration of parameters of Copper, Phenol, Cadmium, Lead, Mercury, Nickel, Arsenic, Hexavalent Chromium (as Cr+6), and Zinc were found below the detection limit.
- ***Sodium***- The values Sodium in the samples varied from 224 to 370 mg/l.
- ***Chloride***- The range of chloride concentration in the samples were found to be 69 to 158 mg/l.
- ***Total Alkalinity (as $CaCO_3$)***- The alkalinity values of the samples were varied from 528 to 760 mg/l.
- ***Total Nitrogen (as N) and Potassium (as K)*** - The concentration of total nitrogen varied from 4.1 to 9.0 mg/l and for Potassium, it varied from 16 to 21 mg/l. The variation of Total nitrogen and potassium value in surface water samples is attributed to the different sources where from the samples were collected.
- ***Total Hardness (as $CaCO_3$)*** - The values of total hardness in the samples ranges between 438 to 555 mg/l. The variation of total hardness value in surface water samples is attributed to the different sources where from the samples were collected.
- ***Iron and Fluoride***- The values of Iron and Fluoride in the sample varied from 2 to 13 mg/l and 0.31 to 0.44 mg/l respectively.
- ***Nitrate and Sulphate***- The values of Nitrate and Sulphate in the sample varied from 13 to 20 mg/l and 9.6 to 24 mg/l respectively. The variation of nitrate and sulphate concentrain in surface water samples is attributed to the different sources where from the samples were collected.

The pond water of Dharsa Chowdhury Para can be categorized as CPCB class B water as per CPCB Water Quality Criteria. The pond water can be used for outdoor bathing. The pond water of Shibtala and near the STP gate ccan be categorized as CPCB class C water. It can be used for drinking water after conventional treatment and disinfection.

Note:

This is to be noted that, per NGT, Government of India vide their Order dated 30 April 2019 (Original Application No. 1069/2018 (M.A. No. 1792/2018, M.A. No. 1793/2018, I.A. No. 150/2019 & I.A. No. 151/2019)). The further Notification on any revised effluent discharge standards for STPs is awaited through official gazetted notification from the Ministry of Environment, Forests & Climate Change (Government of India) as on February 2020. Therefore, the surface water quality has been compared against the presently enforced effluent discharge standards for Sewage Treatment Plants as outlined under Environment (Protection) Amendment Rules, 2017.

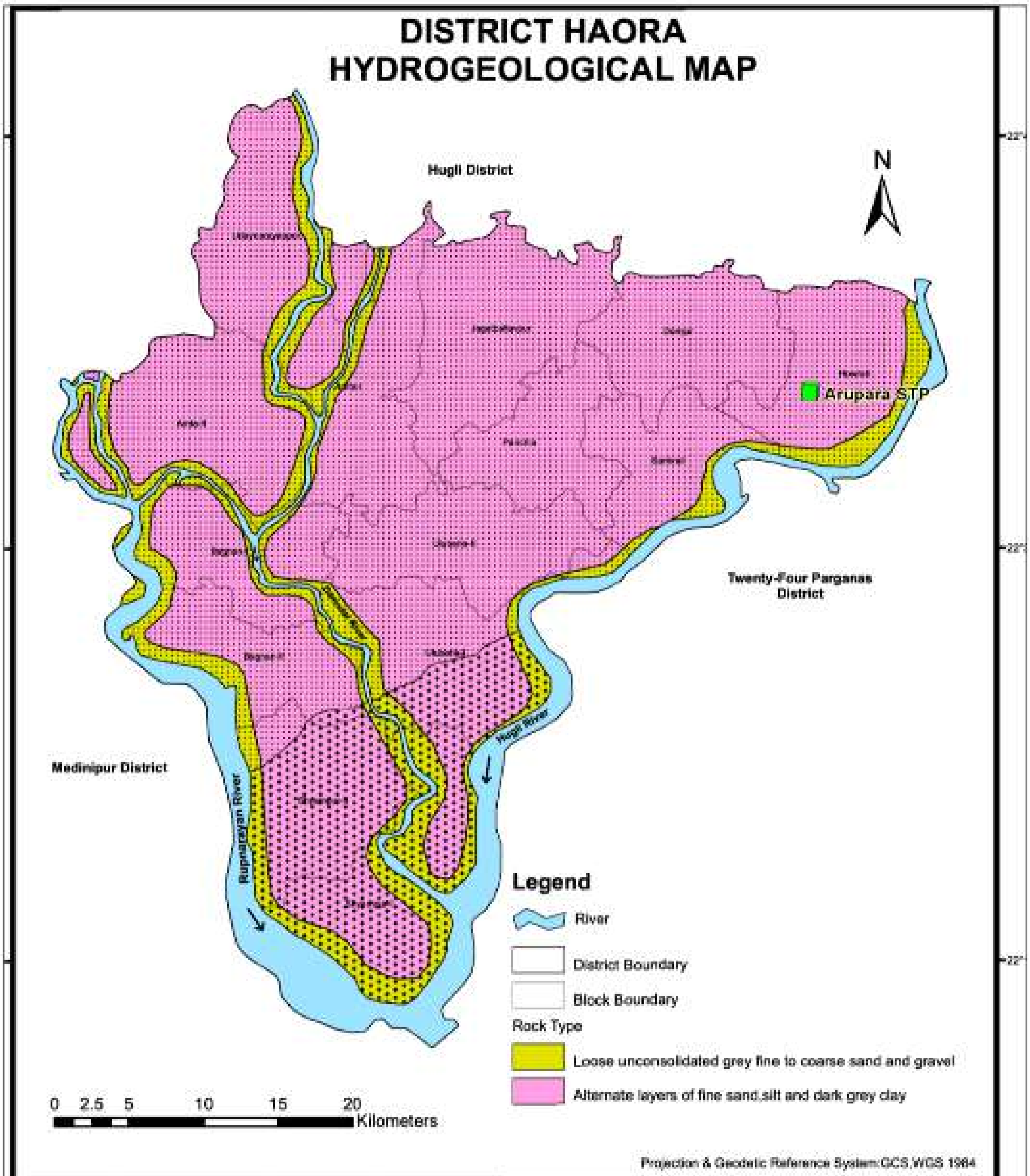
4.2.10 Hydrogeology

Groundwater occurs in the thick alluvium deposit of Bhagirathi-Hooghly River. The alluvium aquifers have high storage capacity. The aquifers of the study area can be categorized into upper unconfined aquifer and deeper confined aquifer. The aquifer in some parts of the district occur at 4.235 mbgl near the Hooghly River. The shallow aquifer in the area are tapped by dug well whereas deeper aquifers are tapped by hand pumps and motor-fitted tube wells. The depth of the dug well in this area varies from 5 to 15m. In some parts of the district, the dug wells dried up during summertime. This phenomenon is observed where the dug wells are excavated in the silty zone or in the areas where the aquifers are tapped partially. The aquifers in this district are separated by thick to thin clay layers. The reported potential aquifer zones are r up to the depth of 300m. The alluvium aquifers generally have a high transmissivity value with high storage capacity.

As per Central Ground Water Board, Government of India, all the blocks of the district are categorized under ‘Safe’ category. Some aquifers in the district contain brackish water with high TDS value. As per the GEC 1997, the total groundwater resource in the area is 33330 mham. The hydrogeological map of the district is shown in **Figure 4.24**.

In study area groundwater related information are collected through field survey and consultation with local people. The study is characterized as one of the high water table area. A number of dug wells present in the study area tapping the shallow aquifer. The water level in these dug wells are within 0.5 mbgl. During pre-monsoon, the water level in these dug wells varies from 0.5 to 0.8 mbgl as per our discussion with the local people. The shallow aquifer in the area consist of fine to medium grain sand (as per our discussion with the local driller of the area). The shallow aquifer is in unconfined condition and this aquifer has a thickness up to 300 mbgl. One Mark-II Tubewell is present near the STP facility. The depth of the Tubewell is 60-80 mbgl (according to local people). Another Tubewell at same depth present within the STP facility used for domestic purposes. A number of ponds present at the study area and these are groundwater-fed ponds.

Figure 4.24 Hydrogeological map of the district



Symbol	Rock Type	Age	Lithology	Aquifer Description	Hydrogeology
	Loose unconsolidated grey fine to coarse sand and gravel/fine sand,silt and dark grey clay	Middle to Late Holocene	Flood plain of Damodar and Rupnarayan and lower mature deltaic plain	Unconfined aquifer of about six hundred sq.km approx having considerable thikness upto 300m bgl	Depth of fresh water in pre-monsoon season is less than 0.5m to greater than 6.5m b.g.l.,flow of ground water is towards south
	Loose unconsolidated grey fine to coarse sand and gravel,fine sand,silt and dark grey clay	Middle to Late Holocene	Flood plain of Damodar and Rupnarayan and lower mature deltaic plain	Confined aquifer of about eight hundred sq.km approx having considerable thikness upto 300m bgl	Area of fresh ground water overlain by saline ground water,flow of ground water is towards south

4.2.11 Groundwater Quality

The shallow and deeper aquifers in Howrah district are classified as Sodium-Bicarbonate facies. Presence of brackish water in the aquifers up to a depth of 150 m are reported from some part of the district. Groundwater throughout the district is slightly alkaline with pH varies from 7.90 to 8.40. Arsenic is mainly present in the shallow aquifers to deeper aquifers up to a depth of 50m in some parts of the district. The groundwater of the district is suitable domestic use except few pockets of contaminated groundwater[27].

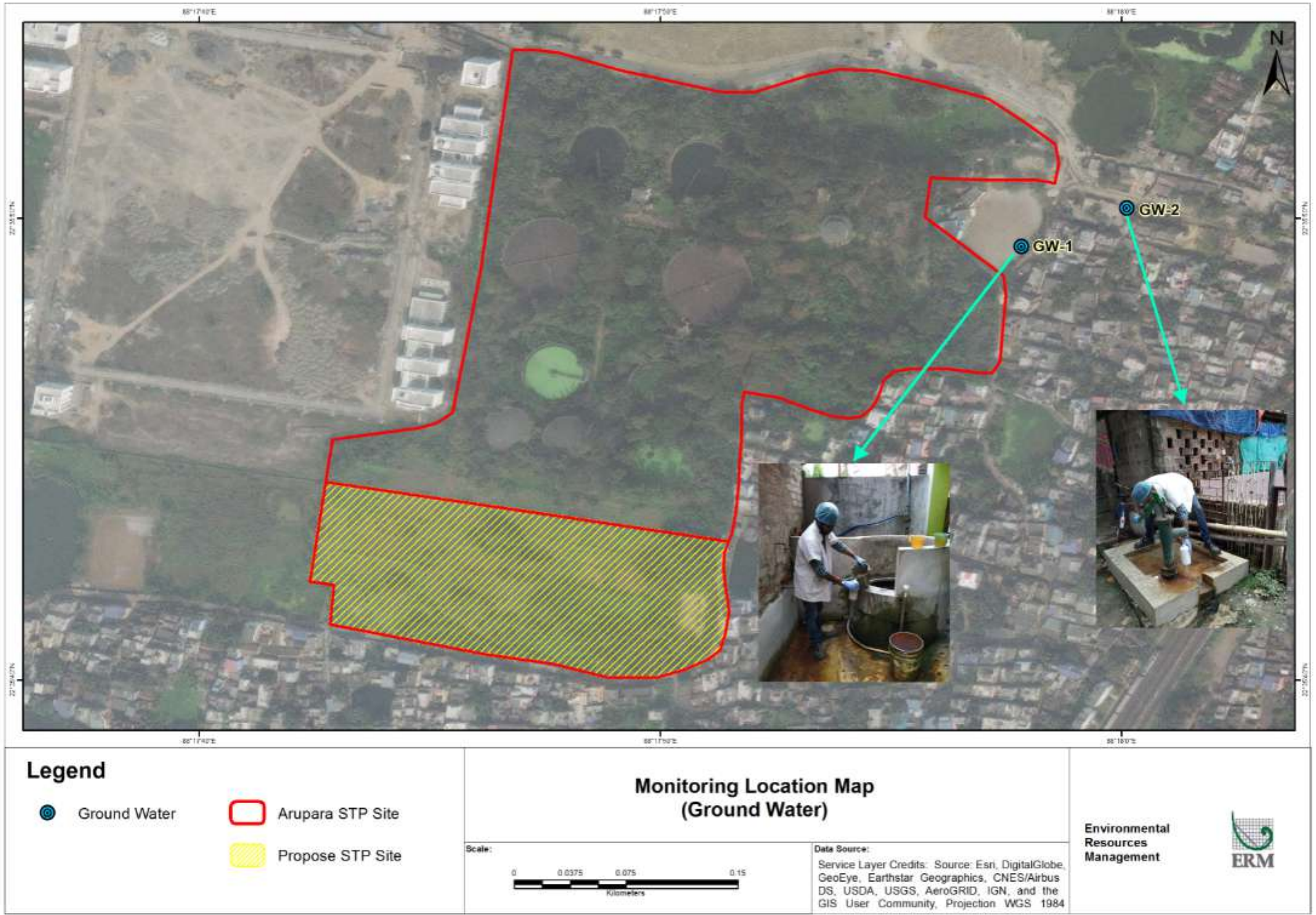
In order to assess the suitability of existing drinking water sources in the immediate vicinity to STP, monitoring was conducted at two stations near the study area. One groundwater sample was collected from dug well tapping the shallow aquifer (5-15m of depth) and the other sample was collected from tube well tapping the deep aquifer (60-80m of depth). The location of the groundwater monitoring stations has been presented in **Table 4.12** and shown in **Figure 4.25**. Initial sampling exercise was conducted on 28th June but some parameters in the sample shows higher concentration than the baseline reports of the area. Resampling was conducted on 6th November, 2019 for both the locations. The analysed parameter values were compared with IS 10500: 2012 Standards to evaluate the suitability of drinking with respect to each parameter.

Table 4.12: Groundwater Monitoring Locations in the Study Area

Sl No.	Monitoring locations	Station No	Latitude	Longitude	Source
1.	Arupara	GW 1	22° 38' 39.59" N	88° 23' 40.26" E	Tubewell
2.	Arupara	GW 2	22° 38' 38.14" N	88° 23' 40.34" E	Dugwell

[27] CGWB district wise report of Howrah.

Figure 4.25 Groundwater Sampling Location Map



4.2.11.1 Groundwater Quality Results

The result of groundwater quality as sampled in the study area has been provided in **Table 4.13.**

Table 4.13: Groundwater Monitoring Results

Sl No.	Parameter	Location	Arupara Dugwell	Arupara Tubewell	IS 10500, 2012		WHO Guideline Value
		Sample Code	GW 1	GW 2	Acceptable Limit	Permissible Limit	
1	Colour	Hazen	<1.0	<1.0	5	15	
2	Odour	-	Unobjectionable	Unobjectionable	Agreeable	Agreeable	
3	pH value	-	7.67 at 25 deg C	6.80 at 25 deg C	6.5-8.5	No relaxation	6.5-8.5*
4	Turbidity	N.T.U.	<1.0	2.4	1	5	5*
5	Total Dissolved Solids (as TDS)	mg/l	1780	1530	500	2000	1000*
6	Aluminium (as Al)	mg/l	<0.01	<0.01	0.03	0.2	0.2*
7	Anionic Detergents (as MBAS)	mg/l	<0.02	<0.02	0.2	1	
8	Barium (as Ba)	mg/l	<0.05	<0.05	0.7	No relaxation	0.7
9	Boron (as B)	mg/l	<0.5	<0.5	0.5	1.0	2.4
10	Calcium (as Ca)	mg/l	154	90	75	200	150*
11	Chloramines (as Cl2)	mg/l	<0.3	<0.3	4	No relaxation	3.5*
12	Chloride (as Cl)	mg/l	789	693	250	1000	250*
13	Copper (as Cu)	mg/l	<0.02	<0.02	0.05	1.5	2
14	Fluoride (as F)	mg/l	0.33	0.40	1.0	1.5	1.5
15	Free Residual Chlorine	mg/l	<0.1	<0.1	0.2	1.0	5
16	Iron (as Fe)	mg/l	0.30	0.71	0.3	No relaxation	0.3*
17	Magnesium (as Mg)	mg/l	88	55	30	100	100*
18	Manganese (as Mn)	mg/l	<0.02	0.19	0.1	0.3	0.1*
19	Mineral Oil	mg/l	<0.01	<0.01	0.5	No relaxation	
20	Nitrate (as NO3)	mg/l	15	32	45	No relaxation	50
21	Phenolic Compounds (as C6H5OH)	mg/l	<0.001	<0.001	0.001	0.002	
22	Sulphate (as SO4)	mg/l	39	8.8	200	400	250*
23	Total Hardness (as CaCO3)	mg/l	575	350	200	600	500*

Sl No.	Parameter	Location	Arupara Dugwell	Arupara Tubewell	IS 10500, 2012		WHO Guideline Value
		Sample Code	GW 1	GW 2	Acceptable Limit	Permissible Limit	
24	Cadmium (as Cd)	mg/l	<0.001	<0.001	0.003	No relaxation	0.003
25	Lead (as Pb)	mg/l	<0.005	<0.005	0.01	No relaxation	0.01
26	Mercury (as Hg)	mg/l	<0.001	<0.001	0.001	No relaxation	0.006
27	Nickel (as Ni)	mg/l	<0.02	<0.02	0.02	No relaxation	0.07
28	Polychlorinated biphenyls (as PCB)	mg/l	<0.0005	<0.0005	0.0005	No relaxation	
29	Polynuclear Aromatic Hydrocarbons (as PAH)	mg/l	<0.0001	<0.0001	0.0001	No relaxation	
30	Arsenic(as As)	mg/l	<0.005	<0.005	0.01	0.05	0.01
31	Zinc (as Zn)	mg/l	<0.02	<0.02	5	15	5*
32	Hexavalent Chromium (as Cr+6)	mg/l	<0.01	<0.01	0.05	No relaxation	0.05
33	Sulphide (as S)	mg/l	<0.01	<0.01	0.05	No relaxation	
34	Ammonia (as NH3)	mg/l	<0.1	<0.1	0.5	No relaxation	
35	Total Alkalinity (as CaCO3)	mg/l	259	454	200	600	
36	Faecal coliform	/100ml	Detected	Not Detected	Shall not be detectable in any 100 ml sample	Shall not be detectable in any 100 ml sample	Must not be detectable in any 100ml sample
37	Total coliform	/100ml	Detected	Not Detected	Shall not be detectable in any 100 ml sample	Shall not be detectable in any 100 ml sample	Must not be detectable in any 100ml sample

4.2.11.2 Interpretation of Monitoring Results of Groundwater Quality

- pH of the groundwater samples were 7.67 and 6.80 for GW 1 and GW 2 respectively. The pH values of ground water samples were in compliance to the IS: 10500, 2012 drinking water standard of 6.5 to 8.5 and WHO drinking water standard of 6.5 to 8.5.
- Turbidity values of the groundwater samples were <1.0 and 2.4 NTU for GW 1 and GW 2 respectively. Turbidity value in GW 1 was within the IS: 10500, 2012 acceptable limit of 1 NTU but the turbidity value in GW 2 was exceed the acceptable limit but within IS: 10500, 2012 permissible limit of 5 NTU. Turbidity value in both the sample were in compliance with WHO guideline value of 5 NTU. The variation in turbidity values in the groundwater samples were observed as the samples were taken from different aquifers as stated above under this sub-section.

- Total Dissolved Solids –Concentration of total dissolved solids in groundwater samples were 1780 and 1530 mg/l GW 1 and GW 2 respectively. The TDS value of the samples were above the IS: 10500, 2012 acceptable limit of 500 mg/l but below the IS: 10500, 2012 permissible limit of 2000 mg/l. The TDS value of both the samples were above the WHO guideline value of 1000 mg/l.
- Total hardness (as CaCO3) –The values of total hardness in groundwater samples were 575 and 350 mg/l for GW 1 and GW 2 respectively. The total hardness value of both the samples GW 2 and GW 1 were within the IS: 10500, 2012 permissible limit 600 mg/l. The total hardness value of GW-2 was in compliance with WHO guideline value of 500 mg/l. The variation in total hardness value in the groundwater samples were observed as the samples were taken from different aquifers as stated above under this sub-section.
- Chlorides – The concentration of chlorides ranged between 789 and 693 mg/l. Chloride concentrations in both the sample were above the acceptable limit but below the IS: 10500, 2012 permissible limit of 1000 mg/l. The chloride concentration in both the samples exceed the WHO guideline value of 250 mg/l.
- Total Alkalinity (as CaCO3) – The alkalinity of the water samples monitored at study area were 259 and 454 mg/l for GW 1 and GW 2 respectively. Alkalinity were reportedly above the IS: 10500, 2012 acceptable limit but below the permissible limit (600 mg/l) for both the locations.
- Fluoride-Fluoride levels in the groundwater samples were 0.33 and 0.40 mg/l for GW 1 and GW 2 respectively. The samples were found to be in compliance to the IS: 10500, 2012 acceptable limit of 1.0 mg/l and WHO guideline value of 1.5 mg/l.
- Sulphate-Sulphate concentrations in the groundwater samples were below the detectable limit of 39 and 8.8 mg/l for GW 1 and GW 2 respectively. The sulphate concentration in both the samples were below the IS: 10500, 2012 acceptable limit and WHO guideline value of 250 mg/l.
- Nitrate- Nitrate concentrations in all groundwater samples were found to be 15 and 32 mg/l for GW 1 and GW 2 respectively. Nitrate concentrations in both the samples were found to be within the acceptable nitrate concentration limit of 45 mg/l as per IS: 10500, 2012 and WHO guideline value of 50 mg/l. The variation in Nitrate concentration in the groundwater samples were observed as the samples were taken from different aquifers as stated above under this sub-section.
- Iron- The concentration of iron monitored at 2 locations were found to be 0.30 and 0.71 mg/l for GW 1 and GW 2 respectively. Iron concentrations in GW 2 was found to be within the IS: 10500, 2012 acceptable iron concentration limit of 0.3 mg/l and and WHO guideline value of 0.3 mg/l. but in case for GW 1, the concentration exceeds the limit as per IS: 10500, 2012. The variation in Iron concentration in the groundwater samples were observed as the samples were taken from different aquifers as stated above under this sub-section.
- Calcium- The concentration of calcium were 154 and 90 mg/l for GW 1 and GW 2 respectively. Calcium levels at all sample were found to be above to the acceptable limit of 75 mg/l but the Calcium concentration in GW1 and GW 2 were within the permissible limit of 200 mg/l as per IS: 10500, 2012. Calcium concentration in GW-2 was in compliance with WHO guideline value of 150 mg/l. The variation in Calcium concentration in the groundwater samples were observed as the samples were taken from different aquifers as stated above under this sub-section.
- Magnesium – The concentration of magnesium were observed to be 88 and 55 mg/l for GW 1 and GW 2 respectively. Magnesium levels in GW-1 exceeds the acceptable limit of 30mg/l but below the permissible limit of 100 mg/l as per IS: 10500, 2012. Mmagnesium concentration in GW-2 was in compliance with WHO guideline value of 100 mg/l. The variation in Magnesium concentration in the groundwater samples were observed as the samples were taken from different aquifers as stated above under this sub-section.
- Manganese – The concentration of manganese were observed to be <0.02 and 0.19 mg/l for GW 1 and GW 2 respectively. Manganese levels at GW 1 were found to be in compliance to the IS:

10500, 2012 acceptable limit of 0.1 mg/l and WHO guideline value of 0.1 mg/l whereas in GW 2 the Manganese concentration was below the permissible limit of 0.3 mg/l as per IS: 10500, 2012. The variation in Manganese concentration in the groundwater samples were observed as the samples were taken from different aquifers as stated above under this sub-section.

- Levels of Chloramines (as Cl2) (<0.3 mg/l), phenolic compounds (<0.001 mg/l), Polychlorinated biphenyls (as PCB) (<0.0005 mg/l), Polynuclear Aromatic Hydrocarbons (as PAH) (<0.0001 mg/l), Mineral oil (<0.01 mg/l) were found to be below detection limits in all the groundwater samples.
- Concentrations of metals Cd, Cu, Hg, Pb, Ni, As, B, Ba and Hexavalent Chromium were found to be below detection limits in the groundwater samples.
- Total and faecal coliforms were detected in both the groundwater samples collected from the study area.

The Concentration of majority of the parameters analysed were within the permissible limit of IS 10500, 2012 standard. pH values of groundwater samples were found to be below drinking water standard of IS 10500: 2012. The high values of Total Hardness, Iron, Faecal Coliform and Total Coliform were detected in the samples.

The presence of Total Coliform bacteria is not likely to cause illness, but their presence indicates that the water supply may be vulnerable to contamination by more harmful microorganisms. Escherichia coli (E. coli) are the only member of the total coliform group of bacteria that is found only in the intestines of mammals, including humans. The presence of E. coli in water indicates recent faecal contamination and may indicate the possible presence of disease-causing pathogens, such as bacteria, viruses, and parasite. Therefore, it is advised to properly treat the groundwater prior to consumption. As described in **Section 4.2.11,** the study area is characterized by high water table, mixing of waste water from toilets and existing brick sewer may be the source of waste water.

4.2.12 Traffic and Transport

Traffic monitoring station was selected at the up and down direction of STP area. Traffic survey was conducted continuously for 24 hours, one time during the study period. The traffic survey was done for both way movement of vehicles and categorized as heavy motor vehicles (truck, bus, dumper, tanker and trailer), light motor vehicle (car, jeep, van, matador, tractor, tempo and mini bus), two/three wheelers (scooter, motor cycle, auto, moped) and non-motorized vehicles (bicycle, tricycle). Summary of traffic observed in the study area is presented in **Table 4.14**, detail result is provided in **Appendix H**.

Table 4.14: Traffic Values observed in the Project study area

Description	Arupara Road (Up)	Arupara Road (Down)
Heavy Motor Vehicles (in Number), 24 hours	0	0
Light Motor Vehicle (in Number), 24 hours	18	24
Two/Three Wheelers (in Number), 24 hours	53	58
Non-motorized Vehicles	77	50
Total PCU (Nos.) in 24 Hours (To & From)	96.25	92.5
Average PCU Flow/Hr	4.01	3.85
Max PCU (Nos)/Hr	10.75	7.5
Min PCU (Nos)/Hr	0	0
Maximum PCU Hours	09:00-10:00	09:00-10:00 and 11:00-12:00

Source: ERM Primary Monitoring

4.2.12.1 Interpretation of Traffic Survey Results

Total 96.25 PCU and 92.5 PCU was recorded at the traffic monitoring station at Arupara Road Up and Down respectively. As per observation made for traffic density, on an average 4.01 PCU and 3.85 PCU was recorded per hour for Up and Down respectively. It was also noticed that contributor of the vehicular traffic at Arupara Road Up and Down Road was Non-motorized vehicle and two/three wheelers (Scooter, Motor Cycle, Auto, Moped).

Figure 4.26 illustrates contribution of different type of vehicle towards total vehicular traffic at Arupara Road Up and Down.

Figure 4.26 Traffic Monitoring Results

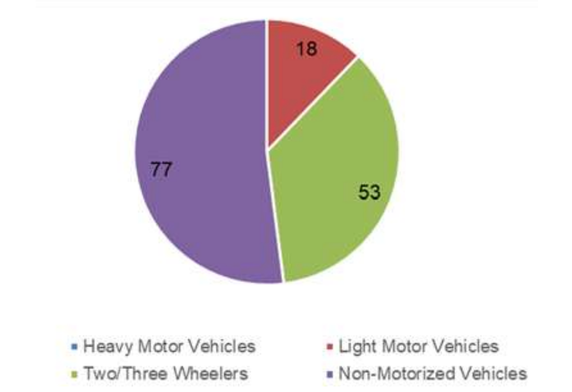
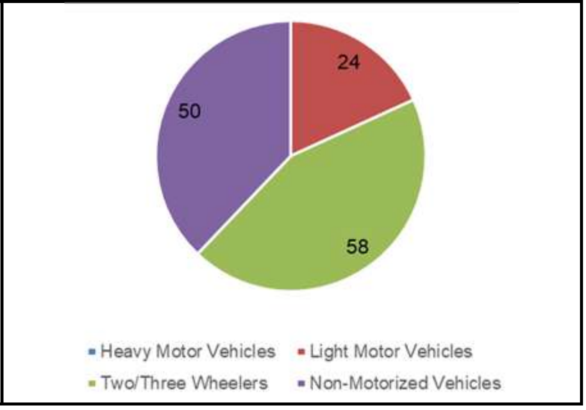
Arupara Road (Up)	Arupara Road (Down)
	

Figure 4.27 Road Traffic Monitoring Location Map

4.2.13 Natural Hazards

West Bengal is vulnerable to natural calamities like flood, cyclonic storms, earthquake, landslides, drought and embankment erosion. The most prevalent hazards of Howrah district are flood, cyclone and earthquake.

Flood: The study area is characterized by low-lying areas of alluvium deposits of Hooghly River. However, extensive man-made alterations of natural drainages in Howrah district has been carried out through the building of drainage systems (canals) and embankments making the area a highly modified watershed. As a result, the vulnerability of these area to flooding events has been significantly reduced and the same has been reflected in the flood vulnerability map of the area prepared by NRSC as a part of the NMCG program. The flood vulnerability map of the area as given in **Figure 4.28**, shows that the study area is not prone to flood.

Consultations with stakeholders in the study area indicate that area around the STP facility has not recently experienced any flooding situation although the area experience water-logging situation during heavy rainfall. In case of heavy rainfall the area faces temporary water-logging which lasts for maximum 3 to 4 hours duration. The area near MPS site do face water-logging situation during heavy rainfall as expressed by the local people. As discussed the Howrah Drainage Channel is able to accommodate all the storm water and STP effluent discharge within the area. So, there are very minimum chances of flood through the overflow of the canal though local level waterlogging may arise. A lock-gate is present in between Hooghly River and Howrah Drainage Channel near Satyen Bose road where the drainage channel drains the wastewater into Hooghly River. This lock gate remains closed during high rainfall events. So, there is low probability of flooding due to the Hooghly River. Moreover, in consultation with local communities, no occurrence of flood has been reported in the area from 2000 to 2014[28].

Future Climate Change Induced Flood risk Scenario:

Based on the report prepared by Climate Central on 29th October 2019 referring to the peer-reviewed paper published by Nature Communications[29], it is estimated that 237 million people in six Asian countries are at risk due to coastal flooding by 2050[30]. West Bengal and coastal Odisha are projected to be particularly vulnerable, as is the eastern city of Kolkata. It is estimated that by 2050, a major part of Kolkata urban area and its surroundings could lie in the annual coastal flood risk zone[31].

As per the CoastalDEM image provided under the Climate Central report, for future flood vulnerability projections during 2050, it appears that the proposed project location is not vulnerable to flood, post completion of Concession period of 15 years. Hence, as stated earlier the proposed project has minimum chances of experiencing such flood related vulnerability scenario even with respect to climate change throughout Concession period i.e. 15 years from the date of project inception.

Figure 4.28 Future Flood vulnerability map of Study Area, 2050

[28] https://www.researchgate.net/publication/275833658 (last accessed on 15th November, 2019)

[29] Kulp, S.A., Strauss, B.H. New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding. Nat Commun 10, 4844 (2019). https://doi.org/10.1038/s41467-019-12808-z

[30] The referenced scientific article has considered the reference timeframe for projected Climate Change Induced Flood Risk Scenario by 2050

[31] https://www.climatecentral.org/news/report-flooded-future-global-vulnerability-to-sea-level-rise-worse-than-previously-understood

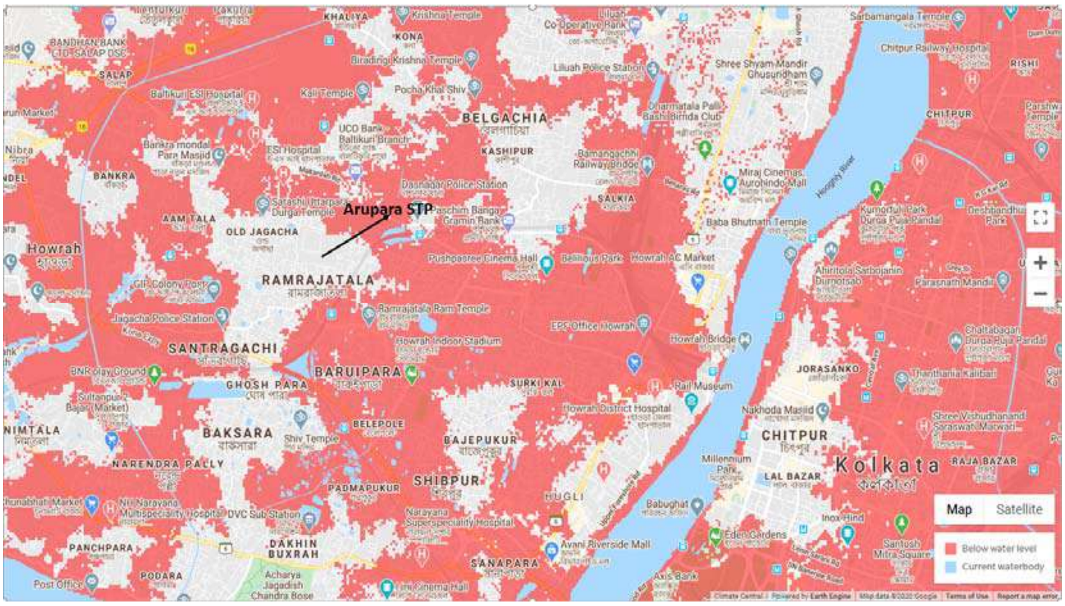
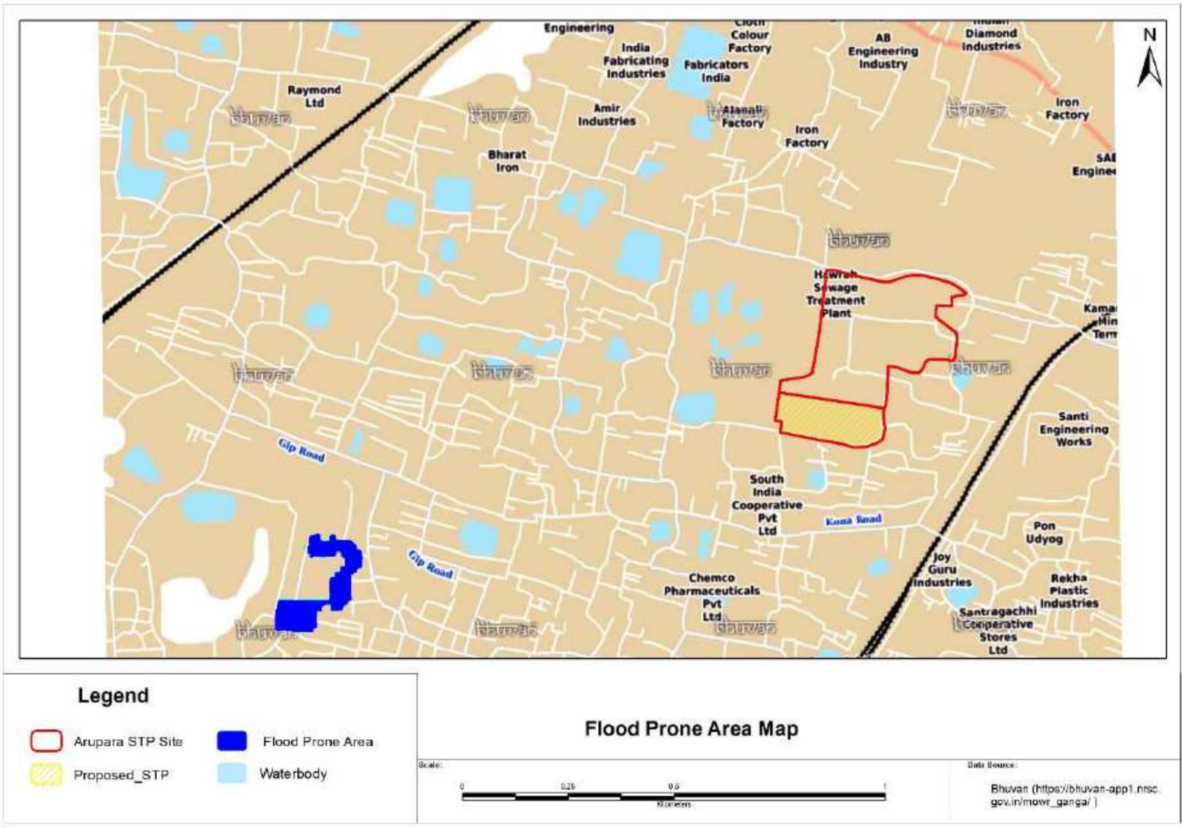


Figure 4.29 Flood vulnerability map of Study Area



Source: Aggregated Flood Layer Map as per Geospatial Support for National Mission for Clean Ganga, NRSC, 2018

As the maps show, there are no flood vulnerable zone present near the study area.

Earthquake: As per seismic hazard map the district of Howrah, lies in Zone III, which comes under Moderate risk zone (MSK VII)[32]. Zone III comprises of regions which have the risk of an earthquake with the maximum expected intensity of around 7.0 on MM scale.

4.3 Biological Environment

The study area falls under the lower Gangetic Delta, which has high population pressures and low ecological sensitivity. The proposed project and study area (1.0 km around the proposed STP) comprises of a modified ecological habitat, influenced considerably by urban pressures on land use as well as on flora and fauna. The proposed STP will be constructed within the exhausted sludge bed of the existing STP site. The proposed site is located at western bank of Hooghly River and approximately 15 km away from East Kolkata Wetland (a designated Ramsar Site). The project has no link to East Kolkata Wetlands based on the ground truthing.

4.3.1 Ecological Habitats of Conservation Importance

4.3.1.1 Terrestrial Habitat

The study area can be categorised as urban area, settlements with homestead plantation, plantation besides the canal, road and railway line side. The terrestrial habitat in the study area is a modified ecosystem due to anthropogenic interference.

4.3.1.2 Aquatic Habitat

Surface waterbodies are located in the study area. The surface water bodies are mostly man-made and some natural depression area. These surface water bodies are mostly used for pisci-culture (common carps, tilapia and nylontica). Several of the waterbodies, including the Howrah Drainage Channel has been observed to have undergone deffierent degrees of eutrophication because of drainage of waste water and sewage with high organic load. As a result, the quality of aquatic vegetation can be considered to be poor with only limited number of species, predominatly ones like water hyacinth and water reeds which grow under nutrient rich swampy conditions.

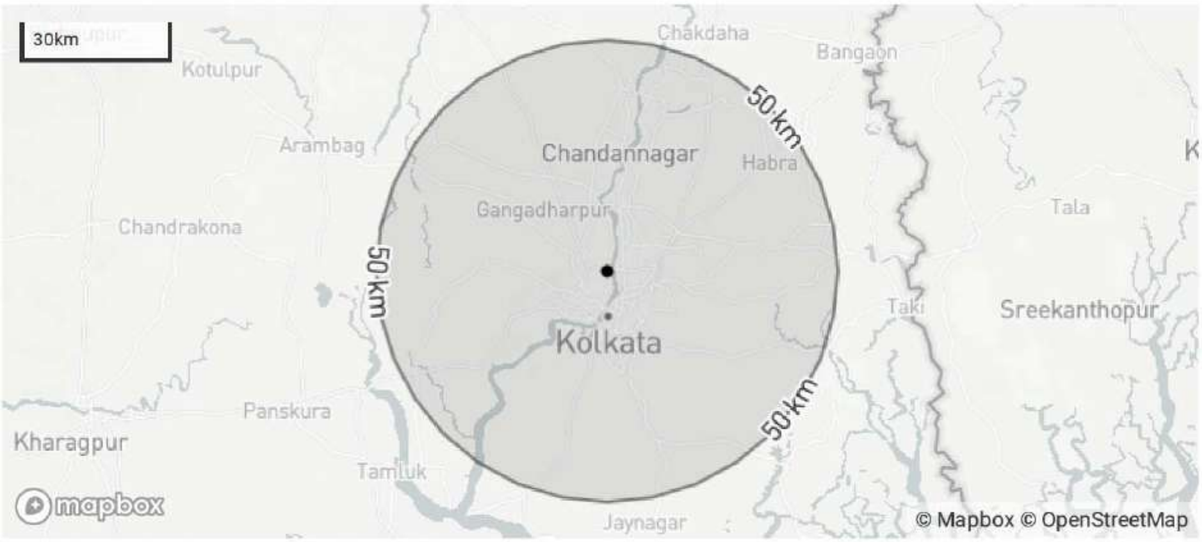
4.3.1.3 Legally Protected Areas for Terrestrial and Aquatic Ecosystem

There are no legally Protected Areas like Wildlife Sanctuary, National Park, Tiger Reserve, etc. in the study area (1.0 km around the STP) as well as within 10km radial area around the proposed STP.

4.3.1.4 IBAT Assessment

A basic risk screening on biodiversity related sensitivity was undertaken utilising the Integrated Biodiversity Assessment Tool (IBAT), that draws together information on globally recognised biodiversity information drawn from a number of IUCN's Knowledge Products: IUCN Red List of Threatened Species, Key Biodiversity Areas (priority sites for conservation) and Protected Planet/The World Database on Protected Areas (covering nationally and internationally recognised sites, including IUCN management categories I–VI. The proximity analysis identified two protected areas within 50 kms radius from the site – East Kolkata Wetlands, a Ramsar site and Chintamani Kar Bird Sanctuary, Narendrapur. No key biodiversity areas (KBAs) was found to be resent within 50 kms radius of the STP site.

[32] West Bengal Disaster Managemnet Plan for Howrah district- 2018



Displaying project location and buffers: 50.0 km

4.3.2 Terrestrial Ecosystem

4.3.2.1 Flora

4.3.4.1.1 Project Site

The existing Arupara STP has green cover (native varieties of mature trees, shrubs) in the vacant land. The proposed facility will be constructed in the sludge drying bed. Ecological survey was carried out in 1st week of September 2019. During site visit, it was observed that sludge drying beds were waterlogged. The entire sludge beds were covered with elephant grass)Pennisetum purpureum(. Only 2-3 mature)Ficus rumphii and Phoenix dactylifera(was recorded.

The vegetation was recorded in the internal road and open area of the STP. The predominant tree species recorded during site visit were Lagerstroemia speciose, Eucalyptus spp., Leucaena leucocephala, Caryota urens, Trema orientalis, Putranjiva roxburghii, Moringa oleifera, Ficus racemose, Swietenia macrophylla, Dalbergia sissoo, Bombax ceiba, Polyalthia longifolia, Azadirachta indica, Albizia lebbeck, Ficus benghalensis, Ficus religiosa, Magnolia champaca, Delonix regia, Peltophorum pterocarpum, Swietenia macrophylla, Phoenix dactylifera, Cocos nucifera, Lagerstroemia speciose, Terminalia cattapa, Tamarindus indica, etc. The shrubs and herbs species recorded during site visit were Caesalpinia pulcherrima, Calotropis procera, Amaranthus spinosus, Boerhavia repens, Cassia sophera, Cassia tora, Ervatamia divaricate, Jatropha curcas, Hibiscus rosa-sinensis, Tabernaemontana divaricate, Pennisetum purpureum etc.

Figure 4.30 Site Vegetation Photographs

Existing Sludge bed (proposed project site)

Existing Sludge bed (proposed project site)

Vegetation at STP site

Vegetation at STP site

Vegetation at STP site

Vegetation at STP site

4.3.4.1.2 Study Area

The major habitats in the study area are homestead land vegetation, riparian vegetation, road and railway side plantation. Habitat wise pre-dominant vegetation are as follows:

- ***Homestead land vegetation:*** In the homestead land vegetation associated with settlements include tree species like mango (*Mangifera indica*), jackfruit (*Artocarpus heterophyllus*), coconut (*Cocos nucifera*), neem (*Azadirachta indica*), Indian Palm (*Borassus flabellifer)*, siris (*Albizia lebbeck),* date Palm (*Phoenix sylvestris*), guava (*Psidium guajava*), sajina (*Moringa oleifera*), tamarind (*Tamarindus indica*), arjun (*Terminalia arjuna),* chhatim (*Alstonia scholaris*)*,* jam (*Syzigium cumini*)*,* radhachura (*Peltophorum pterocarpum*)*,* simul (*Bombax ceiba*)*,* sisoo (*Dalbergia sisoo*)*,* rain Tree (*Samanea saman*), debdaru (*Polyalthia longifolia*), Bel (*Aegle marmelos*) Ata (*Annona squamosa*), Jam (*Syzygium cumini)* Kul (*Zizyphus mauritiana*), Teak (*Tectona grandis)* etc. The shrubs and herbs includes *Desmodium gangeticum, Ervatamia divaricate, Gardenia jasminoides, Gossypium herbaceum, Hibiscus rosa-sinensis, Ixora coccinea, Jasminum multiflorum, Jatropha curcas, Musa paradisiaca*, etc.
- ***Riparian Vegetation***: The banks of canals and surface waterbodies within the study area have some riparian vegetation. The dominant species of riparian vegetation are *Alstonia scholaris, Syzygium cumini, Cocos nucifera, Trema orientalis, Casuarina equisetifolia*, *Bombax ceiba* etc.

- ***Road and Railway side vegetation***: The plantation was also recorded besides the road and railway side as well as railway yard. Major tree species are *Acacia Arabica, Acacia auriculiformis, Albizia lebbeck, Albizia procera, Alstonia scholaris, Annona squamosal, Anthocephalus chinensis, Azadirachta indica, Bauhinia racemose, Bombax ceiba, Borassus flabellifer, Cassia siamea, Dalbergia sissoo, Delonia regia, Eucalyptus globosus, Ficus benghalensis, Ficus racemose, Ficus religiosa, Lagerstroemia speciose, Leucaena leucocephala, Mangifera indica, Mimus opselengi, Moringa oleifera, Peltophorum pterocarpum, Phoenix sylvestris, Polyalthia longifolia, Pongamia glabra, Sesbania grandiflora, Samanea saman, Spathodea campanulata, Spondias mangifera, Swietenia mahagoni, Syzygium cumini, Tamarindus indica, Tectona grandis, Terminalia arjuna, Trema orientalis*. The shrubs and herbs are *Adhatoda vasica, Caesalpinia pulcherrima, Calotropis procera, Cassia tora, Caesalpinia bonduc, Datura metel, Desmodium gangeticum, Jatropha curcas, Lantana camara, Ricinus communis, Thevetia peruviana, Vitex negundo*, etc.

Figure 4.31 Photographs of Vegetation in the Study Area

Vegetation in Homestead Land

Vegetation in in open area and canal side

Riparian vegetation around pond

Riparian vegetation besides canal

Homestead land Vegetation

Road side vegetation

Homestead land Vegetation

Homestead land Vegetation

4.3.2.2 Fauna

There is no natural forests in the entire study area. The diversity of fauna (native population of mammals, birds, reptiles and amphibian) species recorded in the modified habitat was low. The species recorded and reported in the study area has been presented in ***Table 4.15***.

Table 4.15: Faunal Species Recorded/ Reported in Study Area

S. No.	Common Name	Scientific Name	Wildlife Schedule[33]	IUCN Status (2017-3)
A.	**Mammals**			
1.	Lesser Bandicoot Rat	*Bandicota bengalensis*	V	LC
2.	Five Stripped Palm Squirrel	*Funambulus pennatti*	-	LC
3.	Little Indian Field Mouse	*Mus booduga*	V	LC
4.	House Mouse	*Mus musculus*	V	LC
5.	Indian Flying Fox	*Pteropus giganteus*	V	LC
6.	Small Indian Civet	*Viverricula indica*	II	LC
7.	Common Palm Civet	*Paradoxurus hermaphroditus*	II	LC
8.	Golden Jackal	*Canis aureus*	II	LC
9.	Indian Grey Mongoose	*Herpestes edwardsii*	II	LC
10.		*Pipistrellus coromandra*		
B.	**Avi-fauna**			
11.	Jungle Myna	*Acridotheres fuscus*	IV	NT
12.	Common Myna	*Acridotheres tristis*	IV	LC
13.	Common Kingfisher	*Alcedo atthis*	IV	LC
14.	White-breasted Kingfisher	*Halcyon smyrnensis*	IV	LC
15.	White-breasted Waterhen	*Amaurornis phoenicurus*	IV	LC
16.	Asian Openbill Stork	*Anastomus oscitans*	IV	LC
17.	Indian Pond Heron	*Ardeola grayii*	IV	LC
18.	Spotted Owlet	*Athene brama*	IV	LC

[33] A number of wild animal and bird species have been listed in various schedules of the Indian Wildlife (Protection) Act, 1972. Similarly, these species are also categorized under IUCN Red List, CITES and Convention on Migratory Species (CMS). This database provides information on categorization of species under these legal instruments. (http://wiienvis.nic.in/Database/ScheduleSpeciesDatabase_7969.aspx)

S. No.	Common Name	Scientific Name	Wildlife Schedule[33]	IUCN Status (2017-3)
19.	Cattle Egret	*Bubulcus ibis*	IV	LC
20.	Purple Sunbird	*Cinnyris asiaticus*	IV	LC
21.	Common Pigeon	*Columba livia*	IV	LC
22.	Oriental Magpie-Robin	*Copsychus saularis*	IV	LC
23.	House Crow	*Corvus splendens*	IV	LC
24.	Asian Palm Swift	*Cypsiurus balasiensis*	IV	LC
25.	Black Drongo	*Dicrurus macrocercus*	IV	LC
26.	Little Egret	*Egretta garzetta*	IV	LC
27.	Intermediate Egret	*Egretta intermedia*	IV	LC
28.	Asian Koel	*Eudynamys scolopacea*	IV	LC
29.	Coppersmith Barbet	*Megalaima haemacephala*	IV	LC
30.	Green Bee eater	*Merops orientalis*	IV	LC
31.	Black Kite	*Milvus migrans*	I	LC
32.	Common Tailorbird	*Orthotomus sutorius*	IV	LC
33.	House Sparrow	*Passer domesticus*	IV	LC
34.	Little Cormorant	*Phalacrocorax niger*	IV	LC
35.	Baya Weaver	*Ploceus philippinus*	IV	LC
36.	Rose-ringed Parakeet	*Psittacula krameri*	IV	LC
37.	Red-vented Bulbul	*Pycnonotus cafer*	IV	LC
38.	Red wattled Lapwing	*Vanellus indicus*	IV	LC
39.	Pied kingfisher	*Ceryle rudis*	IV	LC
C.	**Reptiles**			
40.	Common garden lizard	*Calotes versicolor*	-	LC
41.	House gecko	*Hemidactylus flaviviridis*	-	LC
42.	Common Skink	*Mabuya carinata*	IV	LC
43.	Common Rat snake	*Ptyas mucosus*	II	LC
44.	Buff striped keelback	*Amphiesma stolatum*		LC
45.	Checkered keelback	*Fowlea piscator*		LC
46.	Bengal monitor	*Varanus bengalensis*		LC
D.	**Amphibians**			
47.	Common Indian Toad	*Duttophrynus melanostictus*	IV	LC
48.	Indian Bull Frog	*Hoplobatrachus tigerinus*	IV	LC

4.3.3 Aquatic Ecosystem

4.3.3.1 Aquatic Vegetation

Aquatic macrophytes are mainly recorded in the surface waterbodies and marshy land in the study area. Major species recorded in these habitats were *Ipomea aquatica, Ipomoea carnea, Alternanthera* *sessilis, Enhydra fluctuens, Typha angustifolia, Lemna perpusilla, Phragmites karka, Pistia stratiotes, Typha angustifolia, Wolffia arrhizal,* etc.

4.3.3.2 Aquatic Fauna

4.3.5.2.1 Fishes

The canal system in the study area are mostly used for discharge of untreated sewage from the urban area and drainage of surface runoff during monsoon season. The canals are not suitable habitat for aquatic fauna, especially for fishes. The fishes are mostly reported from the surface water bodies (ponds) in the study area.

Anguilla bengalensis bengalensis (Ban), *Amblypharyngodon mola* (Morala), *Anabas testudineus* (Koi), *Catla* (Catla), *Channa punctatus* (Lata), *Channa striatus* (Shol), *Cirrhina mrigala* (Mrigel), Clarius batrachus (Magur), *Glossogobius giuris* (Beley), *Heteropneustes fossilis* (Singi), *Hypopthalmicthys molitrix* (Silver carp), *Labeo bata* (Bata), *Labeo calbasu* (Calbaush), *Labeo rohita* (Rui), *Mystus tengara* (Tengra), *Oreochromis mossambicus* (Tilapia), *Oreochromis niloticus* (Nilotica), *Puntius chola* (Puti), *Puntius ticto* (Puti), etc.

4.3.5.2.2 Birds

The aquatic birds were recorded in the study area *Alcedo atthis, Amaurornis phoenicurus, Egretta garzetta, Egretta intermedia, Phalacrocorax Niger, Halcyon smyrnensis, Ceryle rudis, etc.*

4.3.4 Ecological Species of Conservation Importance

The Black Kite (*Milvus migrans*) is only the faunal species is Schedule I species under Indian Wildlife Protestation Act 1972. The other floral and faunal species recorded/ reported from the study area are not protected under Wildlife Protestation Act 1972 or IUCN Red List

4.4 Socio-economic Environment

4.4.1 Approach and Methodology for Socio-economic Study

This section establishes the socio economic baseline of the Project area for the Sewage Treatment Plant (STP) and its linked facilities which are situated in HMC, situated in Howrah Sadar Sub Division of Howrah District, West Bengal**.** This baseline will provide a context for assessing the impacts of the Project on the socio-economic environment of the area where the STP and its linked facilities will be established.

The socio economic baseline has been carried out through collection and analysis of primary data (based on a structured tool and provided as **Appendix E**) as well as secondary data analysis. Over 23 households (HHs) residing in proximity to the STP and its linked facilities in HMC, were surveyed during the month of August, 2019.

4.4.2 Study Area

4.4.2.1 Study Area for Primary Socio-Economic Survey

The study area for the primary socio-economic baseline has been established as one kilometre radius around the Arupara STP. The settlements within the one km radius are located in various wards across Howrah Municipal Corporation (HMC). Since not all wards in HMC are within the one km radius, the ward numbers are not in sequence. Moreover, as per the 1 km radius drawn on the google earth, it is observed that a percentage of the respective ward is within the 1 km circle (refer **Figure.**

4.31). The percentage was calculated based on the google earth map and accordingly the percentage of the population was considered out of the total population given in Census 2011.

For example, in Ward No. 19 of HMC, 90% of the ward area has been considered, therefore the total population representation is 90% of the total population in Ward 19, as per Census 2011.

4.4.2.2 Study Area for Socio-economic Environment of Settlements near STP

A socio- economic baseline has been conducted on the settlements situated within one-kilometre radius of the Arupara STP. Available primary information through site assessments as well as secondary data from the 2011 Census of India reports were analysed to ascertain the socio-economic parameters and trends of the study area. Arupara STP is surrounded by various settlements within the one-kilometre radius, namely Dharsa Panchanantala, Dharsa Kanta Pukur, Old Jagacha, Ramrajatala, Arupara, Hatpukur Para, GIP Colony, Kamardanga, Sitala Tola, Dasnagar, Kalitala, Balitkuri and Surkimill. These identified settlements are located in various wards across HMC. Demographic data from these settlements has been sourced from the 2011 Census of India reports. Since some proportions of the settlements fall outside the defined radius of one- kilometre from the STP, the proportions have been defined accordingly, based on google imagery analysis (Figure 4.32). Therefore, the following percentage of the respective municipal wards have been considered for the baseline study: 10% of the population in Ward 44, 40% of the population in ward 47, 90% of the population in ward 48, 70% of the population in ward 49, and 30% of the population in ward 50 (**Table 4.16**).

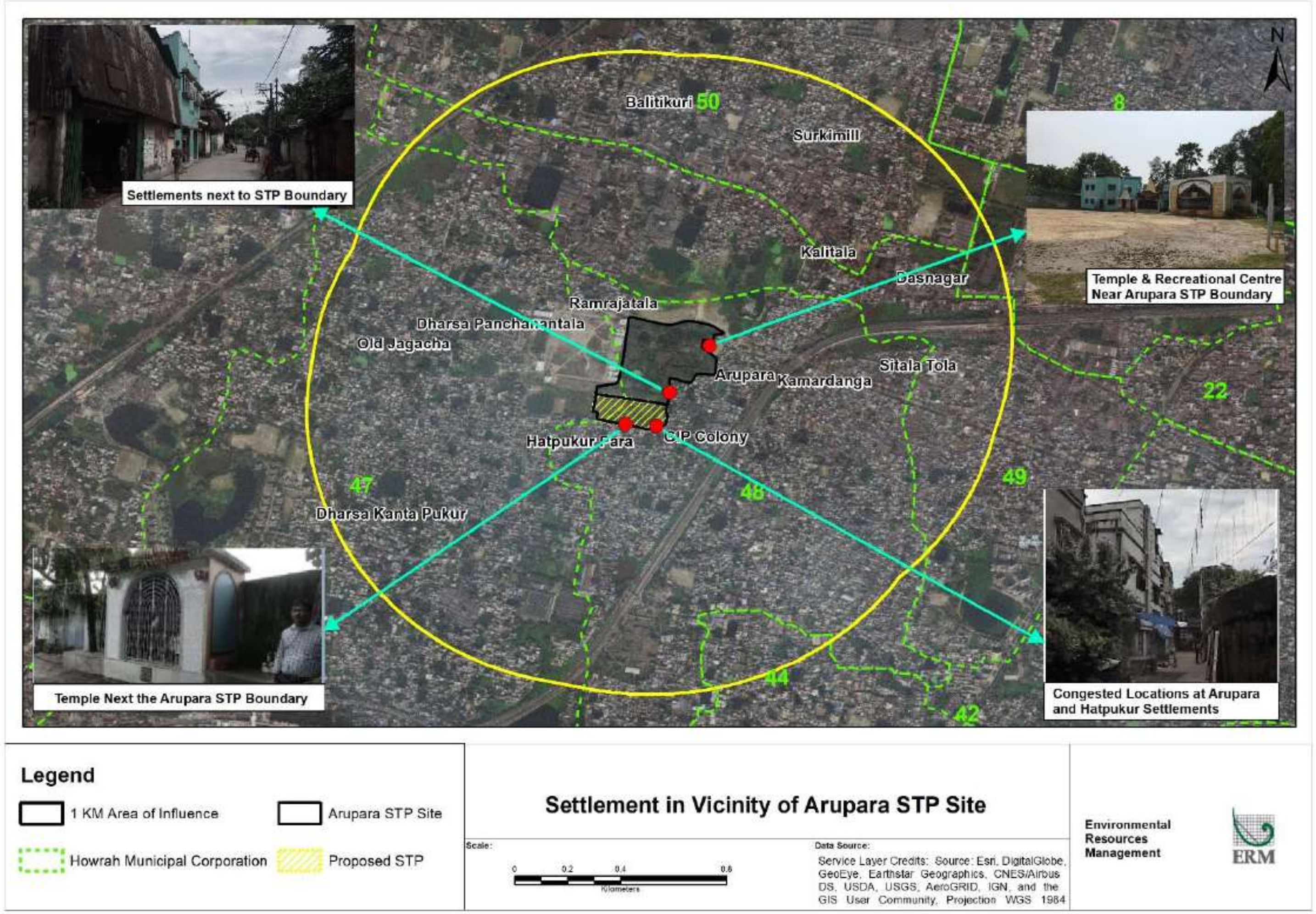
Table 4.16: Settlements and Percentage of Respective Municipal Wards under Baseline Study

Study Location	Municipality	Name of Settlements	Ward Number	% Considered for Baseline Study
Arupara STP Location	Howrah Municipal Corporation		44	10%
		Dharsa Panchanantala Dharsa Kanta Pukur Old Jagacha	47	40%
		Ramrajatala Arupara Hatpukur Para GIP Colony Kamardanga Sitala Tola	48	90%
		Dasnagar Kalitala	49	70%
		Balitkuri Surkimill	50	30%

Source: Census of India 2011

The settlements in the vicinity of the Arupara STP, including the ward information are presented in **Figure 4.32** below.

Figure 4.32 Settlements in Vicinity of Arupara STP Site



4.4.2.3 Study Area for Socio-economic Environment of Population along Sewer Lines

A socio- economic baseline has been conducted on the settlements situated within a 500 metre buffer on each side of the sewer line alignment. Available primary information through site assessments as well as secondary data from the 2011 Census of India reports were analysed to ascertain the socio-economic parameters and trends of the study area. These settlements are located in various wards across Howrah Municipal Corporation. Demographic data from these settlements has been sourced from the 2011 Census of India reports and since some proportion of the settlements fall outside the defined 500 metre buffer from the sewer line alignment, the proportions have been defined accordingly based on google imagery analysis.

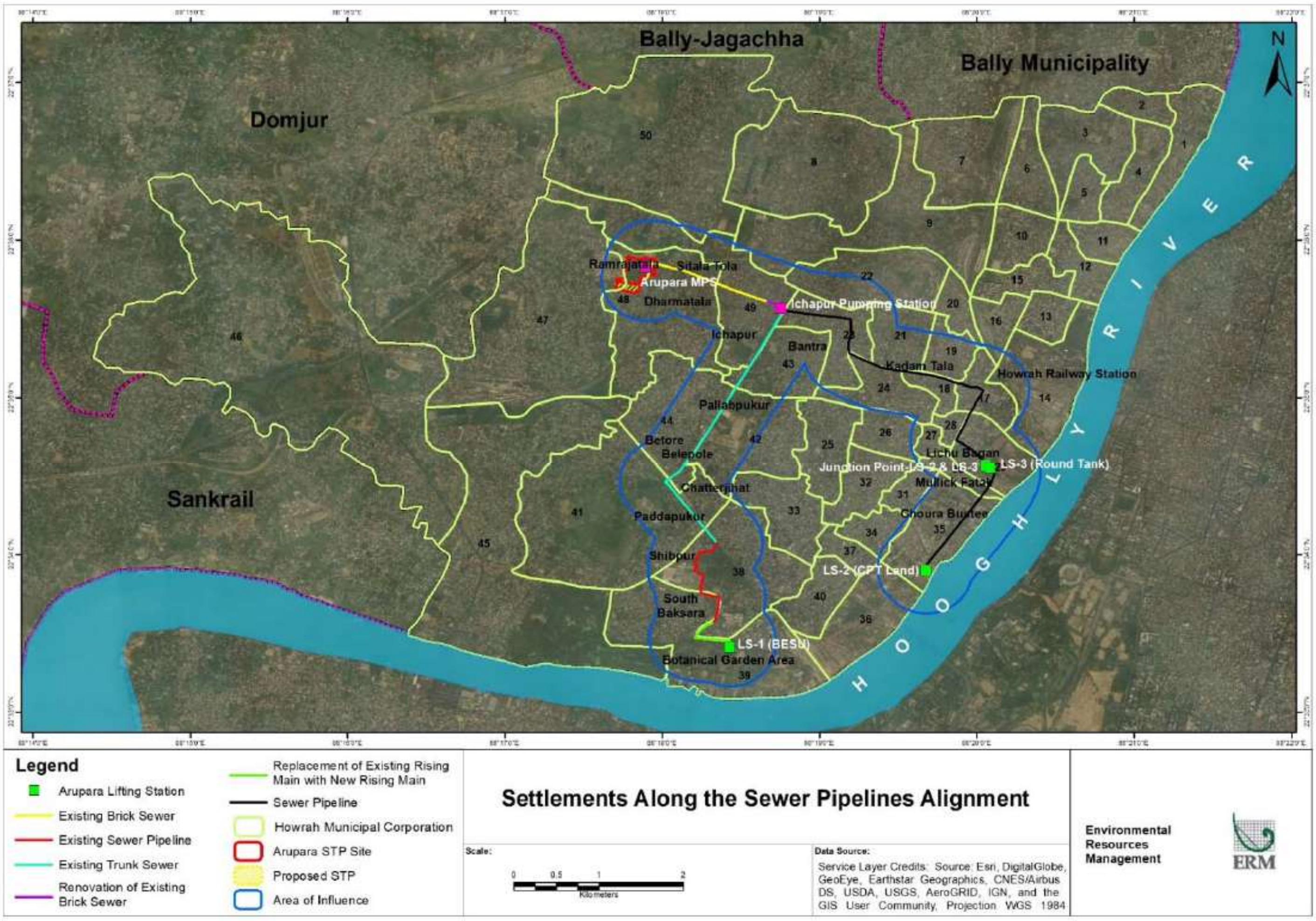
The settlements along the sewer line alignment include ward numbers 17,18,19, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 34, 35, 36, 38, 39, 41, 42, 43, 44, 48 and 49. An analysis of the google earth map **(***Figure 4.33***)** indicates that a proportion of the settlements in the wards are located outside the 500 metre buffer zone, therefore, based on the analysis, proportionate percentages of the respective municipal wards have been considered for the baseline study which have been detailed in Table 4.17 below.

Table 4.17: Settlements and Percentage of Respective Municipal Wards near along Sewer Lines, under Baseline Study

STP Location	Municipality	Ward Number	% Considered for Baseline Study
Arupara	HMC	17	100%
		18	100%
		19	90%
		21	80%
		22	40%
		23	100%
		24	95%
		26	5%
		27	100%
		28	100%
		29	100%
		30	100%
		31	5%
		34	10%
		35	100%
		36	20%
		38	70%
		39	60%
		41	30%
		42	40%
		43	80%
		44	60%

STP Location	Municipality	Ward Number	% Considered for Baseline Study
		48	50%
		49	80%

Figure 4.33 Settlements along Sewer Lines



4.4.3 Administrative Structure

The Arupara STP and its linked facilities are dedicated for the sewerage system of HMC. Therefore HMC area has been considering for broad level contextual setting for the baseline conditions, including ward level data for analysis of the baseline conditions within the one kilometre radius of the STP facility.

4.4.3.1 Howrah District

Howrah district covers a total area of 1467 sq. km. The northern part of the district shares a boundary with Hooghly district, the eastern boundary is shared with the Hooghly River, North 24 Parganas and South 24 Parganas districts, the southern boundary is shared with Purba Medinipur district and the western boundary is shared with Paschim Medinapur District. The district consists of two sub-divisions i.e. Haora Sadar sub-division and Uluberia sub division. It has 14 Community Development blocks, one Municipal Corporation i.e. the Howrah Municipal Corporation and Uluberia Municipality. The district has a total of 650 villages and 138 census towns.

4.4.3.2 Howrah Municipal Corporation

HMC was established in 1862 and became a municipal corporation in 1984, through the Howrah Municipal Corporation Act of 1980. HMC is situated in Howrah Sadar Sub Division of Howrah District, West Bengal. Additionally, it is important to note that during the years 1882-83, a portion of HMC was separated and formed into Bally Municipality. However, since 2015, Bally Municipality has merged again with HMC. HMC area is divided into 50 wards which are distributed across 7 Boroughs and is bound by Bally Jagacha Block towards the north, Domjur Block towards the west, Sankrail Block towards the south-west, and the Hooghly River towards the east and south-east. Howrah is close to Kolkata city and is also in the jurisdiction of Kolkata Metropolitan Development Authority (KMDA). Howrah has over 300 kms in road length and has both open and closed drains. Historically, Howrah had many jute mills and now it is home to many steel and aluminium industries.

4.4.4 Demographic Profile of the Study Area

4.4.4.1 Howrah District

As per the 2011 Census of India, the total population of Howrah district is 4,850,029 comprising of 1,061,336 households (**Table 4.18**). Out of the total population, 2,500,819 are men and 2,349,210 are women. The total number of Schedule Caste (SC) population is 718,951, with 367,053 men and 351,898 women. The total number of Schedule Tribe (ST) population however is 15,094 with 7,761 men and 7,333 women. Moreover, as per the 2011 Census of India, the average annual growth of the population in the HMC was 0.69% as the population was 1,007,532 in 2001 and increased to 1,077,075 in 2011.

Table 4.18: Population Trends of Howrah District

Index	2011	2001
Total Households	1,061,336	838,520
Total Population	4,850,029	4,273,099
Population Density Per Sq. K.M	3,306	2,913
Sex Ratio	939	906
Average Annual Increase	1.35%	1.46%
Average Household (HH) size	4.6	5.1

Source: Census of India 2011

4.4.4.2 Howrah Municipal Corporation

As per the 2011 Census of India, Howrah Municipal Corporation has a total population of 1,077,075 individuals residing in 244,135 households and constitutes approximately 22.2 percent of the total population of Howrah district (**Table 4.19**). Out of the total population, men constitute 561220 while women constitute 515,855. The population density of the municipality is 20,817 individuals per sq. km, which is much higher than the district average i.e. 3,306 individuals per square kilometre.

Table 4.19: Population Trends of Howrah Municipal Corporation

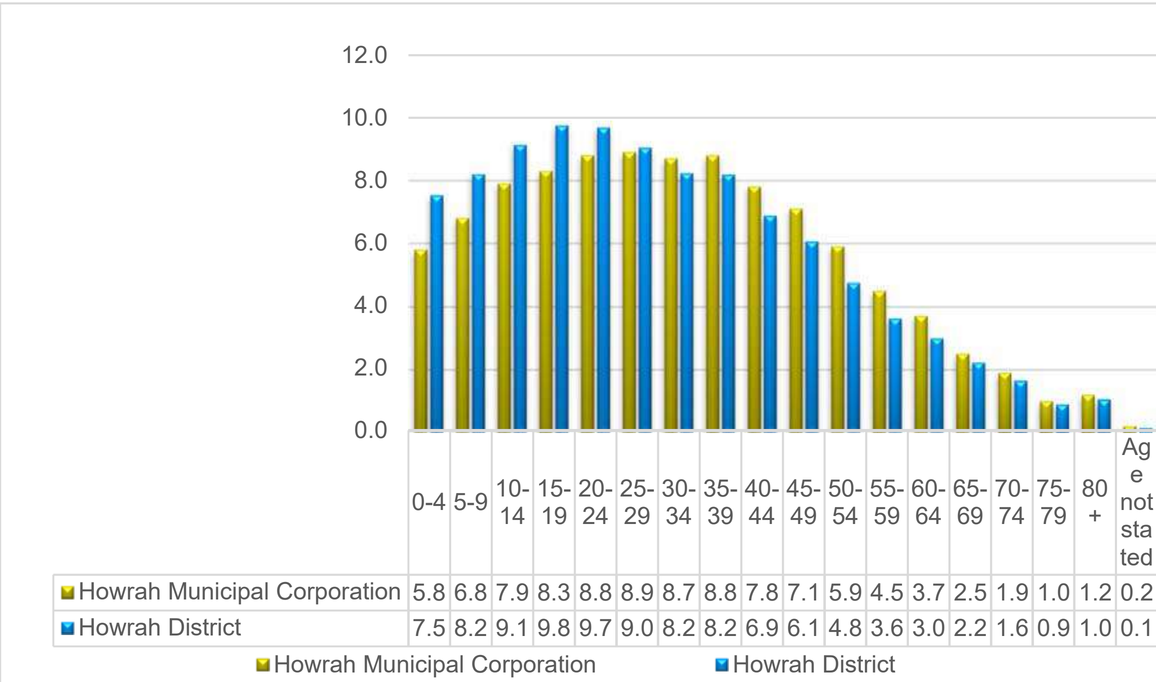
Index	2011	2001
Total Households	244,135	211,441
Total Population	1,077,075	1,007,532

Index	2011	2001
Population Density Per Sq. K.M	20,817	19,473
Sex Ratio	919	842
Average Annual Increase	0.69%	0.6%
Average Household (HH) size	4.4	4.8

Source: Census of India 2011

The figure below (**Figure 4.34**) presents the age wise distribution among the population in Howrah Municipal Corporation as well as the Howrah district. At the Howrah Municipal Corporation, it is observed that the age category with the highest population is 25-29 at 8.9%. At the district level however, the age category with the highest population is 20-24 at 9.6% and 15-19 at 9.8%.

Figure 4.34 Age Wise Distribution of Population in Howrah Municipal Corporation & Howrah District



Source: Census of India 2011

4.4.4.3 Demographic Profile of Settlements near STP

Presented below (**Table 4.20**) is the demographic profile of the municipal wards and settlements within the one kilometre radius of the STP as per the 2011 Census of India. An analysis of the data indicates that there are approximately 18,777 HHs and a population of 77,763 persons, collectively, within the defined radius of one km from the Arupara STP. Out of 77,763 persons, 51% (39,430) are male, and 49% (38,333) are female and the average HH size is 4.1.

It is observed that ward number 48 has the highest population density with 25,594 inhabitants residing in 6,269 HHs, followed by ward number 50 with 17,748 inhabitants and 4,208 HHs. Ward number 47 has 16,353 inhabitants residing in 3,895 HHs. Ward number 49 has 15,973 inhabitants residing in 3846 HHs. Ward 44 only has 2,095 inhabitants residing in 559 HHs.

Table 4.20: Demographic Data of Settlements around Arupara STP based on Percentage of Respective Municipal Wards Considered under Study Area

Municipality	Settlements / Paras	Ward No	Total HHs	Total Population	Average HH Size	Male	%	Female	%
Howrah Municipal Corporation		44	559	2,095	3.7	1,043	50	1,052	50
	Dharsa Panchanantala Dharsa Kanta Pukur Old Jagacha	47	3,895	16,353	4.2	8,303	51	8,050	49
	Ramrajatala Arupara Hatpukur Para GIP Colony Kamardanga Sitala Tola	48	6,269	25,594	4.1	12,877	50	12,717	50
	Dasnagar Kalitala	49	3,846	15,973	4.2	8,128	51	7,845	49
	Balitkuri Surkimill	50	4,208	17,748	4.2	9,079	51	8,669	49
Total			**18,777**	**77,763**	**4.1**	**39,430**	**51**	**38,333**	**49**

Source: Census of India 2011

4.4.4.4 Demographic Profile of Settlements along Sewer Lines

Demographic profile of the municipal wards and settlements within the 500 metre buffer of the sewer line alignment, as per the 2011 Census of India is presented under Table 4.21 below. An analysis of the percentage of the ward area considered under the study area and proportionally the percentage population of the respective municipal wards, indicates that there are approximately 65,628 HHs and a population of 280,628 persons, collectively, within the defined buffer zone. Out of 280,628 persons, 52% (145,525) are male, and 48% (135,103) are female and the average HH size is 4.3. It is observed that ward number 29 of HMC has the highest population density with 23,233 persons, followed by ward number 39 followed by 19,873 persons.

Table 4.21: Demographic Data of Settlements along Sewer Lines based on Percentage of Respective Municipal Wards Considered under Study Area

Municipality	Ward No	Total HHs	Total Population	Average HH Size	Male	%	Female	%
HMC	17	2376	11028	4.6	5906	54	5122	46
	18	2812	11766	4.2	6111	52	5655	48

Municipality	Ward No	Total HHs	Total Population	Average HH Size	Male	%	Female	%
	19	3308	16424	5.0	8503	52	7921	48
	21	2217	9028	4.1	4566	51	4462	49
	22	1559	6749	4.3	3476	52	3273	48
	23	3888	15529	4.0	7796	50	7733	50
	24	2972	12331	4.1	6190	50	6141	50
	26	195	788	4.0	388	49	399	51
	27	3109	14260	4.6	7389	52	6871	48
	28	2155	9047	4.2	4589	51	4458	49
	29	4937	23233	4.7	12828	55	10405	45
	30	4117	18859	4.6	10248	54	8611	46
	31	174	871	5.0	466	54	405	46
	34	297	1268	4.3	642	51	626	49
	35	2452	11341	4.6	6433	57	4908	43
	36	1307	7059	5.4	3743	53	3316	47
	38	3081	12431	4.0	6332	51	6099	49
	39	5014	19873	4.0	10173	51	9700	49
	41	2801	11598	4.1	5888	51	5710	49
	42	1852	7338	4.0	3697	50	3641	50
	43	3772	14762	3.9	7461	51	7302	49
	44	3355	12571	3.7	6256	50	6314	50
	48	3483	14219	4.1	7154	50	7065	50
	49	4395	18255	4.2	9290	51	8966	49
Total		**65628**	**280628**	**4.3**	**145525**	**52**	**135103**	**48**

Source: Census of India 2011

4.4.5 Literacy Profile

4.4.5.1 Howrah District

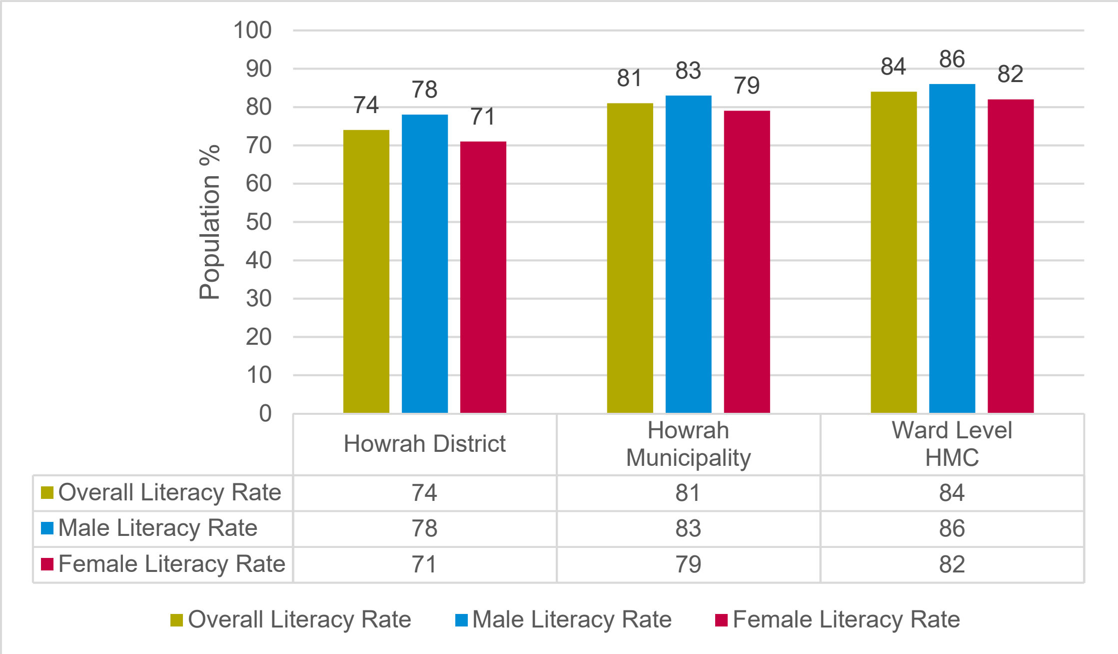
As per the 2011 Census of India, the overall literacy rate of Howrah District is 81% with a male literacy rate of 83% and a female literacy rate of 79%. The male literacy rate is thus higher than the female literacy rate (**Figure 4.35**).

Out of the total literate population at the district level i.e. 3,605,206 numbers, 4% (157,077 numbers) are literate without any education level, 23% (827,106 numbers) have below primary level education and 25% (898,201 numbers) have completed their primary education. Over 19% (688,347 numbers) have completed their middle level education, 10% (348,989 numbers) have completed secondary education and 10% (352,120 numbers) have completed their higher secondary education. Over 0.3% (10160 numbers) have completed technical education and 9% (312,823 numbers) are graduates. Approximately 0.3% (10,403) have an education level that has not been classified (**Table 4.22**).

4.4.5.2 Howrah Municipal Corporation (HMC)

As per the 2011 Census of India, the overall literacy rate of Howrah Municipal Corporation is 81% and it is higher than Howrah district's literacy rate of 74%. Moreover, the literacy rate of men is higher than the literacy rate of women at both the district and municipal level. The literacy rate of men in Howrah Municipal Corporation is 83% while the literacy rate of women is 79 %. The literacy rate of men in Howrah District is 78% while the literacy rate of women is 71% (**Figure 4.35)**.

Figure 4.35 Literacy Profile of Population in Howrah District and Howrah Municipal Corporation



Source: Census of India 2011

Table 4.22: Education Level at Howrah District and Howrah Municipal Corporation

Location	Literate w/o education level		Below Primary		Primary		Middle		Secondary		Higher Secondary		Technical/ Diploma		Graduate		Not Classified	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Howrah District	157077	4	8,27,106	23	8,98,201	25	6,88,347	19	3,48,989	10	3,52,120	10	10,160	0	3,12,823	9	10,403	0
HMC	31216	4	113084	13	1,54,457	18	164427	19	129553	15	122782	14	5178	1	151490	17	2304	0

Source*:* Census of India 2011

4.4.5.3 Literacy Profile of Settlements in Near STP Area

This section presents the literacy profile of the settlements and the municipal wards within the one kilometre radius of the STP; it is observed that the average literacy rate of the settlement and wards within the one km radius is 84% (65,237 numbers). The overall male literacy rate is 86% (33,807 numbers) and the overall female literacy rate is 82% (31,430 numbers).

Ward number 44 and 48 both have the highest literacy rate at 88% while ward number 49 and 50 both have the lowest literacy rate i.e. 81%. (**Table 4.23**).

Comparative analysis of the literacy rates at the district, municipal and ward level reveal that the ward level overall literacy rate i.e. 84% is much higher than the district level which is 74%, and the municipal level which is 81%. The literacy rate for women is lower than the men's literacy rate at the district level, the municipal level and the ward level.

Table 4.23: Literacy Profile of Settlements

Municipality	Settlements/ Paras	Ward No.	Total Population	Total Male Population	Total Female Population	Literate Population	Male Literate Population	Female Literate Population	Total Literacy Rate %	Male Literacy Rate %	Female Literacy Rate %
Howrah Municipal Corporation	Dharsa	44	2095	1,043	1,052	1,846	927	919	88	89	87
	Panchanantala	47	16,353	8,303	8,050	1,3669	7088	6581	84	85	82
	Dharsa Kanta Pukur	48	25,594	12,877	12,717	2,2420	11493	10927	88	89	86
	Old Jagacha	49	15,973	8,128	7,845	1,2879	6708	6171	81	83	79
	Ramrajatala	50	17,748	9,079	8,669	14,423	7592	6832	81	84	79
Total			**77,763**	**39,430**	**38,333**	**65,237**	**33807**	**31,430**	**84**	**86**	**82**

Source: Census of India 2011

4.4.5.1 Literacy Profile of Settlements along Sewer Lines

This section presents the literacy profile of the settlements and the municipal wards within the 500 metre buffer on each side of the sewer line alignment. It is observed that the average literacy rate of the settlement and wards within the defined buffer zone is 89.7% (232,565 numbers), the male and female literacy rate is 92.2% (123,929 numbers) and 87.1% (108,636 numbers) respectively. Ward number 21 and 28 have the highest literacy rate within the buffer zone at 95.3% and 94.9% respectively. However, wards number 35 and 19 have the lowest literacy at 71.5% and 82.1% respectively. (Table 4.24)

It is thus observed that the overall literacy rate of the settlements along the sewer lines i.e. 89.7% are higher than the average of the settlements within the 1 km radius i.e 84%.

Table 4.24: Literacy Profile of Settlements along Sewer Lines

Municipality	Ward No.	No. of HHs.	Total Population	Total Male Population	Total Female Population	Literate Population	Male Literate Population	Female Literate Population	Total Literacy Rate %	Male Literacy Rate %	Female Literacy Rate %
HMC	17	2376	11028	5906	5122	9071	5074	3997	90.0	93.9	85.6
	18	2812	11766	6111	5655	10383	5507	4876	94.4	96.6	92.0
	19	3308	16424	8503	7921	12236	6566	5670	82.1	85.0	78.9
	21	2217	9028	4566	4462	8055	4160	3895	94.9	96.8	92.9
	22	1559	6749	3476	3273	5579	2987	2592	89.5	92.9	85.9
	23	3888	15529	7796	7733	13781	7033	6748	93.9	95.5	92.4
	24	2972	12331	6190	6141	10725	5524	5200	92.9	95.6	90.2
	26	195	788	388	399	686	345	341	92.6	94.8	90.4
	27	3109	14260	7389	6871	12019	6405	5614	91.4	94.3	88.2
	28	2155	9047	4589	4458	8054	4113	3941	95.3	96.3	94.1
	29	4937	23233	12828	10405	18560	10668	7892	87.2	90.4	83.2
	30	4117	18859	10248	8611	14664	8385	6279	85.1	89.2	80.2
	31	174	871	466	405	655	364	291	82.8	85.7	79.5
	34	297	1268	642	626	1109	575	535	92.8	94.8	90.7
	35	2452	11341	6433	4908	7190	4408	2782	71.5	76.4	65.0
	36	1307	7059	3743	3316	5423	2991	2432	85.9	89.1	82.2
	38	3081	12431	6332	6099	10572	5522	5051	91.5	93.9	88.9
	39	5014	19873	10173	9700	16368	8614	7754	89.4	91.7	87.1
	41	2801	11598	5888	5710	9603	5025	4577	90.3	93.0	87.4
	42	1852	7338	3697	3641	6544	3345	3199	94.8	96.0	93.5
	43	3772	14762	7461	7302	13038	6706	6332	93.7	95.7	91.8
	44	3355	12571	6256	6314	11075	5561	5515	93.7	94.8	92.6
	48	3483	14219	7154	7065	12456	6385	6071	94.1	95.9	92.3
	49	4395	18255	9290	8966	14718	7666	7052	88.3	90.4	86.2
	Total	**65,626**	**280,627**	**145,525**	**135,103**	**232,565**	**123,929**	**108,636**	**89.7**	**92.2**	**87.1**

Source: Census of India 2011

4.4.6 Religious Composition

4.4.6.1 Howrah District

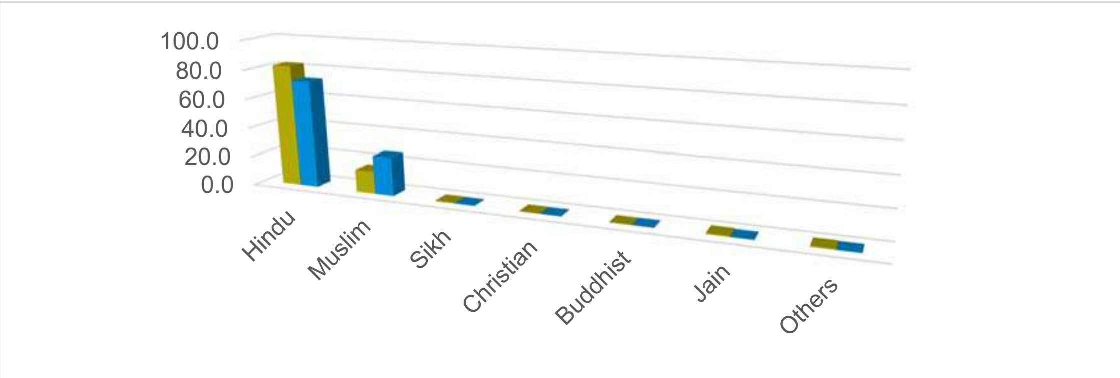
In Howrah district however, 72.9% (3,535,844 numbers) are Hindus, 26.2% (1,270,641 numbers) are Muslims, 0.18% (8,666 numbers) are Christian, 0.09% (4,380 numbers) are Sikh, 0.03% (1,258 numbers) are Buddhist, 0.2% (9,699 numbers) are Jain and 0.4% (19541 numbers) are listed as others.

4.4.6.2 Howrah Municipal Corporation (HMC)

As per the 2011 Census of India, the total Schedule Caste (SC) population in Howrah Municipal Corporation is 35,025 with 18,289 being men and 16,736 being women. The total Scheduled Tribe (ST) population is 3,339 with 1,735 being men and 1,604 being women.

With regard to the religious composition in Howrah Municipal Corporation, 82.72% (890,984 numbers) of the population are Hindus, 15.25% (164,261 numbers) are Muslims, 0.34% (3,636 numbers) are Sikhs, 0.19% (2,057 numbers) are Christian, 0.04% (434 numbers) are Buddhists, 0.75% (8124 numbers) are Jain, while 0.70% (7,579 numbers) are listed as others (**Figure 4.36**).

Figure 4.36 Religious Composition



	Hindu	Muslim	Sikh	Christian	Buddhist	Jain	Others
Howrah Municipality	82.7	15.3	0.3	0.2	0.0	0.8	0.7
Howrah District	72.9	26.2	0.2	0.1	0.0	0.2	0.4

Source*:* Census of India 2011

4.4.7 Employment and Occupational Profile in the Study Area

4.4.7.1 Howrah District

As per the 2011 Census of India reports, main workers account for 31% (1,496,267 numbers) of the total population at Howrah District, where men comprise 87% (1,304,435 numbers) and women comprise 13% (191,832 numbers). Marginal workers account for 7% (193,735 numbers) of the total district population, with 60% (193,735 numbers) men and 40% (129,843 numbers) women. Non-workers however account for 62% (3,030,184 numbers) of the total district population thereby constituting a majority, with 33% (1,002,649 numbers) men and 67% (2,027,535 numbers) women (Table 4.25).

Table 4.25: Employment in Howrah District

Type of Workers	Total	%	Men	%	Women	%
Main Workers	1,496,267	31	1,304,435	87	191,832	13
Marginal Workers	323,578	7	193,735	60	129,843	40
Non Workers	3,030,184	62	1,002,649	33	2,027,535	67
Total	**4,850,029**		**2,500,819**		**2,349,210**	

Source*:* Census of India 2011

Moreover, out of 1,819,845 workers at Howrah District, 8% (80,575 numbers) are cultivators out of which 3.9% (71,163 numbers) are men and 1.2% (9,412 numbers) are women. Moreover, 10% (181,662 numbers) are agricultural labourers, with 8.8% (160,530 numbers) men and 1.2% (21,132 numbers) women. 16% (297,774 numbers) are engaged in household industries, with 10.9% (198,995 numbers) men and 5.4% (98,779 numbers) women. Additionally, over 69.2% (1,259,834 numbers) are engaged in other activities, with 58.7% (1,067,482 numbers) men and 10.6% (192,352 numbers) women. Since Howrah District mainly comprises of urban settlements, majority of the population are therefore engaged in commercial activities as well as the service sector for their source of income. Additionally, very few women are engaged in the workforce (**Table 4.26**).

Table 4.26: Sector Wise Employment in Howrah District

Type of Workers	Total	%	Men	%	Women	%
Cultivators	80,575	4.4	71,163	3.9	9,412	0.5
Agricultural Labourers	181,662	10.0	160,530	8.8	21,132	1.2
Household Industries	297,774	16.4	198,995	10.9	98,779	5.4
Other	1,259,834	69.2	1,067,482	58.7	192,352	10.6
Total	**1,819,845**		**1,498,170**		**321,675**	

Source*:* Census of India 2011

4.4.7.2 Howrah Municipal Corporations (HMC)

As per the 2011 Census of India, main workers account for 33.3% (358,922 numbers) of the population in HMC. Out of this, 88% (316,146 numbers) are men and 12% (42,776 numbers) are women. Marginal workers account for 4% (38,126 numbers) of the population, with 54% (20,454 numbers) men and 46% (17,672 numbers) women. The non-workers account for 63% (680,027 numbers) of the population, with 33% (224,620 numbers) men and 67% (455,407 numbers) women. The data thus shows that women account for majority of the non-working population (**Table 4.27**).

Table 4.27: Employment in Howrah Municipal Corporation

Type of Workers	Total	%	Men	%	Women	%
Main Workers	358,922	33	316,146	88	42776	12
Marginal Workers	38,126	4	20,454	54	17,672	46
Non Workers	680,027	63	224,620	33	455,407	67
Total	**1,077,075**		**561,220**		**515,855**	

Source*:* Census of India 2011

It is observed that majority of the population are engaged in activities other than cultivation, agricultural labour and household industries. **Table 4.28** below highlights the population breakdown according to sector of employment as well as well as highlighting the gender-disaggregated data for each sector. Over 15.2% (11,128 numbers) of the population are engaged as cultivators, with 14.5%

(10,615 number) men and 0.7% (513 numbers) women. Over 36% (26,398 numbers) of the population are engaged as agricultural labourers, with 31.8% (23,320 numbers) men and 4.2% (3,078 numbers) women. Around 4.8% (3,512 numbers) of the population are engaged in household industries, with 2.4% (1,736 numbers) men and 2.4% (1,776 numbers) women, thus showing an equal participation of men and women in household industries. Over 44% (32,219 numbers) individuals which constitute a majority of the population, are engaged in other activities, with 37.2% (27,252 numbers) men and 6.8% (4,967 numbers) women. The reason there are fewer individuals engaged in agricultural and household industries is that Howrah city is an urban settlement where most individuals are engaged in the service sector and commercial activities.

Table 4.28: Sector Wise Employment in Howrah Municipal Corporation (HMC)

Type of Workers	Total	%	Men	%	Women	%
Cultivators	11,128	15.2	10,615	14.5	513	0.7
Agricultural Labourers	26,398	36	23,320	31.8	3,078	4.2
Household Industries	3,512	4.8	1,736	2.4	1,776	2.4
Other	32,219	44	27,252	37.2	4,967	6.8
	73,257		**62,923**		**10,334**	**14.1**

Source*:* Census of India 2011

4.4.7.3 Work Participation Ratio at Settlements near STP

This section presents the occupational profile of the settlements in the area. The Work Participation ratio (WPR) is defined as the percentage of total workers including main and marginal workers out of the total population of the study area. Out of the total population of 77,763 persons, approximately 39% (30,045 numbers) are participating in the workforce. Approximately 87% (26,022) are main workers and approximately 13% (4023) are marginal workers. Ward number 27 has the lowest WPR at 37% while all the other wards have a WPR of 39%. As the study area is an urban settlement, the numbers of persons engaged in agricultural and household industries are negligible (Table 4.29).

Table 4.29: Work Participation Ration of Settlements near STP

Municipality	Settlements/ Paras	Ward No	WPR%	Total Population	Total Workers	Main Workers	Main Workers %	Marginal Workers	Marginal Workers %
Howrah Municipal Corporation		44	39	2095	823	712	86	111	14
	Dharsa Panchanantala Dharsa Kanta Pukur Old Jagacha	47	37	16353	6044	5066	84	978	16
	Ramrajatala Arupara Hatpukur Para GIP Colony Kamardanga Sitala Tola	48	39	25594	9941	8694	87	1247	13
	Dasnagar Kalitala	49	39	15973	6243	5517	88	726	12
	Balitkuri Surkimill	50	39	17748	6994	6033	86	960	14
Total			**39**	**77763**	**30045**	**26022**	**87**	**4023**	**13**

Source: Census of India 2011

A comparative analysis of the data reveals that majority of the population at Howrah municipal level as well as the district level, are engaged in non-agricultural activities, which include commercial activities and the service sector. Being urban settlements, there are very few households engaged in cultivation, agricultural labour as well as household industries.

Howrah municipal level has a higher number of main workers (33%) than Howrah District (31%), while Howrah District has a higher number of marginal workers (7%) than the municipal level (4%). There is a higher percentage of non-workers at the district level (62%), than at the municipal level.

At the ward level, over 39% of the population in the settlements near the STP location are participating in the workforce where 87% are main workers and only 13% are marginal workers.

4.4.7.4 Work Participation Ratio at Settlements along Sewer Lines

This section presents the occupational profile of the settlements in the area. The Work Participation ratio (WPR) is defined as the percentage of total workers including main and marginal workers out of the total population of the study area. Out of the total population of 280,627 persons with the defined buffer zone, approximately 36.8% (103,321 numbers) are participating in the workforce. Approximately 91% (93,543 numbers) are main workers and approximately 9% (9,778) are marginal workers. It is observed that ward 41 has the highest WPR at 39.4%, while lowest WPR within the defined radius is at ward 31 at 31.9%. As the study area is an urban settlement, the numbers of persons engaged in agricultural and household industries are negligible (Table 4.30).

Table 4.30: Work Participation Ration of Settlements along Sewer Lines

Municipality	Ward No	WPR%	Total Population	Total Workers	Main Workers	Main Workers %	Marginal Workers	Marginal Workers %
HMC	17	36.4	11028	4015	3747	93.3	268	6.7
	18	37.3	11766	4385	3952	90.1	433	9.9
	19	33.8	16424	5552	5193	93.5	359	6.5
	21	36.2	9028	3270	3182	97.3	89	2.7
	22	37.7	6749	2547	2279	89.5	268	10.5
	23	36.5	15529	5664	5537	97.8	127	2.2
	24	37.3	12331	4604	4405	95.7	199	4.3
	26	35.9	788	283	271	95.6	13	4.4
	27	34.9	14260	4970	4791	96.4	179	3.6
	28	35.9	9047	3247	3172	97.7	75	2.3
	29	34.8	23233	8093	7217	89.2	876	10.8

Municipality	Ward No	WPR%	Total Population	Total Workers	Main Workers	Main Workers %	Marginal Workers	Marginal Workers %
	30	36.7	18859	6920	6008	86.8	912	13.2
	31	31.9	871	278	264	95.0	14	5.0
	34	37.5	1268	475	402	84.6	73	15.4
	35	37.2	11341	4219	3795	90.0	424	10.0
	36	32.1	7059	2263	2020	89.3	243	10.7
	38	38.1	12431	4739	4238	89.4	501	10.6
	39	37.3	19873	7420	6041	81.4	1379	18.6
	41	39.4	11598	4573	3972	86.9	601	13.1
	42	37.4	7338	2746	2515	91.6	231	8.4
	43	37.0	14762	5462	5137	94.1	325	5.9
	44	39.3	12571	4939	4271	86.5	667	13.5
	48	38.8	14219	5523	4830	87.5	693	12.5
	49	39.1	18255	7134	6305	88.4	830	11.6
	Total	**36.8**	**280,627**	**103,321**	**93,543**	**91**	**9,778**	**9**

Source*:* Census of India 2011

4.4.8 Housing, Sanitation & Drinking Water Access

4.4.8.1 Howrah District

As per the 2011 Census of India, over 79.22% (815,217 numbers) HHs in Howrah District are permanent, 17.85% (183,705 numbers) HHs are semi- permanent, 2.59% (26,614 numbers) HHs are temporary structures. Moreover, approximately 12.6% (129,715 numbers) HHs have closed drainage systems, 27.83% (284,404 numbers) HHs have open drainage systems while 59% (616,995 numbers) HHs have no drainage systems.

As per the Census of India 2011, out of 1,029,114 HHs, 28.13% (289,518 numbers) HHs have access to tap water from a treated source, 3.88% (39,955 numbers) have access to tap water from an untreated source, 0.61% (6,266 numbers) HHs have drinking water access from a covered well, while 0.53% (5,450 numbers) HHs have access to uncovered wells. Additionally, 43.35% (466,683 numbers) HHs have access to hand pumps, 21.06% (216,717 numbers) HHs have access to tube wells and/or boreholes, 0.03% (260) HHs have access to springs and 0.04% (423 numbers) HHs have access to rivers and/or canals. Over 0.12% (1,255) HHs have access to tanks, ponds and/or lakes, while 0.25% (2,587) HHs have access to other sources for their drinking water (**Table 4.31**).

4.4.8.2 Howrah Municipal Corporations (HMC)

As per the 2011 Census of India, over 93.5% of the housing structures in Howrah Municipal area are permanent, 5.4% are semi-permanent, 0.5% are temporary, 0.2% are serviceable, 0.3% are non-serviceable structures and 0.6% are not classified. The households in Howrah Municipal Corporation have both open and closed systems of drainage. Moreover, there are 145,000 HHs with septic tanks, 400 while the toilets with flush or pour flush and 1,500 HHs have been listed as others.

Out of 230,520 HHs, 69.9% (161,069 numbers) have drinking water access through taps from a treated source, while 2.8% (6,383 numbers) HHs have access to tap water from an untreated source. 0.9% (2,082 numbers) HHs have access to covered wells while 1.4% (3,331 numbers) HHs have access to un-covered wells. Moreover, 8.7% (19,966 numbers) HHs have access to hand pumps while 15.4% (35,499 numbers) HHs have access to tube wells/ boreholes. Over 0.1% (161 numbers) HHs have access to springs for their drinking water source and over 0.1% (212) HHs have access to rivers and canals for their drinking water sources. Over 0.3% (758 numbers) HHs have access to tanks/ponds and lakes for their drinking water source and 0.5% (1,059 numbers) HHs have access to other sources of drinking water (**Table 4.31**).

Table 4.31: Drinking Water Access

Area Name	Total No of HHs	Tap water from treated source		Tap water from untreated source		Covered well		Un-covered well		Hand pump		Tube well/ Borehole		Spring		River/ Canal		Tank/Pond/Lake		Other sources	
	No	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Howrah District	1,029,114	289,518	28.13	39,955	3.88	6,266	0.61	5,450	0.53	466,683	43.35	216,717	21.06	260	0.03	423	0.04	1,255	0.12	2,587	0.25
Howrah (M)	230520	161069	69.9	6383	2.8	2082	0.9	3331	1.4	19966	8.7	35499	15.4	161	0.1	212	0.1	758	0.3	1059	0.5

Source: Census of India 2011

A comparative analysis of the district and municipal level data reveals that over 93.5% of the housing structures at the municipal level are permanent structures while only 79.22% of the housing structures at the district level are permanent structures. Moreover, over 69.9% of the HHs the municipal have access to drinking water through taps from a treated source while only 28% of the HHs are the district level, have access to tap water from a treated source.

4.4.9 Educational Facilities

4.4.9.1 Howrah Municipal Corporations (HMC)

As per the 2011 Census of India, there are 229 government primary schools, 75 private primary schools, 151 government middle schools, 41 private middle schools, 131 government secondary schools and 10 private secondary schools in Howrah Municipal Corporation. The municipality also has 77 government senior secondary schools and 9 private senior secondary schools. The municipality also has 1 government arts, science and Commerce College, 1 Government Medical College, 2 Government Engineering College, 1 private Management institute, 4 government polytechnic institute as well as 5 private institutes for shorthand typewriting.

4.4.9.2 Educational Facilities near STP Area

As per the site assessments, it is observed that there are three educational institutions located within the one kilometre radius, the Satashi High School in Ward 47, Ichapur High School and Dr. Kanailal Bhattacharyya College in Ward 49.

4.4.10 Health Facilities

4.4.10.1 Howrah Municipal Corporations (HMC)

With regard to access to health institutions, the 2011 Census of India indicates that Howrah Municipal Corporation has 3 hospitals, 3 dispensaries/ health centres, and does not have any Family Welfare Centre, Maternity and Child Welfare Centre, as well as Maternity Homes.

4.4.11 Financial Institutions

As per the 2011 Census of India, Howrah Municipal Corporation has 81 nationalised banks and 703 non-agricultural credit societies.

4.4.12 Cultural and Historical Heritage

Howrah has a history dating back to five hundred years, and has been considered to be an important sea faring business hub during the period of the East India Company. Additionally, the Howrah Railway Station was established in 1854 which catalysed industrial development in the area as raw material was being brought in from other parts of the country, to be processed in the factories in Howrah. During that period, several flour and jute mills were set up in the area. There are no recorded cultural heritage sites in the vicinity of the STP and the linked facilities.

4.4.13 Potential Areas of Sensitivity near STP

The potential areas of sensitivities are defined as congested settlements with poor housing structure and sanitation facilities. Assessment of sensitive areas for the ESIA also includes educational institutions and hospitals located within the AOI. As observed during the site assessment, Hatpukur and Arupara settlements which are located in ward number 48, are situated very close to the boundary of the Arupara STP. It was observed that the width of the road between the settlements and the boundary is only 10 metres.

There are also two temples in the vicinity of the STP, one is situated near the entrance of the STP and one is a small temple situated along the STP wall boundary.

It is also observed that there are three educational institutions located within the one kilometre radius, the Satashi High School in Ward 47, Ichapur High School and Dr. Kanailal Bhattacharyya College in Ward 49. Since there are no proposed renovation and upgradation works along these identified sensitive locations, the potential social impacts are negligible. For the potential environmental impacts, please refer to sections 5.4.1 on Visual Aesthetics and Odour Nuisance, 5.4.3 on Ambient Air Quality, 5.4.4 on Ambient Noise and 5.4.8 on Road Traffic.

Figure 4.37 Potential Areas of Sensitivity near STP Location

Settlements next to STP Boundary

Temple next the Arupara STP Boundary

Congested Locations at Arupara and Hatpukur Settlements

Temple & Recreational Centre near Arupara STP Boundary

Figure 4.38 Potential Areas of Sensitivity near STP Location

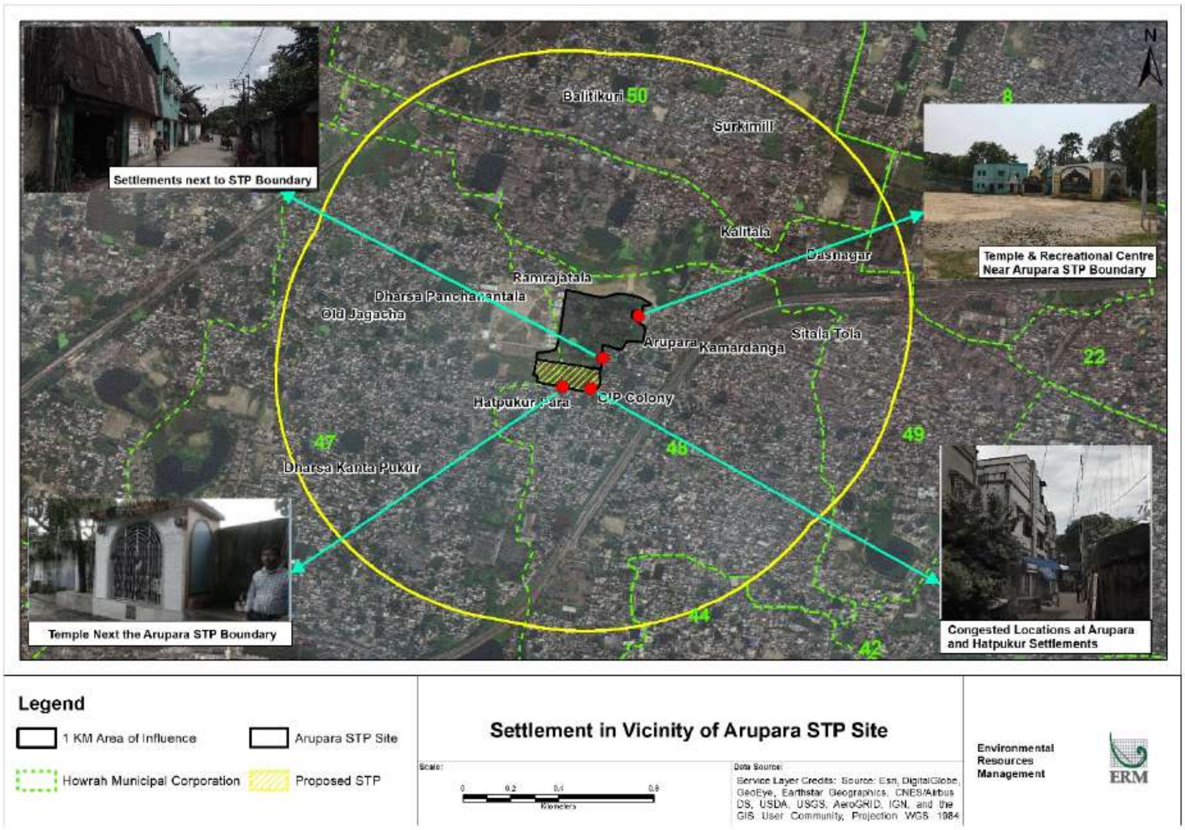


Figure 4.39 Potential Areas of Sensitivity along Sewer Lines

Commercial Squatters next to BESU Lifting Station, Swarnamoyee Road

4.5 Primary Socio Economic Survey

A socio-economic survey was conducted on the population residing within 100 meters of the alignment (50 m on each side) of the proposed replacement or laying of the sewer pipelines, therefore those who may potentially be impacted directly by the project either through loss of income or access and traffic disruption have been assessed. In addition, receptors in the vicinity of the locations of the proposed pipeline work have also been considered for the survey as they may be indirectly impacted by the project activities. The survey was conducted through random sampling that includes 23 households and potentially at those locations where physical work will be undertaken. The locations where the primary survey and consultations were conducted are presented in **Figure 4.40** below.

The locations of the surveys and number of Project Affected Households (PAHs) among the surveyed HHs are presented in **Table 4.32** below. Total 13 surveyed HHs are situated near near the Arupara STP location and 10 surveyed HHs are situated near Lifting Station 1 BESU out of which seven are PAHs. Therefore out of the 23 surveyed HHs, seven are PAHs.

The locations and number of participants in the stakeholder consultations are presented in the table below. The stakeholder consultations were attended by 42 participants. Therefore for collection of primary data from the study area 65 PAPs were consultated (23 HH survey plus the 42 participants from stakeholder consultations).

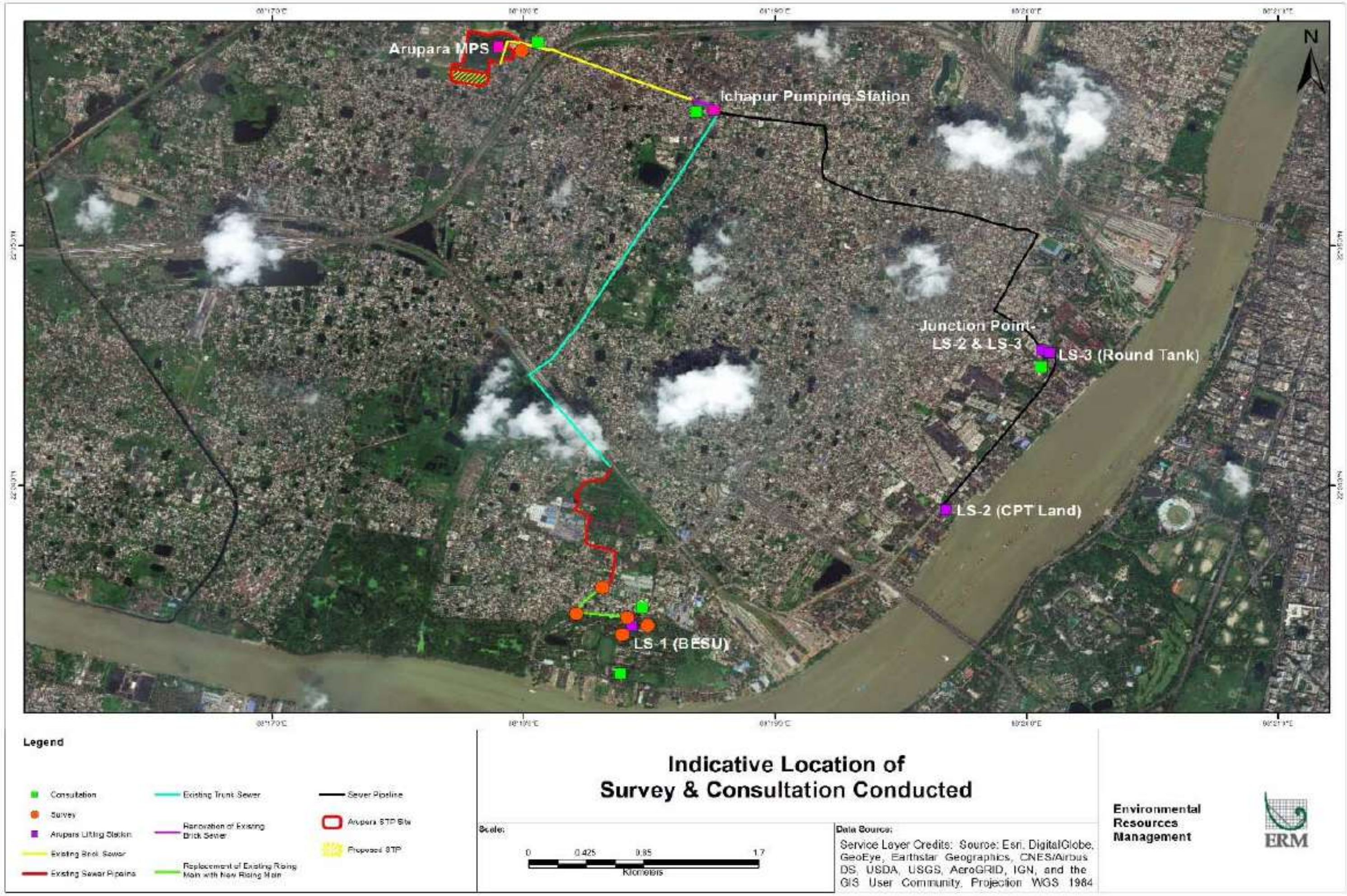
Table 4.32: Locations of Surveyed Population

Component	Location	HHs Surveyed	Project Affected Households (PAH)
STP & MPS-Arupara	Arupara	13	-
LS-1	BESU, B.E College	10	7
	Total	**23**	7

Table 4.33: Details of Stakeholder Consultations Conducted

Stakeholder Group	Location	Date	Number of Participants
Existing STP Contractual Workers	Arupara STP	5th of July, 2019	6
Existing MPS Contractual Workers	Itchapur MPS	5th of July, 2019	8
Existing Contractual Worker at Itchapur MPS	Roundtank Road, Howrah	18th of July, 2019	1
Existing Contractual Worker at Round Tank Lifting Station	Foreshore Road, Howrah	18th of July, 2019	1
Existing Contractual Worker at BESU Lifting Station	BESU, Howrah	18th of July, 2019	1
Joint Consultation between Existing Workers at Arupara STP and Lifting Stations and KMDA, VA Tech Wabag & ERM	Chittaranjan Bayam Samiti, Howrah	17th of September 2019	25
Disclosure meeting with the Howrah Municipal Corporation –Urban Local Body (ULB)	Howrah Municipal Corporation (HMC) Office	12th November 2019	3
Information Disclosure Meeting with the local community and Affected Persons	Sreemoyee Road, Near BESU lifting station	23rd November 2019	11
Broad Community Support Consultation with the Affected shopkeepers and ward Councilor	College Road, near BESU lifting station	21st January 2020	15
Consultation wil locat community at GIP Colony, near Arupara STP	GIP Colony Arupara	11th February 2020	15
Total			86

Figure 4.40 Locations for Primary Survey and Consultations Conducted



The total 23 HHs surveyed constitutes a total population of 100, out of which 54% (54 numbers) are males and 46% (46 numbers) are females. **Table 4.34** below presents the family details and the social categorization of the households surveyed. The average family size of the 23 HHs is 4.3. Majority of the HHs, i.e. 65% (15) belong to the General category while 26% (6) HHs belongs to the Scheduled Caste category. None of the HHs belong to the Scheduled Tribe (ST) category and only 9% (2) HHs belong to the Other Backward Classes (OBC) category.

Table 4.34: Family Details and Social Categorization

Location	Total HHs	Average Family Size	Social Categorization					
			Gen	%	SC	%	OBC	%
Arupara	23	4.3	15	65%	6	26%	2%	9

Source*:* ERM socio-economic survey

Table 4.35 below presents the religious affiliation of the households considered under the primary survey; and 96% (22 numbers) of the surveyed HHs are Hindu while only 4% (1 number) HH is Muslim.

Table 4.35: Religious Affiliation of the Surveyed Households

Location	Hindu		Muslim		Total
	No.	%	No.	%	
Arupara	22	96%	1	4%	23

Source*:* ERM socio-economic survey

4.5.1 Age and Sex Composition

Out of the 100 persons 54% (54 numbers) are males and 46% (46 numbers) are females. The age category with the highest frequency is between 19 to 60 years i.e 68% (68 numbers) followed by 7 and 14 years i.e. 11% (11 numbers). 9% (9 numbers) of the surveyed population are below age 6; 11% (11 numbers) are between ages 15 and 18 years and 6 % (6 numbers) are above 60 years old. **Table 4.36** below highlights the sex composition while **Table 4.37** below highlights the age composition.

Table 4.36: Sex Composition of the Surveyed Persons

Location	Male		Female		Total
	No.	%	No.	%	
Arupara	54	54%	46	46%	100

Source*:* ERM socio-economic survey

Table 4.37: Age Composition of the Surveyed Persons

Location	<=6		07 to 14		15-18		19-60		>60		Total Persons
	No.	%	No.	%	No.	%	No.	%	No.	%	
Arupara	9	9%	11	11%	6	6%	68	68%	6	6%	100

Source*:* ERM socio-economic survey

4.5.2 Education Profile

Over 18% (18 numbers) of the surveyed population are illiterate, while 43% (43 numbers) have completed their primary education. Only 18% (18 numbers) have completed their secondary education and 16% (16 numbers) have completed their higher education. 5% (5 numbers) of the surveyed population are not of school going age. Moreover, all the surveyed HHs have access to primary, secondary and college institutions.

The surveyed population has a higher rate of individuals who have completed their primary education I.e. 43%, as compared to the district level (25%), as well as the municipal level (18%). Moreover, over 18% of the surveyed population have completed their secondary education, which is higher than the district level (10%) as well as the municipal level. Over 16% of the surveyed population have completed their higher education, which includes graduates, which is higher than the district level (9%) but lower than the municipal level (17%) Table 4.38 below presents the literacy profile of the surveyed population.

Table 4.38: Education Profile of the Surveyed Persons

Location	Illiterate		Primary Education		Secondary		Higher		Not School Going Age		Total Persons
	No.	%	No.	%	No.	%	No.	%	No.	%	
Arupara	18	18%	43	43%	18	18%	16	16%	5	5%	100

Source*:* ERM socio-economic survey

4.5.3 Occupational Profile

Dataset presented under Table 4.39 outlines the occupational patterns. Out of 100 surveyed persons, 29 individuals are presently working. Over 31% (9 numbers) of the surveyed population are working as daily labourers and all of them are male. Over 28% (8 numbers) are shop owners and all of them are male. 10% (3 numbers) are tea, food stall owners and all of them are male. Over 7% (2 numbers) are engaged in trading, and 17% (5 numbers) are engaged in private service and all of them are male. Over 10% (2 numbers) are engaged in other activities which include tailoring and domestic work.

Table 4.39: Occupational Patterns

Location	Daily Labour		Food & Tea Stall		Shop Owner		Trading		Private Service		Other		Total Persons
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	
Arupara	1	8	-	3	-	8	-	2	-	5	1	1	
	9		3		8		2		5		2		29
	31%		10%		28%		7%		17%		7%		

Source*:* ERM socio-economic survey

4.5.4 Workforce Participation

The working age is categorised between ages 19 and 60 and the table below presents the workforce participation of the population that is of working age. Out of the 100 surveyed individuals, 68 individuals are of working age i.e. between 19 and 60, and 32 individuals are not of working age i.e. they are either below 19 years of age, or above 60 years of age. It may be noted that there are two individuals who are above the age of 60 and are still working. Therefore the total number of working individuals from the entire surveyed population of 100, is 29, as reported in **Table 4.39** above.

Out of those 68 individuals of working age (between ages 19 and 60), 40% (29 numbers) are presently working and 60% (41 numbers) are presently not working. Out of the 22 working individuals, 93% (27 numbers) are male and only 7% (2 numbers) are female. However, out of the 41 non-working population, 29% (12 numbers) are male and 71% (29 numbers) are female, therefore majority of women who are of working age, are presently not working. The consultations also revealed that majority of the women are engaged in unpaid domestic work.**Table 4.41** below presents the workforce participation data of the surveyed population.

Table 4.40: Workforce Participation

Location	Yes- Total Working Population (Age 19-60)						No- Total non-working Population (Age 19 - 60)						Total Working Age Population
	Female		Male		Total		Female		Male		Total		
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Arupara	2	7%	25	93%	27	40%	29	71%	12	29%	41	60%	68

Source: ERM socio-economic survey

4.5.5 Income Distribution Pattern

The monthly family incomes of the HHs are presented below. Out of the surveyed HHs, 78% (18 numbers) have an income between Rs. 5,000 and Rs.10,000, 13% (3 numbers) have an income between Rs. 10,001 to 20,000 and 4% (1 number) HH has an income between Rs. 20,001 and 30,000. 4% (1 number) HH has an income between Rs. 30001 and above. Rs. 32,000 is the highest income among the surveyed households. Additionally, none of the surveyed HHs fall within the BPL category. [34]**Table 4.41** below presents the monthly incomes of the surveyed HHs.

Table 4.41: Monthly Income

Location	Rs. 5000-10000		Rs. 10001-Rs. 20000		Rs.20001-30000		Rs.30001 and above		Total HHs
	No.	%	No.	%	No.	%	No.	%	
Arupara	18	78	3	13	1	4	1	4	23

Source: ERM socio-economic survey

4.5.6 Drinking Water & Electricity Access

All the HHs source their drinking water from tap water, supplied by the municipality and the table below presents the drinking water access. Only 30% (7 numbers) of the HHs have access to their own source of drinking water (individual connection) while 70% (16 numbers) share their drinking water source with other HHs (**Table 4.42**). The survey also revealed that over 96% (22) HHs have access to an electricity connection while one HH does not have access to electricity.

Table 4.42: Drinking Water Ownership

Location	Owned by the HH		Shared Source		Total HHs
	No.	%	No.	%	
Arupara	7	30%	16	70%	23

Source: ERM socio-economic survey

4.5.7 Sanitation

Table 4.43 below highlights the sanitation arrangement of the HHs; over 22% (5 numbers) HHs have access to a non- sanitary toilet, 13% (3 numbers) have a sanitary water-sealed toilet, and 13% (3 numbers) have a sanitary non water-sealed toilet. Additionally, 13% (3 numbers) have a septic tank, 9% (2 numbers) have a soak pit, 17% (4 numbers) utilise public toilets and 13% (3 numbers) utilise open drains.

Table 4.43: Sanitation Arrangement

Location	Open Drain		Non Sanitary		Sanitary-Non Water Sealed		Sanitary Water Sealed		Septic Tank		Soak Pit		Public Toilet		Total HHs
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Arupara	3	13%	5	22%	3	13%	3	13%	3	13%	2	9%	4	17%	23

Source: ERM socio-economic survey

[34] As per the Planning Commission of India, the income limit for households for qualifying as a beneficiary under the BPL (below poverty line) list has been pegged at about Rs. 27,000 per annum. If a person earns less than this amount, he can get a Below Poverty Line Certificate issued to avail the different subsidies offered by the government using this service.

4.5.8 Health

Access to Health Care Facilities

An analysis of the access to health care facilities reveals that 96% (22) HHs have access to government hospitals, while 1 HH has access to private hospitals for their health care services. (**Table 4.44**).

Table 4.44: Access to Health Care Facilities

Location	Private Hospital		Govt. Hospital		Both		Total HHs
	No.	%	No.	%	No.	%	
Arupara	1	4%	22	96%	-	-	23

Source: ERM socio-economic survey

Problems with Chronic Health & Vector Borne Diseases

Out of the 23 HHs surveyed, only two HHs indicated having chronic health problems i.e. asthma and diabetes. In addition, none of the HHs indicated having faced any water- borne or air-borne diseases. (**Table 4.45**).

Table 4.45: Chronic Problems Faced

Location	Yes		No		Total HHs
	No.	%	No.	%	
Arupara	2	9%	21	91%	23

Source: ERM socio-economic survey

4.5.9 Water Logging

Over 43% (10) of the surveyed HHs indicated waterlogging as a problem in their locality especially during the monsoons, while 57% (13) HHs have no problems with waterlogging. The data is presented in **Table 4.46**.The 7 HHs that indicated water logging as a problem in their locality are located near the Arupara STP location, BESU Lifting Station 1 and at Botanical Garden Road which is also located near BESU Lifting Station 1. Consultation with the local community at GIP colony revealed that waterlogging takes place in the area, especially during the rainy season. Therefore the water from the manholes overflows in the neighbourhood and often floods the homes of some residents.

Table 4.46: Water Logging Problems

Location	Yes		No		Total HHs
	No.	%	No.	%	
Arupara	10	43%	13	57%	23

Source: ERM socio-economic survey

4.5.10 Gender & Vulnerability

At the Arupara project area, out of the 23 HHs, there are two woman-headed HHs which are both located near the Arupara STP site. Both of the HHs are squatters and have an average family income of INR 5,000. The primary survey revealed that none of the HHs have any members who are living with any form of disability. [35]

Over 18% (18 numbers) of the surveyed population are illiterate out of which 12% (12) are women and 6% (6) are men. Over 43% (43 numbers) have completed their primary education out of which 20% (6) are women and 23% (23 numbers) are men. Only 18% (18 numbers) have completed their secondary education, with 6% (6 numbers) women and 12% (12 numbers) men. Over 16% (16 numbers) have completed their higher education out of which 6% (6 numbers) are women and 12% (10 numbers) are men. 5% (5 numbers) of the surveyed population are not of school going age. It is thus observed that there is a higher percentage of women who are illiterate. Moreover, majority of the surveyed population have only completed their primary education, with women having a lower percentage than men.

An analysis of the workforce participation of the surveyed population indicates that majority of the women are not participating in the workforce and the consultations also revealed that majority of the women are engaged in unpaid domestic work. Similarly, a review of the workforce participation at the Arupara STP and linked facilities reveal that all the workers are male workers, with the exception of one female employee at LS 2 Foreshore Road. Therefore women are almost entirely unrepresented in the workforce (**Table 4.47**).

Table 4.47: Gender Disaggregated Literacy Profile of Study Area

Location	Gender	Illiterate		Primary Education		Secondary		Higher		Not School Going		Total Persons
		No.	%	No.	%	No.	%	No.	%	No.	%	
Arupara	Women	12	12%	20	20%	6	6%	6	6%	2	2%	46
	Men	6	6%	23	23%	12	12%	10	10%	3	3%	54
Overall		**18**	**18%**	**43**	**43%**	**18**	**18%**	**16**	**16%**	**5**	**5%**	**100**

Source*:* ERM socio-economic survey

4.6 Existing Manpower at Arupara STP

This section presents the details of the existing manpower deployed at the Arupara STP and its linked facilities which include the three Lifting Stations and two Main Pumping Station. Presently, there are two O&M agencies engaged, the Associated Cooperative Labour Contractor and Construction Society Ltd and M.C.E Construction since 2009 and 2008 respectively. Associated Cooperative Labour Contractor and Construction Society Ltd has a total of fifty-two workers engaged at the Arupara STP and linked facilities, while M.C.E Construction has five workers engaged at LS 1, BESU. Consultations revealed that there is one female employee engaged at LS 2 Foreshore Road (**Table 4.48**).

[35] As per IFC PS 1, this disadvantaged or vulnerable status may stem from an individual's or group's race, color, sex, language, religion, political or other opinion, national or social origin, property, birth, or other status. The client should also consider factors such as gender, age, ethnicity, culture, literacy, sickness, physical or mental disability, poverty or economic disadvantage, and dependence on unique natural resources.

Table 4.48: O&M Agencies at Arupara STP and Associate Facilities

O&M Agency	Time Period
Associated Cooperative Labour Contractor and Construction Society Ltd	2009 to present
M.C.E Construction	2008 to present

Source: Stakeholder Consultation with Workers on 17th of September 2019

During the stakeholder consultation which was conducted with the workers in the presence of representatives from KMDA, VA Tech Wabag and ERM[36], the list of workers shared by KMDA (hereinafter stated as "KMDA list"), was verified against those workers present during the consultation. Those who could not attend the consultation were verified by the representatives of their respective agencies, as well as by their co-workers at their respective facilities. This exercise thus revealed that the name of Mr. Achinta Roy who was recently engaged at Arupara MPS, (as confirmed by his co-workers) was not included in the KMDA list. Therefore there are a total of nine (9) workers at the Arupara MPS, not eight (8) workers, as reported in the KMDA list. Moreover, Mr. Dip Adhikari has been engaged at the Itchapur MPS in place of his recently demised father Mr. Samir Adhikary. This engagement has been confirmed by the KMDA as per their letter to the Secretary of Associated Cooperative Labour Contractor and Construction Society Ltd, dated 26th of June, 2019.

As per consultations held with the workers dated 17th of September 2019, revealed that there are a total of nine (9) workers at the Arupara MPS, however as per the list provided by KMDA, the total number of workers at the Arupara MPS are eight (8) workers. Moreover, there are a total of eight (8) workers at the Itchapur MPS, not seven (7) workers, as reported in the KMDA list. In, addition, the name Mr. Pratap Karmakar, who is engaged as an operator at Arupara MPS is incorrect as per the KMDA list; his actual name is Mr. Pratip Karmakar. However, as per the updated list of workers shared by Wabag on 31st of October, 2019, it was observed that there are only eight (8) workers at the Arupara Main Pumping Station (MPS), as opposed to the nine (9) workers reported during the joint consultation. Though Mr. Achinta Roy's name has been added, Mr. Prabir Hazra's name is now missing from the new list. Additionally, as per the updated list of workers shared by Wabag, there are only seven (7) workers at the Itchapur Main Pumping Station (MPS) as opposed to the eight (8) workers reported during the joint consultation. Though Mr. Dip Adhikari's name has been added in place of Mr. Samir Adhikari, Mr. Srimangal Soumondra's name is now missing from the new list.

Therefore as per the verification during the joint consultation, there are a total of sixty-three (63) workers at the Arupara STP and associated facilities, however, as per the new list shared by Wabag on the 31st of October, 2019, there are a total of sixty-one (61) workers.

Furthermore, the KMDA list only mentions the name of only one O&M agency i.e. Ganga Action Plan Contract Workers Co-operative Society. The verification however revealed that Associated Cooperative Labour Contractor and Construction Society Ltd and M.C.E Construction are in fact the O&M agencies at these two sites. Reportedly, the security guards working at the Arupara facilities are engaged directly by KMDA, and KMDA has its own plan to relocate the guards, as per their requirement.

Based on the KMDA list, the workforce at Arupara STP and associated facilities are between ages 24 and 60 years old and there are total eight (8) workers who fall within the age bracket of 55 – 59 years. The service duration of the total existing workforce are ranging from minimum one (1) year to

[36] Stakeholder Consultation with Workers of Arupara STP and Linked Facilities on 17th of September, 2019

maximum 28 years and with an average of 22 years. There is also one female worker employed at LS 2 Foreshore Road.

As per the circular from the Labour Commissioner, Government of West Bengal, the minimum wage rate for workers employed in a manufacturing activity as defined under Section 2(k) of the Factories Act, 1948 is Rs. 8005 for the period between 1st of January, 2019 and 30th of June, 2019. However this minimum wage rate has been revised to Rs. 8177 for employment period between 1st July 2019 and 31st December 2019. The daily rate is Rs. 314.5 (Rs. 8177/ 26 days).

As per the list made available by KMDA, it is highlighted that the workers at the Arupara STP, Arupara MPS and Itchapur MPS are earning Rs. 11,775 per month. It may be noted that Mr. Achinta Roy, newly joined employee at Arupara MPS is earning Rs. 8500 per month. The workers at Lifting Station 1 BESU are Rs. 11,610 per month and the security guards are earning Rs. 13,500 per month. The workers at Lifting Station 2 CPT Land Foreshore Road and Lifting Station 3 Round Tank Road are earning Rs. 387 per day. Therefore as per the revised wage rate of the Government of West Bengal, the wages of the existing workers is above the minimum wage rate.

However, the site assessments and consultations with the workers at the facilities also indicated that they are enrolled in the PF and ESI schemes and are engaged in three shifts i.e. morning, day and night shift, along with the general working hours. Additionally, none of the workers indicated having received any training on Health & Safety and they were not utilizing any Personal Protective Equipment (PPE).

The details of the existing workers and contractors are presented in **Table 4.49** below.

Table 4.49: Details of Existing Workers and Contractors

Project Components	Location	Contractor	Manpower Involvement	Designation
STP-Arupara	Arupara Sewage Treatment Plant, South Howrah Zone	Associated Cooperative Labour Contractor and Construction Society Ltd	24	5 Operators
MPS-Arupara	Arupara Main Pumping Station		9	5 Operators
MPS- Itchapur	Itchapur Main Pumping Station		8	5 Operators; 1 Sweeper
LS-3	Round Tank Road		6	6 Operators; 1 Sweeper
LS-2	CPT Land, Foreshore Road		5	6 Operators; 2 Sweepers
LS-1	BESU, B.E College	M.C.E Construction	5	20 Operators; 20 Operators/Helpers; 2 Cleaners
STP	Security Personnel	Reportedly, they are directly engaged by KMDA	6	Security Personnel
Total			**63**	

Source: Stakeholder Consultation on 17th of September 2019 & KMDA (List of Existing Manpower)

4.6.1 Contract Agreement between KMDA and Contractor

The contract agreements between Kolkata Metropolitan Water & Sanitation Authority (KMW&SA) and the O&M Agencies engaged at the Arupara STP and linked facilities i.e. Associated Co-operative Labour Contract & Construction Society Ltd; Ganga Action Plan Contract Workers Co-operative Society Ltd., and MCE Construction, have been shared for review.

The contract agreements between KMW&SA (KMW&SA) and the Associated Co-operative Labour Contract & Construction Society Ltd. and Ganga Action Plan Contract Workers Co-operative Society Ltd are for the years 2013-2014. It is specified that the agreements are renewed on basis of mutual terms. The agreements specified the following with regard to the workers' terms of employment, benefits and compliance with statutory regulations:

- Each member of the Co-operative Society engaged under the KMW&SA are to be paid the daily rate wages as declared by the State Government (Clause 1).
- None of the co-operative members are allowed to work for more than the maximum man days of work as per the calendar month (28/29/30/31 days as the case may be) on a no work no pay basis and double payment will not be allowed either (Clause 2).
- The agreement also specifies that the duties of the operational personnel will be allotted by observing the applicable State labour laws and also specifies that the EPF and ESI amounts will be reimbursed to the personnel as per the statutory rates and provision. (Clause 2) Additionally, the agreement also specifies compliance with statutory provisions for bonus and ex-gratia. (Clause 8).
- Additionally, the agreement specifies that in the event of any cessation of membership of any member, due to illness or death, the member's next of kin may be deployed in his/her place, with prior approval from the KMW&SA (Clause 10).

The agreement also specifies that the maximum age allowed for work is 60 years and benefits will be provided as per State Government Rules.

The contract agreement between the KMW&SA and MCE Construction specifies the following with regard to the workers' terms of employment, benefits and compliance with statutory regulations:

- The contractor has to honour the statutory liabilities under Employees State Insurance Act, 1948 and Employees Provident Funds and Miscellaneous Provisions Act, 1952
- The 'General Rules and Directions for the Guidance of Contractors' document of the KMW&SA has further laid down certain conditions of contract in relation to labour. It is specified that in the event KMW&SA is obliged to pay compensation to a workman employed by the contractor, under the provisions of Workmen's Compensation Act, 1923, KMW&SA will recover from the contractor the amount of the compensation paid through deduction from the security deposit or any sum due by the KMW&SA to the contractor (Clause 18B). The condition of the contract also specified that no female labour shall be employed within the limits of the cantonment and there should be no employment of labour below the age of 12 years (Clause 19, 19A, 19B).
- The contractor is required to comply with the provisions of the Payment of Wages Act, 1936; Minimum Wages Act, 1948; Employers Liability Act, 1948; Industrial Dispute Act, 1947; Maternity Benefits Act, 1961 and the Contract Labour (Regulation and Abolition) Act, 1970 and the Contract Labour (regulation and Abolition) Central Rules 1971, wherever applicable (Clause 19B)
- The contract agreement also specifies a section on the conditions for termination of the contract agreement, in the event of any violation of the terms of the contract agreement by the contractor such as non-payment to labourers, or non-compliance with labour laws etc. KMW&SA may thus

prematurely terminate the contract of the O&M agency after giving a seven (7) days written notice to the contractor.

5. IMPACT ASSESSMENT AND MITIGATION MEASURES

5.1 Introduction

This section identifies and assesses the potential impacts to the physical, biological and socioeconomic environment that can be expected from the proposed project at Arupara. The impacts due to the Project activities have been identified and assessed. Impacts are identified and predicted based on the analysis of the information collected from the following:

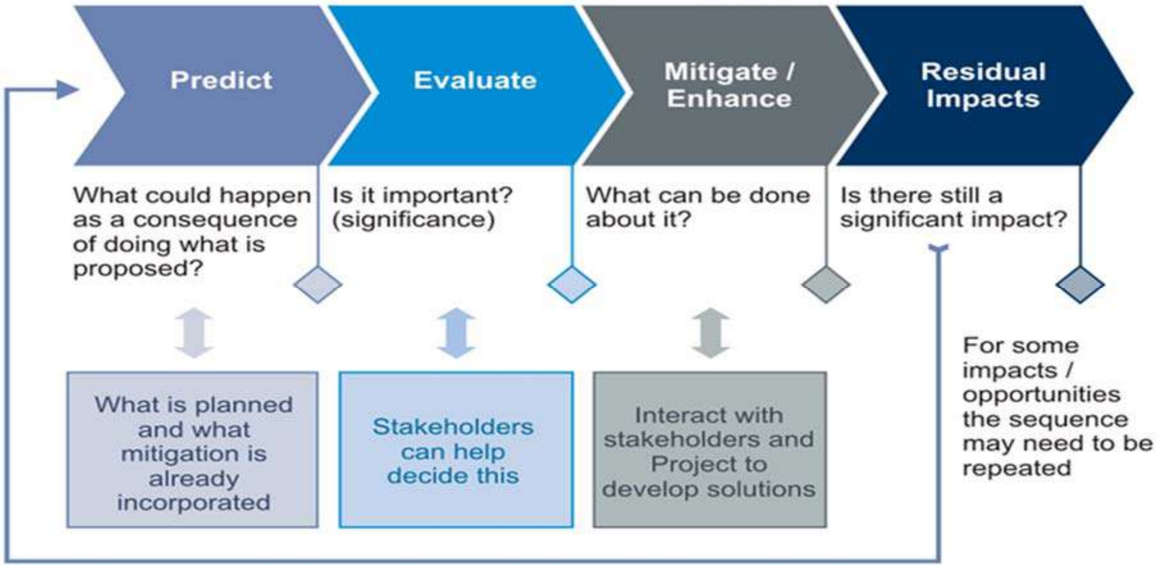
- Project site information (*as outlined in* **Section 2**)**;**
- Baseline information (*as outlined in* **Section 4**).

5.2 Impact Assessment Methodology and Approach

The identification of likely impacts during construction and operation phases has been carried out based on understanding of activities and their consequent impacts on various environmental and socio-economic resources or receptors. Impact identification and assessment starts with scoping and continues through the remainder of the impact assessment process (IAP).The principal impact assessment (IA) steps are summarized and comprise:

- **Impact prediction**: to determine what could potentially happen to resources/receptors as a consequence of the Project and its linked activities;
- **Impact evaluation**: to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource/receptor;
- **Mitigation and enhancement**: to identify appropriate and justified measures to mitigate negative impacts and enhance positive impacts;
- **Residual impact evaluation**: to evaluate the significance of impacts assuming effective implementation of mitigation and enhancement measures.

Figure 5.1 Impact Assessment Process



5.2.1 Prediction of Impacts

Prediction of impacts is essentially an objective exercise to determine what could potentially happen to the environment as a consequence of the project and its linked activities. This is essentially a repeat of the process undertaken in scoping, whereby the potential interactions between the Project and the baseline environment are identified. From these potential interactions, the potential impacts to the various resources/receptors are identified, and are elaborated to the extent possible. The diverse range of potential impacts considered in the IA process typically results in a wide range of prediction methods being used including quantitative, semi-quantitative and qualitative techniques. The nature and types of impacts that has been addressed in this ESIA is defined below.

Box 5.1: Nature & Type of Impacts Considered for Impact Assessment

- **Negative:** when impact is considered to represent adverse change from the baseline or introduced a new undesirable factor;
- **Positive or beneficial:** when impact is considered to represent improvement to baseline or introduced a new desirable factor;
- **Direct:** impacts that result from a direct interaction between the project and a resource/ receptor;
- **Indirect:** impacts that follow on from the direct interactions between the project and its environment as a result of subsequent interactions within the environment; and
- **Induced:** impacts that result from other activities (which are not part of the project) that happen as a consequence of the project.

5.2.2 Evaluation of impacts

Evaluation of significance of an impact is assessed by ascertaining a) magnitude and b) sensitivity/vulnerability/importance of resource/receptor likely to be impacted as defined in the following description:

a) Determining Magnitude of an Impact

Magnitude, i.e. severity of an impact or degree of change caused by a project activity is a function of interaction characteristics of Scale, Extent and Duration. The criteria that have been evolved for each of these key elements resulting in degree of change with corresponding ranking/level of impacts (low, medium and high) on the environmental component are presented in ***Table 5.1.***

Table 5.1: Impact Prediction Criteria

Impact Elements	Criteria	Ranking
Scale: Degree of damage that may be caused to the environmental components concerned	■ **Irreversible damage to natural environment** and/or likely difficult or may not to revert back to earlier stage with mitigation; ■ **Major changes in comparison to baseline conditions** and / or likely to regularly or continually exceed the standard;	High
	■ **Reversible damage to natural environment** but likely to easily revert back to earlier stage with mitigation; ■ Perceptible change from baseline conditions but **well within acceptable norms**.	Medium
	■ Effect is **within the normal range** of natural variation; ■ **No perceptible or readily measurable change** from baseline conditions;	Low
Extent: Spatial or geographical extent of impact due to a project and related activities	■ Project site and the entire study area i.e. beyond Project influence area.	National
	■ Project site & its surroundings (2.0 km from Project components	Regional
	■ Project site & its immediate vicinity (0.5 km from Project components	Local
Duration: Temporal scale of the impact in terms of how long it is expected to last	■ Spread beyond the lifecycle of the project	Long Term
	■ Spread across several phases of the project lifecycle	Medium Term
	■ Only during particular activities or phase of the project lifecycle	Short Term

Magnitude essentially describes the intensity of the change that is predicted to occur in the resource/receptor as a result of the impact. The magnitude combines the impact characteristics of Extent, Duration and Scale and is a multiplicative factor of these three criteria set. Based on the above understanding magnitude of impact is assessed as per the **Table 5.2*.***

Table 5.2: Assessing Magnitude of Impact

Scale	Extent	Duration	Magnitude
Low	Local	Short Term	**Negligible**
Low	Regional	Short Term	**Small**
Low	Local	Medium term	
Medium	Local	Short Term	
Low	National	Short Term	
Low	Local	Long term	
High	Local	Short Term	
Low	Regional	Medium term	
Medium	Regional	Short Term	
Medium	Local	Medium term	
Low	National	Medium term	**Medium**

Medium	National	Short Term	
Low	Regional	Long term	
High	Regional	Short Term	
Medium	Local	Long term	
High	Local	Medium term	
Medium	Regional	Medium term	
Low	National	Long term	
High	National	Short Term	
High	Local	Long term	
Medium	National	Medium term	**Large**
Medium	Regional	Long term	
High	Regional	Medium term	
Medium	National	Long term	
High	National	Medium term	
High	Regional	Long term	
High	National	Long term	

b) Determining Sensitivity/ Importance/ Vulnerability of Receptor

In addition to ascertaining magnitude of impact, the other principal step necessary to assign significance for an impact is to define the sensitivity/vulnerability/ importance of the impacted resources/ receptor. There are a range of factors to be taken into account when defining the sensitivity/ vulnerability/ importance of the resource/ receptor, which may be physical, biological, cultural or human as per the following understanding:

- Where the resource is physical (for example, fresh water body) its quality, sensitivity to change and importance (on a local, regional, national importance) are considered;
- Where the resources/ receptor is biological or cultural (for example, sea turtle habitat and nesting site), its importance (for example local, regional or national importance) and its sensitivity to the specific type of impact are considered;
- Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered.

Definition as defined in ***Table 5.3*** has been adopted to determine sensitivity/ importance/ vulnerability of environmental resources or receptor.

Table 5.3: Sensitivity/Importance/ Vulnerability Criteria

Sensitivity	Contributing Criteria
High	■ Existing physical environment quality is already under stress; ■ Ecologically sensitive/ protected area, provides habitat for globally protected species; ■ Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the project. ■ Human receptors/ vulnerable community are located within the project footprint and directly affected by the project ■ Resource exclusive for community use

Sensitivity	Contributing Criteria
Medium	■ Existing physical environment quality shows some sign of stress; which is sensitive to change in quality or physical disturbance; ■ Natural habitat provides habitat for wildlife, which are protected under National regulations; ■ Some, but few areas of vulnerability; still retaining an ability to at least in part adapt to change brought by the project; ■ Human receptors/ vulnerable community are located adjacent the project site and likely to be affected by the project; ■ Alternative resource available with community.
Low	■ Existing physical environment quality is good; ■ Modified habitat provides habitat for common species; ■ Human receptors are located away and are not likely to be affected due to the project related activities

c) Evaluating Significance of Impacts

Based on interaction of magnitude of impact and sensitivity/ vulnerability/ importance of resource/ receptor likely to be impacted, the significance of impact is assigned for each impact using the matrix shown in ***Figure 5.2***

Figure 5.2 Assessing Significance of Impact due to Proposed Project Related Activities

		Sensitivity /Vulnerability / Important Resource / Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

The context of various impact significance ratings is defined in ***Box 6.2.***

Box 5.2 Context of Impact Significance

An impact of **negligible** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of **minor** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards.

An impact of **moderate** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of **major** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

5.2.3 Identification of mitigation and enhancement measures

Once the significance of an impact is assessed, the next step is to evaluate appropriate mitigation and enhancement measures are warranted. In this ESIA, following Mitigation Hierarchy has been adopted:

- Avoid or Reduce at Source: avoiding or reducing at source through the design of the project;
- Abate on Site: add something to the design to abate the impact;
- Abate at Receptor: if an impact cannot be abated on-site then control measures can be implemented off-site;
- Repair or Remedy: some impacts involve unavoidable damage to a resource and these impacts can be addressed through repair, restoration or reinstatement measures;
- Compensate in kind, compensate through other means: where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate.

The priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the linked Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

Once mitigation and enhancement measures are declared, the next step in impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation and enhancement measures.

5.2.4 Management and monitoring

The final stage in the impact assessment process is to define the management and monitoring measures that are needed to identify whether: a) impacts or their linked Project components remain in conformance with applicable standards; and b) mitigation measures are effectively addressing impacts and compensatory measures and offsets are reducing effects to the extent predicted.

Environmental Management Plan summarises all actions (including mitigation/enhancement and compensatory measures) which the Project Proponent has committed to executing with respect to environmental/social/ health performance for the Project, is also included as part of the ESIA report. The Plan also includes monitoring measures to assess performance of the actions

5.3 Assessment of environmental and social impacts and Mitigation Measures

The potential impacts have been identified through a systematic process whereby the activities (both planned and unplanned) linked with the Project have been considered with respect to their potential to interact with environmental and social resources or receptors. In addition to the project components like the existing STP, proposed STP, existing and proposed sewage lines, new proposed I&D structures and Main Pumping Station (MPS) has also been considered for the purpose of this current assessment.

The interaction matrix enables a methodical identification of the potential interactions each Project activity may have on the range of resources/ receptors within the Area of Influence i.e. the study area for the Project.As per project schedule (*refer 2.9*) it was noted that time frame for de-commissioning and construction phase overlapped each other, hence assessment of environmental and social impacts and mitigation measures have been combined.

Table 5.4: Impact Identification Matrix for Arupara STP and Linked Facilities

Project Activities	Potential Impacts																								
	Environmental Resources											Ecological Resource						Social-Economic Resources							
	Visual Aesthetics & Odour Nuisance	Land Use	Soil Quality	Air Quality	Ambient Noise	Topography & Drainage	Surface water	Surface water quality	Ground water resource	Ground water quality	Traffic (road)	Terrestrial Flora & Fauna	Aquatic Flora (Inland & Marine)	Aquatic Fauna (Inland & Marine)	Migratory Route/ Corridor	Job & economic opportunity	Livelihood Loss	Social & Cultural Structures	Livelihood Loss of Existing Worker	Physical Displacement	Land Use (Economic Displacement)	Access Disruption	Cultural Resources	Community Health & Safety	Occupational health & safety
I. Construction Phase																									
Mobilization and Operation of earthmoving equipment																									
Land preparation (cleaning and grading)																									
Land excavation																									
De-watering of excavated area																									
On-site handling and storage of excavated material																									
On-site handling and storage of construction waste including concrete residue																									
Off-site disposal of construction waste including concrete residue																									
Installation of STP structures																									

Project Activities	**Potential Impacts**																								
	Environmental Resources											**Ecological Resource**						**Social-Economic Resources**							
	Visual Aesthetics & Odour Nuisance	Land Use	Soil Quality	Air Quality	Ambient Noise	Topography & Drainage	Surface water	Surface water quality	Ground water resource	Ground water quality	Traffic (road)	Terrestrial Flora & Fauna	Aquatic Flora (Inland & Marine)	Aquatic Fauna (Inland & Marine)	Migratory Route/ Corridor	Job & economic opportunity	Livelihood Loss	Social & Cultural Structures	Livelihood Loss of Existing Worker	Physical Displacement	Land Use (Economic Displacement)	Access Disruption	Cultural Resources	Community Health & Safety	Occupational health & safety
Installation of electro-mechanical equipment																									
Operation of DG sets (standby)																									
Use of water for construction activities																									
Wastewater generated during construction activities																									
Vehicular Movement *(*RMC Trucks, raw material unloading vehicles, waste disposal trucks etc*.)*																									
II *(a). Activities at Linked Sewage Infrastructures*																									
Land preparation for sewer pipeline renovation(clearing and grabbing)																									
Mobilization and operation of earthmoving equipment for sewer pipeline renovation																									
Desilting of sewer pipelines																									
Laying of New sewer pipelines																									
On-Site storage and handling of silt/sludge																									

Project Activities	Potential Impacts																								
	Environmental Resources											Ecological Resource						Social-Economic Resources							
	Visual Aesthetics & Odour Nuisance	Land Use	Soil Quality	Air Quality	Ambient Noise	Topography & Drainage	Surface water	Surface water quality	Ground water resource	Ground water quality	Traffic (road)	Terrestrial Flora & Fauna	Aquatic Flora (Inland & Marine)	Aquatic Fauna (Inland & Marine)	Migratory Route/ Corridor	Job & economic opportunity	Livelihood Loss	Social & Cultural Structures	Livelihood Loss of Existing Worker	Physical Displacement	Land Use (Economic Displacement)	Access Disruption	Cultural Resources	Community Health & Safety	Occupational health & safety
Off-Site disposal of silt/sludge																									
Dismantling of Electro-Mechanical equipment at linked facilities (MPS, LS structures, etc.)																									
Renovation of linked facilities (installation of electro-mechanical structures)																									
On-Site handling and Storage of waste generated at linked facilities.(Hazardous and Non-Hazardous)																									
Off-Site disposal of waste generated at linked facilities.(Hazardous and Non-Hazardous)																									
II. Operation Phase																									
STP operation																									
On-Site handling and storage of Bio-Solids																									
Off-Site disposal of Bio-Solids																									
Biogas flaring and flue gas venting (from Biogas engine).																									
Handling and Storage of Chlorine																									

Project Activities	Potential Impacts																									
	Environmental Resources											Ecological Resource						Social-Economic Resources								
	Visual Aesthetics & Odour Nuisance	Land Use	Soil Quality	Air Quality	Ambient Noise	Topography & Drainage	Surface water	Surface water quality	Ground water resource	Ground water quality	Traffic (road)	Terrestrial Flora & Fauna	Aquatic Flora (Inland & Marine)	Aquatic Fauna (Inland & Marine)	Migratory Route/ Corridor	Job & economic opportunity	Livelihood Loss	Social & Cultural Structures	Livelihood Loss of Existing Worker	Physical Displacement	Land Use (Economic Displacement)	Access Disruption	Cultural Resources	Community Health & Safety	Occupational health & safety
Hazardous and Non-Hazardous Waste Storage, Handling and Disposal at STP																									
Hazardous and Non-Hazardous Waste Storage, Handling and Disposal at off-site location																									
DG Set operation (standby)																									

= Represents "no" interactions is reasonably expected

= Represents interactions reasonably possible but none of the outcome will lead to significant impact impacts

= Represents interactions reasonably possible with one of the outcomes may lead to potential significant impact

5.4 Potential Environmental Impacts

As per Impact Identification Matrix for Arupara STP and Linked Facilities (**refer Table 5.4**) proposed project activities have an interaction following environmental resources:

- Visual Aesthetics & Odour Nuisance
- Soil Quality
- Ambient Air quality
- Ambient Noise
- Drainage
- Surface Water
- Ground Water
- Road Traffic
- Community Health and Safety
- Occupational Health and Safety

Detailed impacts linked to above mention have been assessed and respective mitigation measures have be analysed further in this section.

5.4.1 Visual and Aesthetics

Construction Phase

Visual and Aesthetics

The proposed facility shall be developed by clearing shrubs and elephant grass present over the sludge drying bed within the STP complex. During this phase multiple activities will be undertaken within the STP complex, starting from cleaning and grading of land which is mostly covered with elephant grass and shrubs, mobilization of construction equipment, land excavation and piling for making base foundation, etc. Waste generated from these activities will have to be stored within the STP complex temporarily till they are disposed or reutilized for backfilling purpose. They will be stacked at designated place. Continuous stacking builds heaps of these waste along with temporary labour camps which are not soothing for human eye or residents of nearby area. This may have a detrimental effect on the perceived beauty of the place. The site location is disadvantage, as it is situated near to densely populated residential area, having a setback distance which is less than 10 meter along the southern boundary. Receptors along the southern boundaries are residents of Arupara and Hatpukur. Potential impacts on the receptors may be medium to high as the STP is in direct line of vision for the receptors. On the western boundary there is an open low land and residents of Hatpukur at distance of ~250 m, while on northern and eastern boundary heavy green cover blocks the line of site for receptors of Ghosh para (~ 500 m) and Arupara (~200 m) respectively, hence potential impact may be negligible to low. Another visual and aesthetic impact which is envisaged during this phase may arise due transportation construction material and waste by trucks, tippers and dumpers through the only access road i.e. H.I.T road impacting receptors of Kamardanga and Ichapur. Thus overall impact for this phase ***Moderate***.

Embedded Control System:

- As per the C&D waste management plan shared by M/s VA Tech Wabag the building of covered shed for storage of C&D waste

Mitigation Measures: The mitigation measures to minimize the above mentioned impacts are as follows:

- All the construction activities will be restricted within the designated site
- Use of covered trucks, tippers or dumper, if not, then EPC contractor has to make sure that materials are not moved without putting a cover on them.
- On completion of work, all temporary structures, surplus materials and wastes will be completely removed from the site and disposed of at a designated facility.
- Quick disposal of Sludge from existing structures and de-silt material from sewer network.

Impact Significance	Visual and Aesthetics Impacts during Construction Phase			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered ***Minor***			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered ***Minor.***			

Residual Impact: Considering the implementation of above mentioned mitigations measures the significance of residual impact is assessed as **Minor.**

Operational Phase

Visual and Aesthetics

Presence of newly build STP will have a positive effect, as new structures will be constructed, painted, labelled and new internal road will be built improving the overall aesthetic of STP complex.

Impact Significance	Visual and Aesthetics Impacts during Operational Phase			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered ***Minor***			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large

Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered ***Minor.***

Residual Impact: Considering the implementation of above mentioned mitigations measures the significance of residual impact is assessed as **Minor.**

5.4.2 Ambient Air Quality and Odour

Air Quality

Construction Phase

During this phase major source of potential impact on ambient air quality is firstly, due fugitive dust emissions from storage and handling of construction waste. During normal conditions these fugitive dust emissions are likely to spread within a range of ~100 -150 m radially, only during windy condition radial spread of fugitive emission will increase to ~200-250 m and affecting receptors within ~250-300m m from STP site. STP has a settlements of Arupara along the eastern boundary which is guarded by green cover within the STP complex. On southern boundary we have receptors of Arupara, Hatpukur and GIP colony and on western boundary we have police training ground sharing the boundary with STP and residents of Hatpukur at an aerial distance of ~380 m. Presence of industrial area on the northern side and nature of unregulated operation adding to the fugitive emissions cannot be neglected. Fugitive emissions within the influence area of STP, the magnitude of fugitive emissions from construction phase of STP impacting the receptor will be minor in nature adding up to the baseline condition***(*refer 4.2.7*)***.

Another set of activities affecting ambient air quality is vehicular emissions due to movement of trucks carrying construction material and mobilization of construction. Estimated movement of trucks per day for delivering construction material and removal of construction waste ~10 PUC/day. The site has Kona expressway on southern side and heavy traffic on Dr.Bholanath Chakraborty Sarani observed during visit cannot be neglected due high exhaust emission within the area STP is high.

All actives during construction phase will be carried using grid connection and portable DG set will only be used in case of emergency as back source of electricity. Stack emissions from these portable DG sets and vehicular emissions have HC, NOx, PM and CO. Referring to the baseline condition for the site (**refer section 4.2.7*),*** additional load from construction phase will have negligible incremental impacts on the air quality of the surrounding, moreover, radial spread is shall not be more than ~200-250 m which shall have affect the immediate receptors temporarily due to the short duration of this phase. Anticipated impact scenarios mentioned above will be short-term and will exist during construction activities only. As a result they pose medium risk and they are reversible in nature. The potential impact on air quality is assessed to be Minor with effective implementation of embedded control measures and mitigation measures stated below.

Embedded Control Measure: Measure stated in Construction plan shared with ERM are:

- Vehicle, equipment and machinery used for would conform to applicable emission norms(PUC certificate);
- Designated storage area for generated waste with provision of covering.
- Water sprinklers to control fugitive dust emissions.

Mitigation Measures:

The proposed mitigation measures are as follows:

- The construction materials waste will not be stored in the direction of prevailing wind. Further efforts will be made to maintain the stockpile against a wall or obstruction so that it works as a windbreak and fugitive emissions during strong winds can be avoided;

- Hazardous or Non-hazardous waste generated from construction activities at the site will not be burned;
- All loading and unloading activities to be carried out as close as possible to the storage facilities;
- Proper handling of materials to ensure minimal emission of dust. Trucks used for transportation of material during site preparation will be provided with impervious sheeting;
- Stacks heights for DG sets should be by the formula H = h + 0.2 *capacity of DG (in KVA) where H is total height of stack and h is height of building in meters where the generator is installed.

Odour Impacts

During construction phase only source of odour that can be envisaged is solid waste generated from labour camp, grit chambers of MPS and LS. To assess the impacts due to sources stated above we focus on existing environment ***(refer figure 5.3)*** and field visit, we can infer that there is strong odour issue within the area of influence due to improper management of solid waste by the municipal corporation and clogging of peripheral drainage of STP complex during monsoon session. Duration of impact from above aspects are short term and impact magnitude will be negligible to minor in nature. Odour nuisance along the sewer line will have potential impact on residents, shops and markets (**refer section 2.5*)*** due to temporary storage of de-silted material/solid waste from grit screen of LS, along the roadside. Duration of temporary storage may be up to 48hrs maximum which is comparatively short, hence the impact will be of Minor. Receptors of Arupara and Hatpukur as well as GIP colony will encounter odour nuisance, as they are within 10 m from the southern boundary of STP complex. Since the duration of this phase is short term, so the impact magnitude will be of Minor

Figure 5.3 Present Scenario of Arupara STP Location

Mitigation Measures: The mitigation measures to minimize the above mentioned impacts are as follows:

- All the construction and activities will be restricted within the designated site
- Use of covered trucks, tippers or dumper, if not, then Wabag has to make sure that materials are not moved without putting a cover on them.
- On completion of work, all temporary structures, surplus materials and wastes will be completely removed from the site and disposed of at a designated facility.
- Quick disposal of Sludge/de-silt material from sewer network.

Impact Significance	Air Quality and Odour Impact during Construction phase			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Minor.**			

Residual Impact: Considering the implementation of above mentioned mitigation measures, the significance of residual impact on ambient air quality during construction phase is assessed as ***Minor.***

Operational Phase

Air Quality

Embedded Control Measure: The Project embedded control measures are as follows:

- Inbuilt Bio-gas Scrubber to remove sulphates;

Impact Assessment

Sources of impact during operation phase firstly, emergency bio-gas flaring on non-operational condition of bio-gas engine during STP operation. Biogas generated in sludge digester will be cleaned in bio-gas scrubber and then sent to Bio-gas holder. Depending upon the operating pressure gas will either be flared through the stacks or sent to bio-gas engine and the flue gas will be vented out affecting the ambient air quality. To estimate the spread of air emissions from bio-gas flaring modelling study has been conducted. The composition of the biogas is 50-70% of methane, with the remaining gases comprising of Nitrogen, Carbon Dioxide and traces of Hydrogen Sulphide. On combustion, the gas emitted largely comprises of Carbon Monoxide, Total Volatile Organic Carbon (VOC) and Oxides of Nitrogen. The Solid Waste Management Rules, 2016 has provided standards for emissions from incinerators/thermal technologies from solid waste treatment/disposal facility. The Standard is not applicable on emissions from flaring (direct thermal application) and power production (through ignition engines). Hence, standards for emissions recommended from ignition engines and flare stacks in Guidance Note on Landfill Flare and Engine Management and Monitoring, 2012[37] by Environmental Protection Agency, Ireland has been considered in the study. Since the design of flare stack has not been shared, it is assumed that the flare will operate with 99% efficiency and accordingly stack and emission parameters have been considered[38].

The table below shows the estimated emissions from flue gas and bio-gas flaring:

[37] https://www.epa.ie/pubs/advice/air/emissions/Guidance%20Note%20on%20Landfill%20Flare%20and%20Engine%20Management%20and%20Monitoring%20(AG7).pdf

[38] file:///C:/Users/Indrani.Ghosh/Downloads/flare-efficiency-estimator.pdf

Table 5.5: Emission Characteristics from the Proposed Plant

Source of stack	No. of stack	Stack Height (m)	Stack Internal Diameter (m)	Flue gas exit velocity (m/s)	Flue gas temperature (degree Centigrade)	Normal Volumetric Flow rate (Nm^3/hour)	Emission Concentration (mg/Nm^3)			Emission Rate (g/s)		
							NO_x	CO	VOC	NO_x	CO	VOC
Biogas Engine	1	10	0.6	18	450	1237	500	1400	1000	0.17	0.48	0.34
Flaring	1	10	0.6	5	800	795	150	50	10	0.033	0.011	0.002

Impacts due to the operation of the plant were assessed by modelling projected emission rates using the AMS/EPA Regulatory Model (AERMOD). AERMOD is a modelling system consisting of three separate modules: AERMET, AERMAP and AERMOD. AERMET is a meteorological pre-processor and uses hourly surface observations, cloud cover, and upper air parameters from twice-daily vertical sampling of the atmosphere to create two output files consisting of surface and vertical profile data, respectively. The terrain pre-processor AERMAP uses DEM maps as well as user generated receptor grids. AERMAP's output file consists of the x, y locations of each receptor, mean sea level (MSL) elevation and hill profile parameters. The hill profile parameter is used in determining plume flow around elevated terrain.

Model Options: The AERMOD model was run with the following regulatory default options in this assessment:

- Stack-tip downwash;
- Elevated terrain effects;
- Use of calms processing routine;
- Use of missing data processing routine; and
- No exponential decay

Meteorological Data: The input meteorological data for the AERMOD was generated using the MM5 model, which was downscaled to fine grid data suitable for modelling. The data used in the study was site specific and was collected during study period.

Terrain Data: Terrain data for the AERMAP model were taken from the 30 m SRTM database, while land cover data was sourced from satellite imagery of the Project site and its surroundings.

Receptors: The receptor grid or network, defined the locations of predicted ground level concentrations (GLCs) used to assess compliance with the relevant standards or guidelines. The following comprehensive fine and coarse receptor network was used for this analysis:

- 100 m spaced receptors from the source up to 10 km.

Modelling Results

Predicted maximum ground level concentrations within the Project AOI with biogas as fuel are presented in **Table.5.6.** Isopleths of ground level concentration for different averaging periods of the pollutants (NOx, CO and VOC) with biogas as fuel are presented in Figure 4.4 to Figure 4.5.

It is evident from the predictive results outlined under ***Table 5.6*** that, the maximum ground level concentration (maximum baseline concentration + predicted maximum concentration) in the Project AOI with natural gas as fuel will be well within the applicable standards for air quality. The additional pollution load of PM_{10} and NOx from proposed expansion project to the baseline condition (***refer 4.2.7***) may not cause major changes in the existing baseline conditions or exceed the NAAQS. The emissions from the plant will however be long term, i.e. will occur for entire life of the plant. The potential impact on air quality due to emissions from the plant is assessed to be **moderate**.

Table 5.6: Summary of Maximum Incremental Ground Level Concentration Values

Pollutants	24 Hourly Maximum GLC	Distance from Source(m)	Direction
Source – emission from stack attached to Biogas Engine			
NOx	2.24	420	South-West
CO	6.33	419	South-West
VOC	4.48	418	South-West
Source – emission from flare stack			
NOx	2.24	413	South-West
CO	0.43	360	South-West
VOC	0.08	360	South-West

Overall impact on the ambient air quality due to STP operation is ***Minor.***

Figure 5.4 NOx Isopleths of stack connected to Engine

(24 Hourly Maximum Ground Level Concentrations)

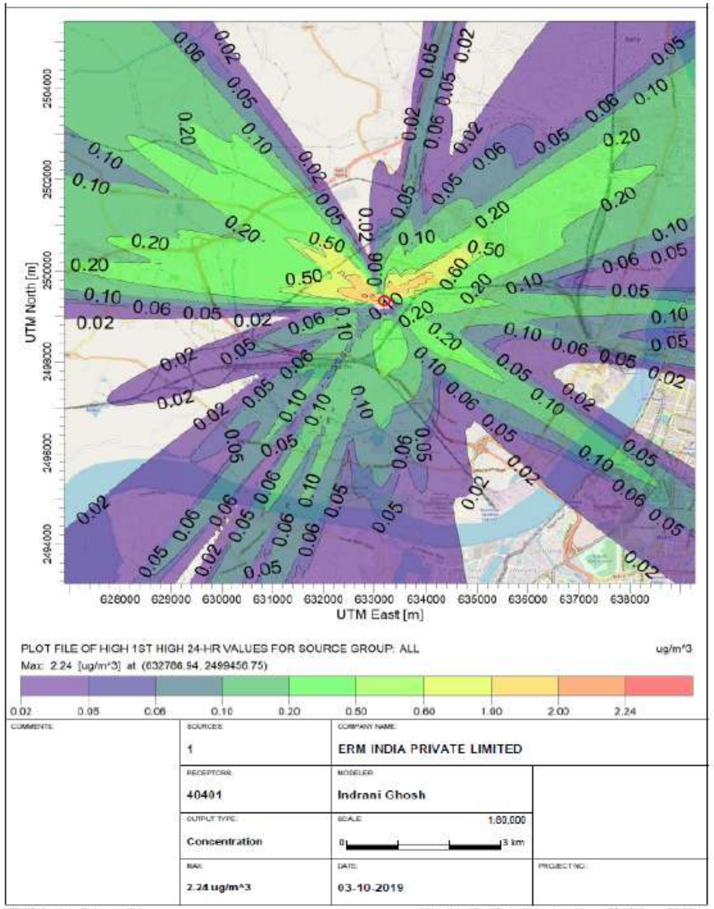


Figure 5.5 CO Isopleths of stack connected to Engine

(24 Hourly Maximum Ground Level Concentrations)

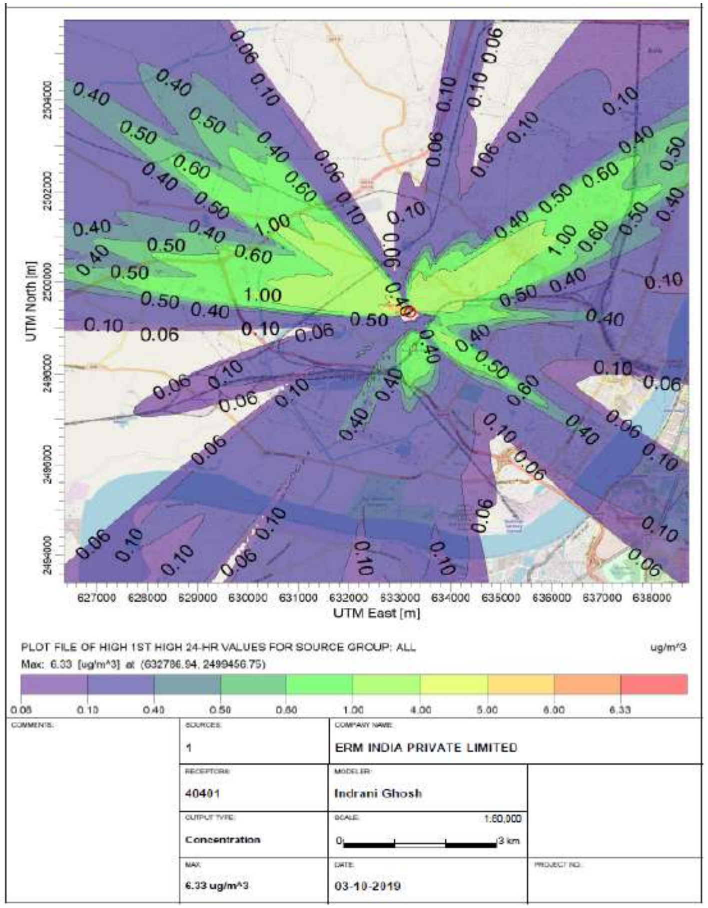


Figure 5.6 VOC Isopleths of stack connected to Engine

Figure 5.7 NOx Isopleths of flare stack

(24 Hourly Maximum Ground Level Concentrations)

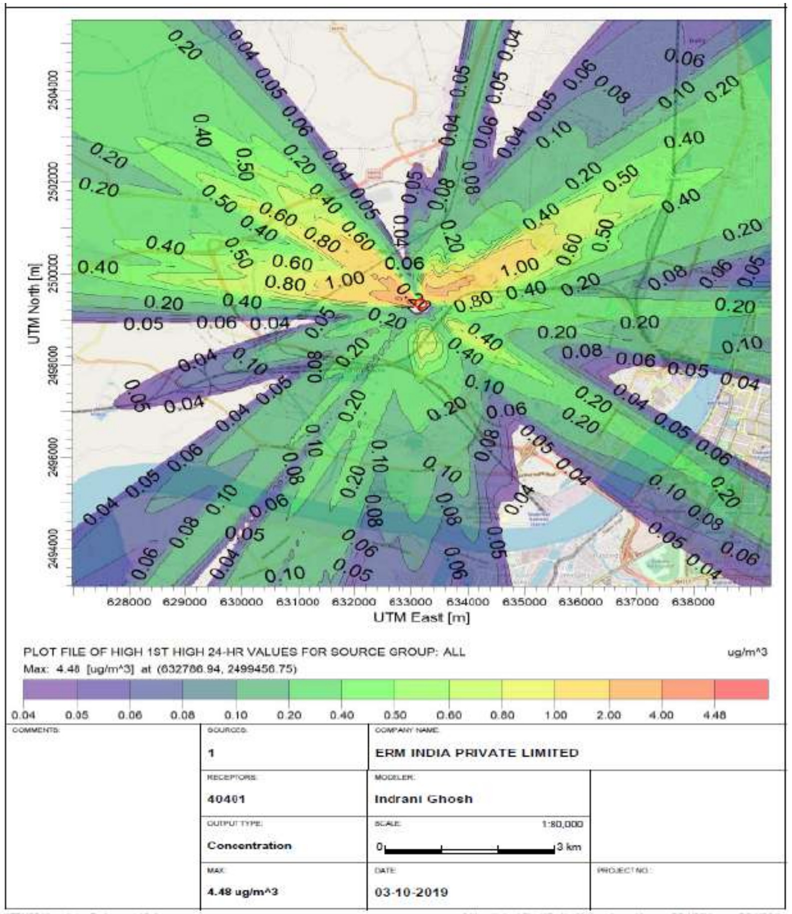


Figure 5.8 CO Isopleths of stack connected to Engine

(24 Hourly Maximum Ground Level Concentrations)

(24 Hourly Maximum Ground Level Concentrations)

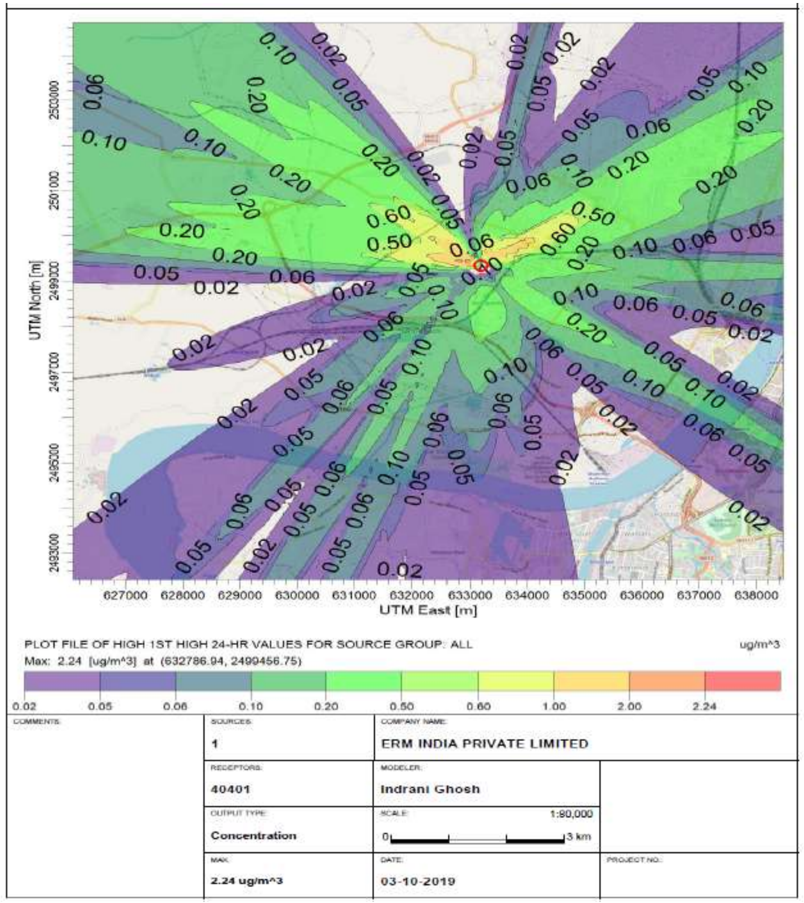
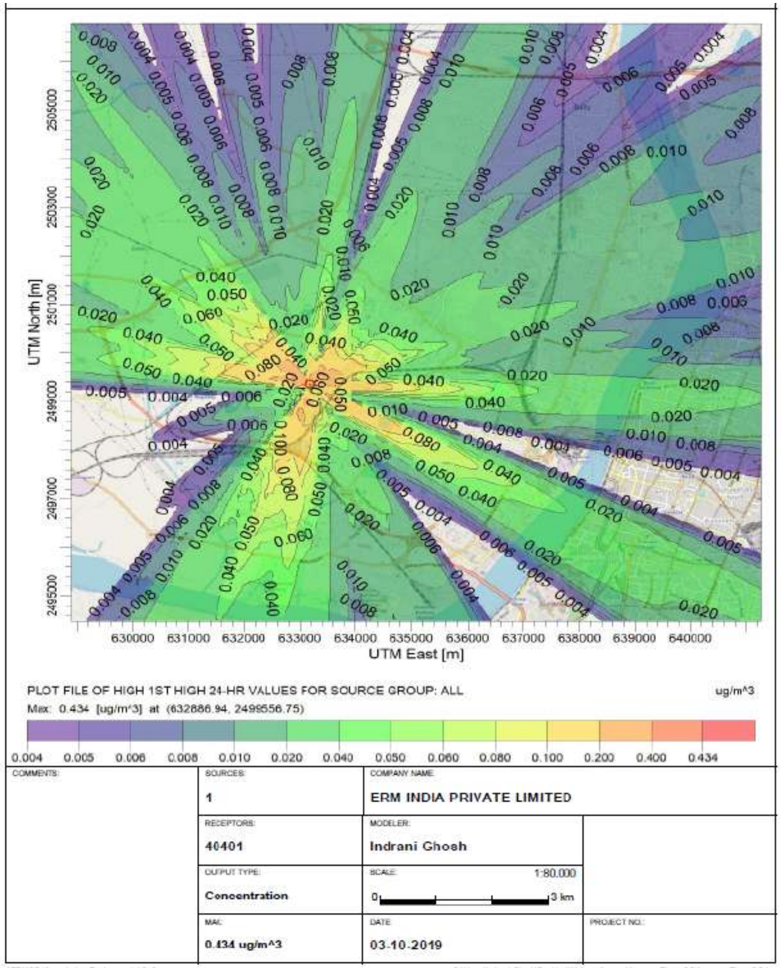
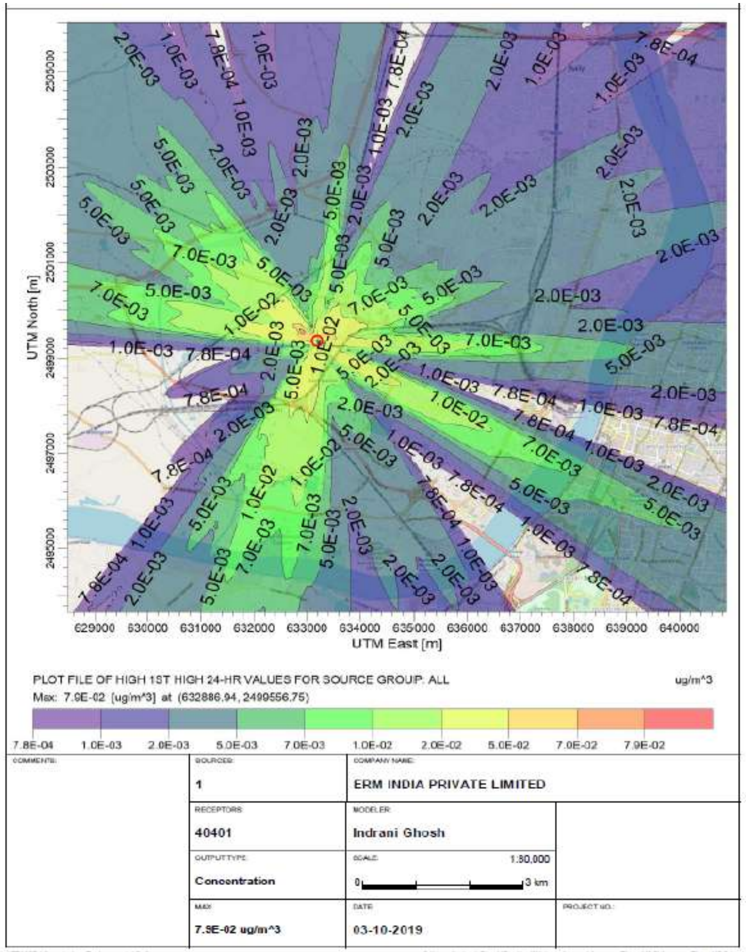


Figure 5.9 VOC Isopleths of flare stack

(24 Hourly Maximum Ground Level Concentrations)


UTM North [m]
UTM East [m]
630000 631000 632000 633000 634000 635000 636000 637000 638000 639000 640000
PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: ALL
ug/m^3
Max: 0.434 [ug/m^3] at (632886.94, 2499556.75)
0.004 0.005 0.006 0.008 0.010 0.020 0.040 0.050 0.060 0.080 0.100 0.200 0.400 0.434
COMMENTS:
SOURCES:
1
COMPANY NAME:
ERM INDIA PRIVATE LIMITED
RECEPTORS:
40401
MODELER:
Indrani Ghosh
OUTPUT TYPE:
Concentration
SCALE:
1:80,000
0
3 km
MAX:
0.434 ug/m^3
DATE:
03-10-2019
PROJECT NO.:


UTM North [m]
UTM East [m]
629000 630000 631000 632000 633000 634000 635000 636000 637000 638000 639000 640000
PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: ALL
ug/m^3
Max: 7.9E-02 [ug/m^3] at (632886.94, 2499556.75)
7.8E-04 1.0E-03 2.0E-03 5.0E-03 7.0E-03 1.0E-02 2.0E-02 5.0E-02 7.0E-02 7.9E-02
COMMENTS:
SOURCES:
1
COMPANY NAME:
ERM INDIA PRIVATE LIMITED
RECEPTORS:
40401
MODELER:
Indrani Ghosh
OUTPUT TYPE:
Concentration
SCALE:
1:80,000
0
3 km
MAX:
7.9E-02 ug/m^3
DATE:
03-10-2019
PROJECT NO.:

Odour Impacts

Nuisance odour generated from sewage and wastewater treatment plants impairs ambient air quality and represents a growing social and public health issue that is increasingly a cause for public discomfort and complaints. Biological treatment and stabilization processes which are widely applied for sewage treatment reduce the nutrient concentration in waste water, thus minimizing environmental impact. However, when anaerobic conditions are reached during microbial decomposition of organic matter present in sewage (food, animal scums, organic compounds, etc.), unpleasant odours are generated. From the chemical nature point of view, the main contributor of such odour are gases like Hydrogen Sulphide as well Volatile Organic Compounds (VOCs) resulting from anaerobic decomposition of organic matter with sulphur and nitrogen content. Other by-products of such decomposition process may comprise of highly odorous compounds like mercaptans, organic sulphur substances and amines.

As per standard STP operation, key emission sources of odour from the proposed STP are as follows:

Potential sources of odour due to mass transfer and organic reaction leading to formation of odourous substances are, aerated grit separator, activated sludge treatment section. As per GSPPL these structures of proposed STP are closed, odour generated within them will not spread outside, hence these have not been considered while estimating odour impactsWhile, sources where new odorants form, i.e., primary/secondary sedimentation, thickening tanks are considered major sources of odour and hence they are considered for odour impact estimation.

In addition, other sources will include underground conduit lines, and existing I&D structures. In order to assess an incremental increase of odour levels consequent adverse impacts in the immediate neighbourhood of the STP site, a dispersion modelling approach has been adopted. It needs to be noted here that there is no ambient odour level standard that are specified by regulations in India – regulatory guidance though mentions that odour levels from discharges /wastes should be managed such that it is not objectionable to receptors. The step-wise methodology adopted for carrying out the prediction exercise is discussed below:

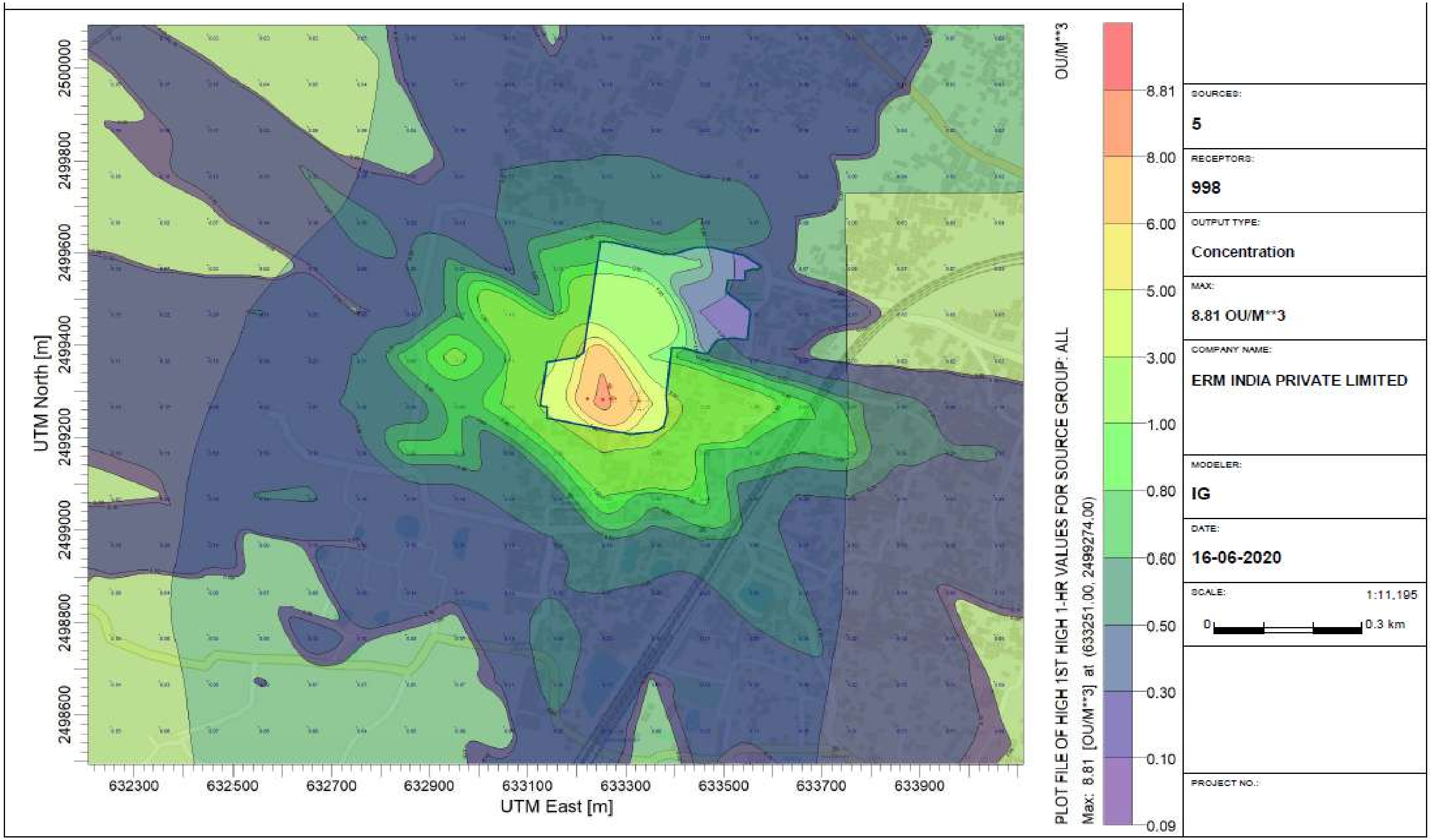
- Considering multiple uncharacterized odorant gases to be the potential source of Odour, standard Odour emission rates/factors, based on review of order of magnitude estimates from specific components of biological water treatment plants (sedimentation tanks, aeration tanks, sludge thickeners, etc.), available in literature has been used (in terms of Odour emission rate in ou per m^2) to estimate source wise contributions/Odour flow rates from the STP, as per **Table 5.7** below.

Table 5.7: Source wise Contributions/Odour Flow Rates from the STP

Source	Area (m^2)	OU/m^2h	OU/m^2s	OU/s
Primary Clarifier	156.16	5000	1.38	216.89
Secondary Clarifier	982.5	500	0.13	136.46

- One season’s meteorological data has been complied based on near site secondary data available and used for the use in the predictive modelling exercise. Given that the terrain is flat, and the proposed buildings and structures are not very high, no terrain data or building wake effects have been considered in the model run.
- Odour dispersion has been predicted using AERMOD steady-state plume model in area source mode resulting in estimation of ground level Odour concentrations (GLC) as Odour units / m3 at specific receptor locations and as contours of specified Odour levels within 1 km radius around plant. **Figure 5.14** provides the odour concentration contours around the source of emissions.

Figure 5.10 Odour Concentration Contours around the Source of Emissions



The dispersion of odour concentrations based on emissions from source of origin shows that the highest concentrations 4.76 OU/m^3 at a point located within 100 m from the source. As per guidance available in the UK, it is generally accepted that odour concentrations of 5 – 10 OU/m^3 give rise to a faint odour which may just exceed the annoyance threshold of human receptors and distinct odour which can give rise to a nuisance results from a concentration of > 10 OU/m^3. Odour impacts will be caused by the operation of the STP for the residents of Arupara. As these residential houses are within ~50 m from STP southern boundary. Moreover, there is a potential for some odour nuisance to be generated along the sewer lines which may impact residents neighbouring the alignment, shops and markets (***refer section 2.5)*** and due to temporary storage of de-silted material/solid waste during de-siltation along the sewer network. Duration of temporary storage may be upto 8 hrs maximum post which these will be collected by collection trucks and disposed to KMDA assigned landfill, which is comparatively short, hence the impact may be considered to be of minor significance.

Impact	**Air quality Odour impact during Operational Phase**			
Impact Nature	Negative		Positive	Neutral
Impact Type	Direct		Indirect	Induced
Impact Duration	Short Term		Medium Term	Long Term
Impact Extent	Local		Regional	National
Impact Scale	Low		Medium	High
Impact Magnitude	Positive	Small	Medium	Large
Resource/ Receptor Sensitivity	Low		Medium	High
Impact Significance	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			

Mitigation Measures:

- Developing a ambient monitoring plan and stack monitoring schedule
- Using low sulphur content diesel for DG sets.
- Keeping the storage areas under moist conditions to prevent dust formation.
- To ensure compliance with the air emission criteria for flue gas stacks, the following measures will be implemented during operations:
  - The use of continuous emission monitoring (CEM) equipment for the measurement of air emission levels in the exhaust stack of HRSG. CEM will be undertaken for PM_{10}, NO_x, SO_2, CO and O_2;
  - $PM_{2.5}$ and VOCs will be monitored periodically, to ensure that these emissions are not occurring as a result of the incomplete burning of the natural gas fuel.
  - The stack will be provided with safe access to sampling points for CEM.

5.4.3 Noise Quality

Construction Phase

Impact Source: The potential impact on noise quality may arise out of the following:

- Machineries and Equipment;
- Vehicular traffic;
- Back-up DG set.

Impact Assessment: The proposed project sites are located near residential settlements having micro and mini scale of industrial activities undertaken in the vicinity of the site apart from vehicular traffic on H.I.T road ***(refer 4.2.13)***. Current noise sources at the site of the project are due to natural sources and homebased or micro scale industrial operation i.e. grinding machine, lathe machines, stamping mills etc. Manmade sources include DG set operation, traffic noise, which was negligible in the project site due to low traffic volumes on nearby roads. The construction of STP will produce significant noise. The cumulative level of noise generated during this phase will be ~70-80 dB(A).This intensity of noise is higher than the standard set by central pollution control board i.e. 55 dB for residential area during day time and 45dB for night time. Minimum distance of receptors from the STP site is ~10 m, the intensity of noise from sources i.e. backhoe, Front loader, Generator, tractors, dozers and concrete vibrators will exceed 55 dB by the time it reaches to the receptors. This may cause discomfort for the construction workers and nearby receptors ***(refer section 2.4)***. The base condition (**refer 4.2**.8) state that the existing environment is stressed due to homebased and micro scale industry operation, noise generated during this phase will add up to this high sensitivity of receptors condition. Since the activities are for shorter duration hence the magnitude of impact is Moderate in nature.

Mitigation Measures: Effective noise management protocols would be implemented wherever applicable during construction and operating phases of the life of this project. Besides this protocol measures, construction work will be limited to day time periods, thus avoiding the night time which is the most noise sensitive. The following measures should be treated as a part of the project proposal which include:

- Switching off unnecessary or idle equipments;
- Fitting of noise mufflers to mobile equipments; and
- Preventive maintenance of equipment to minimize noise emissions.

Operational Phase

During daily operations of STP, noise will generated from pumps and air compressor having noise range of 60-90dB or DG set operation for providing back up for administrative building and noise generated from it with enclosure is within range of 60-70dB. As per Site setting ***(refer 2.4)*** distance of nearest receptor is ~10 m and noise generated from either source will be above 45-55 dB and have moderate effect on the already stressed baseline ***(refer 4.2.8)***.

Mitigation Measures:

- High-quality pump installations will be arranged within the territory of the treatment plant. Much less, noise is generated from pumps, which are made of stainless steel or cast iron. Low-cost pumps, which are made of thin steel sheets produce more noise;
- During the installation of pumps, noise-insulating material such as foam plastic can be used as far as possible;
- Pumps will be arranged on vibration isolation platforms, for which thick rubber sheets can be used;
- If necessary, equip personnel with proper protective equipment;

- Frequent change of personnel that are employed for noisy works;

As discussed in the baseline section and above, the area in the vicinity of the site already has high day and night time noise levels prevailing because of existing noise emitting sources like vehicular and railway traffic and also operation of earth movers and heavy machinery exceeding ambient noise level standards for residential area. In the following section, an attempt has been made to assess incremental noise pressure levels that may be caused by construction and operational activities related to the STP project.

A noise modelling exercise has been undertaken based on sound pressure level propagation equations to predict noise levels generated during construction and operation phase from the proposed site near receptors. The predicted results will help in ascertaining if the sound propagated due to the proposed activities at receptor level will be in compliance with stipulated ambient noise levels and if any receptors in the immediate vicinity of the sites would be adversely impacted and plan for appropriate mitigation measures.

As per principle of sound pressure level propagation, in a free field condition, the sound pressure level decreases in inverse as the distance from the source increases, and the following equation holds:

$$SPL_{(R2)} = SPL_{(R1)} - 20 \log R2/R1;$$

Where, $SPL_{(R2)}$ = Sound Pressure Level at distance R2; and
$SPL_{(R1)}$ = Sound Pressure Level at distance R1.

In addition, the sound pressure level reduces during propagation due to atmospheric attenuation (frictional loss of sound energy for moving through air medium) and due to absorption with solid obstacles such as concrete walls, berms, vegetation, etc, interaction with ground and several other factors as outlined above.

Hence, the refined equation for sound propagation around a noise source has been used for modelling:

$$SPL_{(R2)} = SPL_{(R1)} - 20 \log R2/R1 - Ae - Aabs;$$

Where, Aabs = Atmospheric attenuation of sound energy that varies with frequency of sound level, temperature and relative humidity;
Ae = Excess attenuation is a combination of all effects:

$$Ae = A_{weather} + A_{ground} + A_{turbulence} + A_{barrier} + A_{vegetation}$$

For application to the specific noise sources that would contribute to ambient noise levels, it has been assumed that:

- At any given point of time, all the equipment and vehicle listed in ***Table 5.8*** and a DG set with SPL of 75 dBA are being operated together;
- All the equipment are operating within a radius of 50 m and equivalent noise level from each equipment is cumulatively considered to be a single point source;
- The frequency of noise generated from each equipment is 500 Hz;
- At operation phase, a 800 KW Biogas plant and 800 KVA DG set will operate;
- Meteorological parameters such as wind speed and wind direction were not taken into consideration.

Table 5.8: Equivalent Sound Level (Leq) for Equipment and Vehicles

Equipment/vehicle	Leq (dB)	Equipment/vehicle	Leq (dB)
Wheeled loader	80	Concrete Mixer	84
Tracked loader	82	Batching Plant	78
Dozer	81	Pneumatic Drill	95
Excavator	85	Compressor	70
Dozer	92	Diesel Generator set	75
Grader	83	Hand-held pneumatic rock drill	90
Peumatic breaker	86	Water pump	77
Compressor	87	Hand-held electric circular saw	82
Pneumatic spade	87	Club Hammer	79
Road roller	80	Dumper	89
Auger	90		

It is to be noted that the land use of 500 m around source has been considered for this noise dispersion modelling exercise. The total area has been divided into three quadrants based on the land use. The three quadrants have been described below.

- North to north-north-east - There is a layer of vegetation from 100 m up to 400 m;
- North-north-east to south-west -There is residential area of GIP Nagar, Hatpukur beginning from 10 m from the source to 500 m. There is a boundary of 5 feet around the source and between the residential areas;
- West to north – There is an expanse of fallow land, water body and few buildings (Military Training School) within 200 m. There is residential area between 210 m and 500 m. There is a boundary of 5 feet around the source and between the residential areas.

The results of the noise modelling exercise from the source both during construction and operation phase has been shown in **Figure 5.11** and **Figure 5.12** below.

In construction phase, the Equivalent Sound Pressure Level (Leq) from different equipment and vehicle operation was calculated to be 100.2 dB. In operation phase, the Leq from 800 KW Biogas plant and 800 KVA DG set is calculated to be 90.14 DB. The baseline noise, predicted sound pressure level and cumulative noise at receptors Adarsh Nagar and Pramod Nagar during construction and operation phase is provided below:

Table 5.9: Total Noise Levels at Receptor Locations

Receptor Location	Baseline Noise Level (dBA)	Predicted Sound Pressure Level (dB)	Cumulative Noise Level (dB)	Daytime Noise Standard (dBA)
Construction Phase				
N1	50	46.5	51.6	55
N2	62.8	44.0	62.8	55
N3	62.5	61.0	64.8	55
N4	57.0	53.5	58.6	55
Operation Phase				
N1	50.0	46.4	51.6	55
N2	62.8	33.9	62.8	55
N3	62.5	63.9	66.3	55
N4	57.0	43.4	57.2	55

Figure 5.11 Predicted Incremental Noise Pressure Levels during Construction Phase

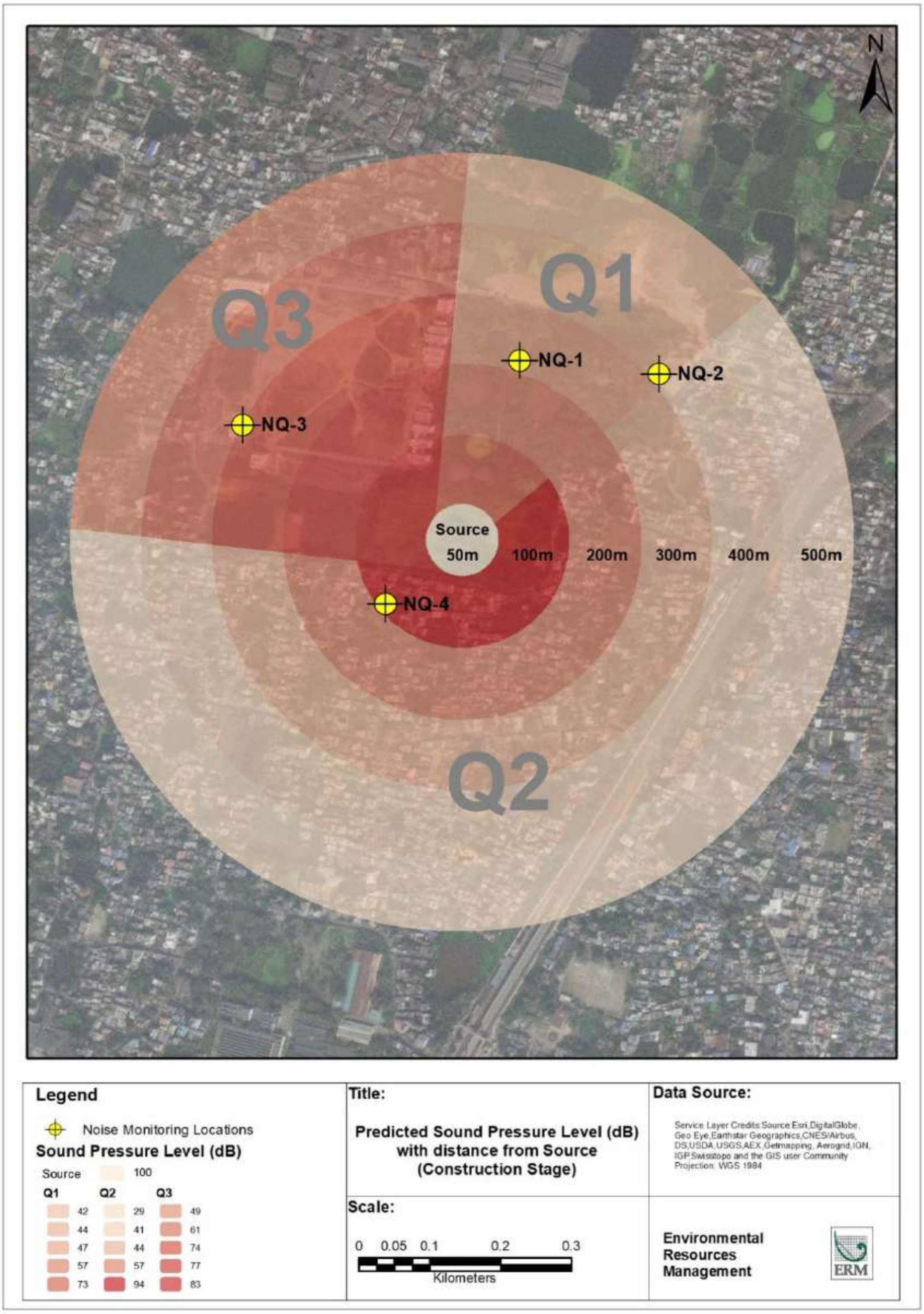
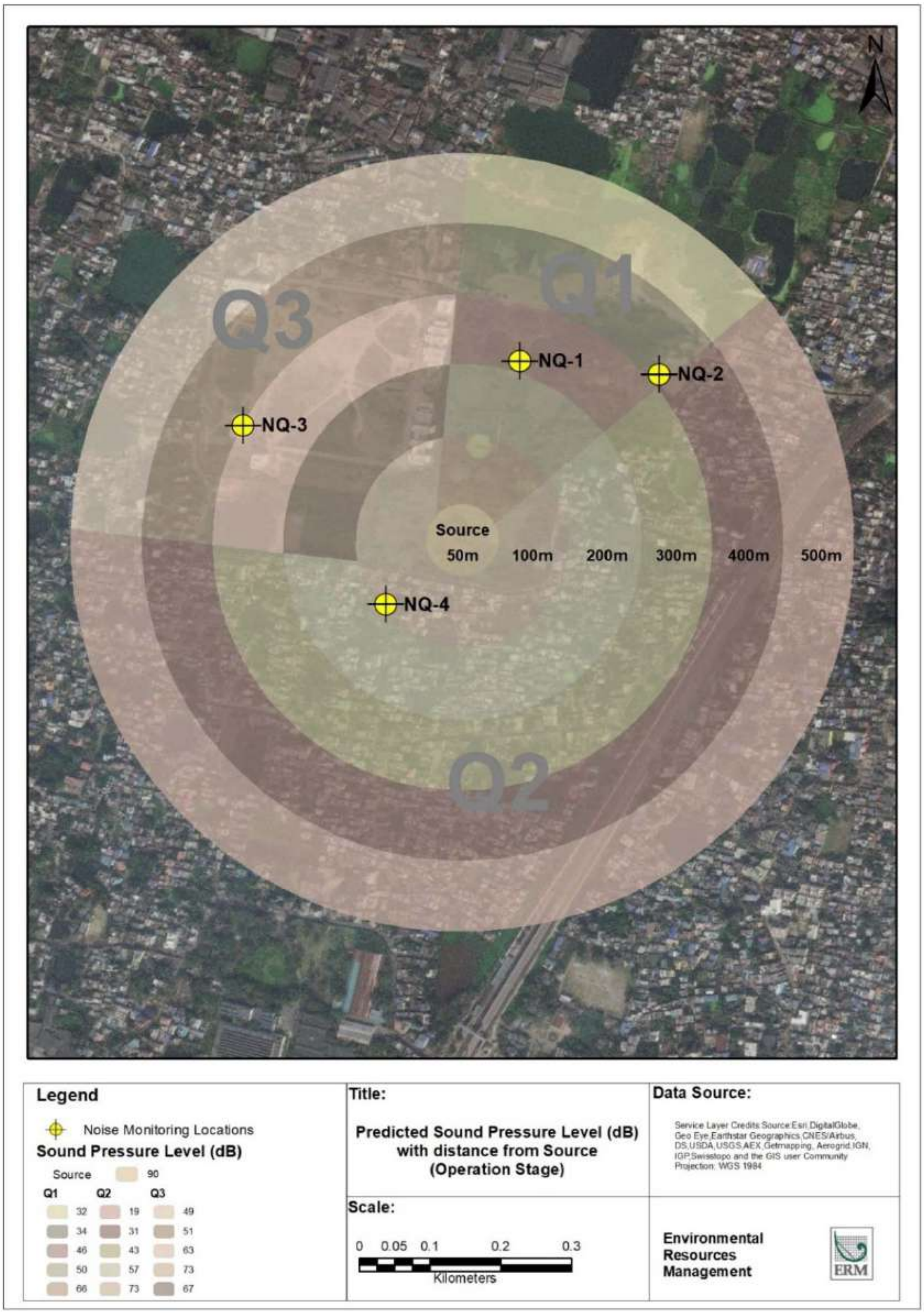


Figure 5.12 Predicted incremental Noise Pressure Levels during Operations Phase



Currently, the existing ambient noise level at monitoring locations is above the daytime stipulated standard of 55 dBA. As shown in the **Table 5.8** above, the cumulative sound pressure level will not increase the existing noise level at the residential areas such as GIP Colony (N4) and Military Training Institute (N3) and within 300m from the proposed construction Site (N1) by more than 2 dB during construction phase. Similarly, in the operation phase, the cumulative noise level will not increase more than 3 dB (at N1 and N3). Since, the cumulative noise level at Site is more than 85 dB, as best practise the workers must be provided with personal protective equipment such as ear muffs to reduce exposure to high noise level. Hence, impact due to incremental noise during construction and operation phase from the proposed project will not significantly impact this area.

Impact Significance	**Impact due noise generation during operational phase**			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered ***Moderate***			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Medium.**			

Residual Impact: Considering the implementation of above mentioned mitigation measures, the significance of residual impact on ambient air quality during construction phase is assessed as ***Medium***

5.4.4 Drainage Impacts

During project life-cycle potential scenarios impacting the surrounding drainage system are, firstly, storm water from northern boundary entering into STP complex through broken boundary, secondly, flood scenario developed due to heavy rainfall. Lastly, daily operation of STP resulting in discharge of treated wastewater. Under all scenarios discussed above, discharge will happen into Howrah drainage channel connected through brick sewer line due to natural slope ***(refer section 4.2.9)***. As discussed in baseline (**refer section 4.2.9**) the carrying capacity of Howrah drainage channel is 7968 MLD. Hence we infer that excess load of 65 MLD from STP operation will not have any impact on the drainage of the surrounding. The potential impact scenarios as discussed above will also have negligible impact on the drainage due to buffer carrying capacity of ~7000 MLD.

Mitigation Measure:

- Site can develop a storm water drainage system as best management practice.

Impact Significance	**Impact on Drainage**			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Negligible**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Negligible.**			

Residual Impact: Considering the implementation of above mentioned mitigation measures, the significance of residual impact on ambient air quality during construction phase is assessed as ***Negligible***

5.4.5 Surface Water Quality

Construction Phase

No adverse impact on surface water quality is envisaged as no discharge into surface water is proposed during construction phase and all proposed phase activities will happen within the STP complex as result the there is no interaction with surface water resource also.

Impact Source: Contamination of surface water bodies during the construction phase is possible in the following cases:

- Oil spill in case of violating the rules of their storage or the rules of construction equipment and vehicles maintenance;
- In case of contaminated water discharge during the earth works;
- In case of discharging vehicles or equipment, wash down water;
- In case of improper management of construction waste;
- In case of improper management of sludge and storm waters, etc.

Mitigation Measures:

- Providing spill kits near oil and grease storage
- Using a secondary container during transfer of oils, grease etc.
- The drainage system at site is to be provided with sedimentation tank and oily-water separator to prevent contaminants, especially oil and grease, from being carried off by surface runoff.

Operational Phase

The objective of the proposed project activity is aimed at creating environmental improvement in terms of reducing pollution load to receiving water stream of Howrah Drainage Channel by installation and operation of STP and linked sewerage infrastructure. The functioning of the STP is ultimately intended to reduce the load of untreated sewage generated in the area to the river Hooghly. The Howrah Drainage Channel, the surface water stream that would receive the discharge is already significantly polluted by untreated sewage and waste water load from upstream areas in it catchment and the downstream Howrah Drainage system has also been observed to be having similar conditions with the average observed BOD concentration in the range of 50 – 60 mg/l. So the treated effluent discharge which is to be having BOD levels (design) of 20 mg/l is unlikely to cause any incremental adverse impact to the receiving surface water environment. The facility has a flat topography**(Refer Section 4.2.1)** ,the only impact during operation phase on surface water would be improper operation or malfunctioning of STP equipment or in case of flood situation resulting to draining of storm water during heavy rains or monsoon season causing overflowing of adjacent ponds existing nearby STP facility **(Refer Section 4.2.9)**

Quantitative Rationale

As discussed earlier in this section discharge from STP during construction and operation phase has no adverse impact and improves the quality of water in drainage channel. We have come across in baseline section that BOD of drainage channel (Pocha Khal) in vicinity to plant discharge point is 52 mg/l or 52 X 10^{-3} kg/m^3, and as per STP design parameters the highest BOD load in STP treated water is 20 X 10^{-3} kg/m^3.

Data

A. Drainage Cannel peak flow (m^3/Hr) :332000

B. STP discharge Peak Flow (m^3/Hr) :2708.33

C. Highest BOD load in drainage Channel (kg/m^3) :52 X 10^{-3}

D. Highest BOD load in STP treated water discharge (kg/m^3) :20 X 10^{-3}

Formulae used for Total BOD in drainage channel and STP Treated water

$$\text{Total BOD (Kg/Hr)} = \text{BOD Concentration (Kg/m}^3\text{)} \times \text{Flow Rate (m}^3\text{/Hr)}$$

E. Total BOD load in Drainage Channel (Kg/Hr) :17264

F. Total BOD load in STP treated water discharge (Kg/Hr) :54.17

Formulae used for calculating cumulative BOD load from STP on drainage Channel

$$\text{Cumulative BOD Load (mg/L)} = \frac{E+F}{A+B}$$

Result

As per formulae stated above the cumulative BOD load on the adjacent drainage channel due the peak BOD load discharge from STP operation is 51.74 mg/L. Hence, there is an improvement in water quality of drainage channel as the there is a reduction of 0.16 mg/L in BOD concentration in drainage channel due to discharge of STP. Above mentioned assessment is based on following assumptions:

1. BOD load is uniformly distributed in the drainage channel water at the upstream from the STP discharge point; irrespective to changing season and time;
2. STP discharge is uniform throughout its operation;
3. No influx of fresh water or wastewater into the drainage channel from surrounding environment.

Note:

Due to upstream and downstream discharge scenario present in the drainage channel, it is not possible to predict the impact of STP treated water discharge in the ultimate receiving body i.e. Hooghly river, as GSPPL and KMDA has no control over the upstream and downstream discharge from the local environment into the drainage channel.

Mitigation Measures:

- Provide emergency measures for potential sewage overflows from sewer systems, including intervention troughs along the affected main surface drains that are likely to receive overflowing sewage. Similar collection trough could also be provided downstream the treatment plants,
- Draw up a monitoring schedule for the treated sewage quality. This should actually constitute an important component of the sewage treatment disposal (sampling at pre-designated locations of the treatment plants and submitting to the laboratory for analysis. Key water pollutants would include organic matter, settable solids and nutrient residuals.

5.4.6 Ground Water Quality

There will be no groundwater extraction during project life-cycle, as per site observation, there exist a borewell near the entrance gate along the eastern boundary or west of existing MPS within the STP complex, which is used for drinking and domestic purpose presently. All water during construction and will be sourced through water tankers and during operation phase water will sourced from municipal supply with daily consumption rate of 0.5 m^3/day as mentioned in Consent to Established (CTE) applied by Wabag. Hence there will no impact on ground water resource. Potential sources of impact for ground water contamination are minor oil and grease spillage, during maintenance of construction machinery, repair of pumps and compressors during operational phase. Leakage from brick sewer line along the H.I.T road and affecting the sub-surface area cannot be ruled out as the soil layer surrounding the STP is sandy-clayey and having high porosity in nature. **(refer section 4.2.2).**

5.4.7 Soil Quality

Construction Phase

Impact scenario envisaged for the project phase are firstly wastewater generated during suppression of fugitive emission during this phase and secondly, chances of oil spills and oil/grease mixed cotton waste not properly disposed after maintenance/repairing activities of construction equipment, during this phase ***(refer section 2.8).***

Construction waste may contain hazardous as well as non-hazardous waste.These waste must be segregated at source or else any leakages or spills viz. grease and lube oil from motors and gearboxes, heavy metals from circuit boards and electrical panels etc. will contaminate the soil within the facility as well as at the disposal ground.However, these impacts are temporary, limited only to STP site and reversible in nature.

Fuels, lubricant, paints, etc., would be stored at designated paved areas. Thus the contamination of soil can happen only due to accidental spillage of fuel, lubricants and paints from storage areas and during transfer of fuels and chemicals. However, in case of a spill, the restoration of top soil is usually difficult and a time taking activity.

The primary monitoring results of soil quality results shows that soil inside and near the STP is highly porous in nature, having heavy metals i.e. Copper, Lead and Zinc but these are not alarming in nature **(Refer Section 4.2.4).** Any impacts from above mentioned activity will be reversible in nature and will deteriorate the baseline condition. The above mentioned soil quality impacts will be localized within the project site or in the immediate vicinity. The significance of potential impact, without mitigation measures in place, on soil quality is assessed as ***Minor***.

Mitigation Measures:

- Manage spills of contaminants on soil using standard engineering practices;
- Impervious storage area, especially for fuel & lubricant, chemical, hazardous waste etc.
- Municipal solid waste generated from the labour camp and construction site will be transferred to the disposal site in consultation with the local municipality;
- Fuel, chemical and lubricant will be stored in paved storage areas.

Impact Significance	**Impact on Soil Quality during Construction Phase**			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Minor.**			

Residual Impact: Considering the implementation of above mentioned mitigation measures, the significance of impact on soil quality is assessed as ***Minor.***

Operational Phase

Potential impact on soil quality can arise due to activity i.e. accidental spillage of fuel (from DG set or used for initial ignition of gas engine) maintenance activity & lubricant (for gears, motors and air compressor unit) from storage facility or from transport vehicles; which will get absorbed by soil and impact the quality of soil within the STP complex, chances of spreading of contaminated soil to receptor surrounding is negligible as all operational phase activity will take place with the STP complex. Secondly activity of improper storage and disposal of STP sludge and biogas scrubber sludge, which have high organic content will have positive impact by increasing the fertility of the soil as dried sludge are mostly used as bio fertilizers. The only case that will heavily impact the soil quality of the STP and surrounding is overflow of STP equipment due to malfunctioning or flood situation. Occurrence of such events is very rare, though these situations are detailed in control measures ***(refer section 2.8)***.Overall impact for this phase is estimated to be negligible has the impact scale is low, sensitivity of receptor is low resulting in magnitude of impact to be as negligible.

Mitigation Measures: The following mitigation measures will be implemented:

- Ensure proper spill control and management at site;
- Monitor and detect any contamination on soil & ground water;
- Good housekeeping to prevent spillage and runoff from site;
- Ensure the disposal of waste into designated storage and disposal area.

Impact Significance	Potential Impact on Soil Quality during Operational Phase			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Negligible**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Negligible.**			

Residual Impact: Considering the implementation of above mentioned mitigation measures, significance of impact on soil quality during operation phase of the Project is assessed as ***Negligible.***

5.4.8 Road Traffic Impacts

As per ***section 2.3*** site has only one access road which is used by residents for daily activities. The STP site is connected through one major route i.e. H.I.T road connecting to Dr.Bholanath Chakraborty Sarani which meets Kona expressway. To understand the baseline condition and traffic influx, baseline monitoring was undertaken on H.I.T road, which would be predominantly used during the de-construction phase for trucks, tippers, and other heavy machinery that will be mobilized.

From the proposed project approximately, additional 10-15 PUC/day carrying construction material, disposal of construction waste and transportation of plant machineries and raw materials will be using the Kona Expressway through H.I.T road and Dr.Bholanath Chakraborty Sarani. Based on the baseline traffic survey conducted (**Refer Section 4.2.13**). The average peak hourly traffic on this route was 4.01 PCU/Hr (up) and 3.85 PCU/hr (down) number of vehicles per hour and maximum traffic load was 10.75 PCU/Hr (up) and 7.5 PCU/Hr (down). The site access road has the carrying capacity of 35 tons vehicles. Movement of heavy vehicles along the road has a potential to cause accidents or hazards due to increase in traffic during construction phase, may cause perceptible changes in the existing scenario as this road is mostly by local resident for day to day activities. This additional load of 10-15 PCU/day of traffic load for the site access road may cause major changes. Receptors on northern, eastern and southern boundaries will be affected. Receptors western boundary i.e. residents of Hatpukur 380 m away will not affected as this road will not be used for project purpose.

Additionally, another cause of traffic congestion is the excavation works that will take place during the laying of the sewer lines, along the main roads. This will cause disturbance to traffic movement, which may cause some inconvenience to inhabitants, especially during the peak hours. As observed during site visit, the line passes through busy roads such as the Swarnamoyee road, Laxman Narayan Tola Road, and Ichapur road (HIT Road). These traffic and access disruption impacts will arise due to transportation of construction materials, movement of machinery and equipment, as well as excavation work.

The excavation and road opening activities may also potentially damage the underground water pipelines or electricity poles near the site of the proposed work. This may lead to disruption or damage of water supply, electricity supply and will also involve expensive repair costs.

The laying of the the 30 m stretch of pipelines, which includes excavation and backfilling will only take three days. Moreover, the use of vehicles of more than 35-ton capacity may damage the road and since the duration of construction phase is short term, the potential impact on road and traffic due to operational traffic is assessed to be ***Minor***. As major movement of traffic will happen only during this phase.

Work along the MPS will be planned so that traffic movement is not disrupted and work along sewer lines will be conducted over short stretches of 500 m in order to cause minimum traffic disruption.

Table 5.10: Location of Road Details

Project Activity	Location of the Impacts	Road Width	Receptors	Receptor
Laying of 700 m New Rising Main of 700mm	Swarnamoyee Road	8 - 10 ft	Squatter shops	 Squatter Shops Along Swarnamoyee Road
Laying of 700 m Gravity Main of 700mm	Botanical Garden Road	14 ft	Access towards BESU College	 College Ghat Road
Renovation of 700 m Brick Sewer Line	Itchapur Crossing (HIT Road), near Itchapur Pumping Station	20ft	Traffic at Itchapur Crossing (HIT Road)	 Itchapur Crossing/ HIT Road

<u>*Mitigation Measures:*</u>

- Trucks are not loaded beyond their load carrying capacity.
- Impose speed limit for vehicles moving in and out of STP complex by put display signs and hazards associated with rash driving.
- Since majority of the roads in the project area are narrow, there will be some traffic congestion, hence alternate traffic routing may be adopted in consultation with concerned traffic police authorities. In case alternative traffic routes are not available, traffic management measures will be adopted.
- Traffic dislocations also have some adverse impact on trade and commerce, hence works at business and market area must be completed in a phased manner and in consultation with the local stakeholders Care should be taken to minimize congestion and negative impacts at schools and hospitals

Impact Significance	**Impact on Road Traffic**			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Small.**			

Residual impact:

Considering the implementation of above mentioned mitigation measures, the residual impact disturbance/ discomfort to local people due to increase of traffic is assessed to be ***small.***

5.4.9 Community, Health and Safety

Experience shows that because of its nature and scale, project like Arupara STP can be expected to have a limited interface with the local community and as a result will have minimal impact on the safety and health of local communities. During the construction stage of the project, there will be an influx of workmen and labours, with some of them being from different socio-cultural settings as compared to the residential settlement around site. In the case that hygienic conditions are not maintained at the project site, there may be a vector borne and other ailments in the immediate vicinity. Unless proper sensitisation of neighbouring communities is undertaken and appropriate safeguards are adopted, there is a possibility for increase in sexually transmitted diseases, though the possibility appears quite remote.

The site clearing activities and construction activities (involving fill materials, brick and concreting work) would result in emissions of dust and noise, discharge of sanitary wastewater and potential littering from labour camps during a short phase and has a potential to contribute to additional nuisance levels for the community and households located immediately adjacent to site. However, with very few people living near the site, no significant health related impacts are expected to the communities in the area. The increase in vehicular movements as a result of plying of construction vehicles on the adjoining roads and the site access road would add to the risk of accidents in which local residents may be involved. Although there is a public concern over the potential health effects associated with the exposure to noise, odour and fugitive emissions, empirical data is insufficient to demonstrate adverse health impacts from typical STP projects. Considering good construction practices and planned embedded measures for mitigating these impacts, the overall significance of community health and safety impacts can be rated to be **minor.**

5.4.10 Spead of Infectious Diseases

Construction and Operation Phase

The influx of workers may impact public health as it may lead to an increase in the prevalence of diseases. The influx of migrant labour during the construction phase may lead to their mixing with the local population, which can have adverse impacts on the public health of the neighbourhood, as potential communicable diseases such as HIV/AIDs can be spread.

To address the impacts associated with the spread of infectious diseases, the following mitigation measures have been proposed.

Mitigation Measures

- Health screening of workers,
- Undertaking health awareness among the local community,
- Training programs on HIV/AIDS and other communicable diseases, etc.
- providing the local community of an understanding of the project activities and the possible health and safety risks associated with the same;
- Implementation of on-site vector control measures.

5.4.11 Occupational Health and Safety

Construction Phase

Impact Source:

- Waste handling and storage;
- Material handling and storage;
- Welding and gas cutting activities;
- Use of earth moving equipment;
- Installation of electrical equipment;
- Installation of chlorination unit;

Embedded Control Measure:

- Health and Safety policy and procedures
- Project specific Health and Safety committee;
- SOPs' for different activities (work to permit, work at height, hot work, confined space entry etc.)

Impact Assessment:

- All the impact sources listed above are hazard prone and involve a significant amount of risk for the people working.If these risks and hazards are not monitored or controlled then they may lead to fatal incidents which will have a negative impact.The receptors are mainly construction workers and people residing near by ***(refer section 2.4).***They are get directly affected by these activities, the impact scale is low and for short duration.
- During construction phase, Personal Protective Equipments (PPE) such as Protective footwear and protective goggles, Welder's protective eye-shields shall be provided to workers who are engaged in welding works, earplugs shall be provided to workers exposed to loud noise, and workers working in crushing, compaction, or concrete mixing operation.Workers deployed for renovation of brick sewer line will work in confined space, with low oxygen availability is another aspect which cannot be neglected. The overall impact with considering the embedded control systems is ***Minor.***

Mitigation Measures:

- Setting up a H&S committee for the site;
- Designated H&S personal for daily activities;
- Following all SOPs listed in WABAG H&S policy and procedures;
- Conduct HIRA and HAZOP study for the project activities.
- The workers will also be provided all necessary safety appliances such as helmets, safety belts, life lines, earplugs, mask, respiratory apparatus etc.
- A well maintained first aid kit including an adequate supply of sterilized dressing materials and appliances will be made available.
- Only the working staff and authorised personnel will only be allowed inside the STP premises.
- Drinking water facility will be made available. Also, adequate ablutions and change facilities to promote appropriate occupational health and safety (OHS) will be provided.
- The O&M and EPC contractor for the project i.e. M/s. VA Tech WABAG has a formalised Occupational Health, Safety and Environmental Policy endorsed by the Managing Director and Group CEO Mr. Rajiv Mittal. This policy will be applicable throughout the concession period. A copy of the Occupational Health, Safety and Environmental Policy is attached as an Appendix A.

Impact Significance	**Impacts on Occupational, Health and Safety during Construction Phase**			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Negligible**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Negligible.**			

Residual Impact: Considering the implementation of above mentioned mitigation measures, the significance of residual impact on ambient air quality during construction phase is assessed as ***Negligible.***

Operational Phase

During operational a number activity i.e. regular maintenance of STP equipment resulting in discharge of lube oils and grease, change over chlorine tonners , sample collection for quality analysis, planned shutdown of STP for cleaning purpose, handling and storage of sludge from sludge digester etc. All of these activity pose potential health and safety risk for employees involved during these activities as well as to the environment.

For hazardous and non-hazardous waste generated during maintenance, waste generated during activity may contaminate the soil due presence of harmful chemicals. Waste from cleaning activity may contain pathogen in them which pose risk to health of employees and receptors within the vicinity of STP causing vector bore disease. Due to embedded control measures (refer section 2.8) impact from above mentioned activities is estimated to be minor. Impact from chlorine tonner is separately assessed and has been attached in **Appendix D.**

Mitigation measure:

- Appointment of Site specific health and Safety officer;
- Formation of Health and Safety committee for developing and implementing plans and procedure.
- Manuals regrading Operations and maintenance procedures will be developed and maintained to ensure optimum environmental management of the activity will be produced.
- The workers involved in O& M will be adequately trained to operate the plant and also trained in environmental management requirements of the plant.

Impact Significance	Impact on Occupational Health and Safety Operational Phase			
Impact Nature	Negative	Positive		Neutral
Impact Type	Direct	Indirect		Induced
Impact Duration	Short Term	Medium Term		Long Term
Impact Extent	Local	Regional		National
Impact Scale	Low	Medium		High
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Minor**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Minor.**			

<u>*Residual Impact:*</u> Considering the implementation of above mentioned mitigation measures, the significance of residual impact on ambient air quality during construction phase is assessed as ***Negligible.***

5.5 Social Impacts

5.5.1 Access Disruption

5.5.1.1 Construction Phase

Source of Impact*:*

STP Facility

The Arupara STP will be constructed on existing STP land owned by KMDA. This has no additional land requirement and thus, does not possess any land acquisition related impacts. Besides, all work to be undertaken for renovation of the Main Pumping station and Lifting station will entails no new land acquisition. All the proposed work will be undertaken within the existing land and RoW that are under the jurisdiction of the KMDA. Additionally, a Land Ownership Declaration letter pertaining to

KMDA's ownership of the land area for the Arupara STP and linked facilities, has been attached as **Appendix E***.*

Sewer Pipelines

The proposed project will entail temporary access disruption during excavation work for laying of new rising mains, replacement and construction work*.* The disruption will be caused due to the excavation work, vehicular movement for transportation of construction materials for carrying out construction materials etc*.* along the narrow and congested areas*.* No new land acquisition will be required for undertaking the proposed work*.* All replacement and renovation work will be undertaken along the existing RoW*.* The diameter of the sewer pipeline is 700 mm and the width of the affected roads ranges between 8 ft to 14 ft*.*

Impact Assessment:

The proposed project will entail access disruption during the laying of new rising main of 700m as identified during the joint site visit*.* The disruption will take place along the congested areas and market areas of the road stretches provided in **Table 5.11** below*.*

The potential receptors that will be impacted due to access disruption are approximately seven shops, which are located along the Swarnamoyee Road and five shops located along Botanical Garden road, near the RoW of the project footprint*.* The access towards these shops will be disrupted during the construction work, particularly if there is excavation work involved*.* Similarly, it has been observed that one college is located near the alignment of the proposed work*.* As observed, the roads along where the sewer line traverses through are very narrow and congested areas*.* Reportedly, the alignment of the pipeline is along the middle of the road*.*

Therefore, in the event of any medical emergency, the community may be impacted*.*
The replacement will be carried out along the existing alignment and the rising main will be installed at a depth of 1m to 1*.*5m*.*

As reported by the project concessionaire, the number of days for the construction will be carried out in stretches and the excavation, replacement and backfilling of a 25 m stretch, will take approximately three days. Therefore the estimated time period that will cause access disruption for the local communities and commuters along these stretches is estimated to be three days. Moreover, as reported by the project concessionaire, the design of the sewers will be laid based on the depth of existing sewer line. The width of the trench excavation along the roads will vary from 0.8 m to 1.5 m and the depth varies from a minimum of 1.5 m to 2 m or as per the existing pipe line. Thus taking into consideration the diameter of the pipeline, the exaction work for replacement of sewer line will affect approximately 5 ft of the total width of the road which comprises of 2.5 m on the left hand side (LHS) and 2.5 m on the right hand side (RHS).The excavation work for replacement will be carried out in stretches*.*
Please refer to above for images and details of the roads that will potentially face access disruption during the proposed upgradation works along the sewer lines*.*

Table 5.11: Location of the Road

Location of the Impact Identified	Road Width Details	Receptor
Swarnamoyee Road	8-10 ft	Squatter shops
Botanical Garden Road	14 ft	Sqatter shops and access towards the BESU college

Source*:* Joint site visit dated 13th August 2019

Embedded control measures:

- For minimizing the duration and extent of the impacts, the concessionaire will carry out the excavation work utilising machines such as the backhoe excavator. Additionally, during the excavation work, safety measures will be put in place such as usage of danger lighting, sight rails, safety barricades, signage of retro-reflective sheet of high intensity grade, to prevent any mishaps to the commuters and pedestrians.
- In locations such as narrow streets and crowded market places where the usage of machines is not feasible, the work will be carry out manually. The concessionaire will put in place necessary precautions such as bracing / shoring for the excavated trenches.
- The concessionaire will carry out replacement of sewer lines in stretches.On each day, the maximum stretch at one location for the construction work which includes trench excavation, replacement and backfilling will be 25-25 m. Thefore the total duration of all stages which include excavation, laying & back-fillin, for one day will be 10-12 working hours. The construction work will be carried out during off-business hours from 1:00 pm to next morning 6:00 am.
- A Traffic Safety Management Plan will be developed for the contractors to comply during construction, where they will carry out work on the road in a manner where there is minimum disruption to the traffic flow while executing the work satisfactorily. Some of the measures to ease traffic congestion includes the following
  - Where construction activities are taking place at multiple sites along the same or on parallel routes, construction activity and the movement of road users is co-ordinated to ensure that the total delay along the route or on signed alternative routes is within acceptable limits;
  - In the urban environment, works requiring partial road closures, alternative routes will be provided.

Mitigation Measures:

- The Concessionaire should build in the following clauses in the contract agreement of the works Contractor and ensure the following:
  - The contractor should inform all the stakeholders well in advance (at least 15 days) before the start of the construction work to enable shop owners to stock up and remain unaffected if goods vehicles are unable to reach them during construction;
  - If necessary, a temporary site alternative/arrangement to be provided for temporary parking space for the cycle stand and e-rickshaw stand in consultation with the local administrative authorities;
  - The contractor should provide proper barricading and signage or notices to indicate the ongoing work. In case by-lanes towards the residential areas/shops are located from the replacement stretches, contractor to provide proper barricading and temporary alternate route for people to access their houses/shops.
  - Alternative access route to be provided for the community to access their residential places and in case of any medical emergency.
  - The above measures will be part of the contract agreement for the work Contractor Agency and will be implemented through it, with careful monitoring by the Concessionaire.

Impact	Access Disruption to the road side entities.		
Impact Nature	Negative	Positive	Neutral

Impact Type	Direct	Indirect		Induced
Impact Duration	Temporary	Short-term	Long-term	Permanent
Impact Extent	Local	Regional		International
Impact Scale	Within the RoW of the existing government roads within which the sewer pipelines will be laid.			
Frequency	During the construction phase			
Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor**			

Residual impact:

Considering the implementation of above mentioned mitigation measures, the residual impact disturbance/ discomfort to local people due to increase of traffic is assessed to be minor.

5.5.2 Temporary Loss of Income

5.5.2.1 Construction Phase

Source of Impact:

Road side vendors and shops who are operating their businesses as squatters within the RoW of the existing rising main will be impacted due to replacement of the 700 mm dia and 700 m rising main from BESU Lifting Station, along Swarnamoyee Road and Botanical Garden road.

Impact Assessment:

a. *Replacement of Rising Main:*

The excavation work may potentially lead to road blockage and access disruption, and as a result the commercial establishments and vendors located near the RoW of the project footprint will face some disturbance in operating their businesses on daily basis. On the basis of screening and site visits along the road stretches through which sewer lines are likely to be laid/replaced reveal that there will be temporary disruption to on-going commercial and vending activities, thus leading temporary income loss during the period of construction period (which is assessed to be around three days). As observed during site visit approximately 12 squatter shops of kutcha structure are located along the Swarnamoyee Road and Botanical Garden Road whereby the width of the road is between 8ft and 14 ft. These 12 identified shops are located near to the RoW of the project footprint. As per discussion with the site representative, the conservative estimates for carrying out entire work process (excavation-replacement-backfilling-repairing of road) will take approximately three days. The estimation and figure of loss will be finalized once the detailed measurement survey will be undertaken.

Embedded Control Measures:

- For minimizing the duration and extent of the impacts, the concessionaire will carry out the excavation work utilising machines such as the backhoe excavator. Additionally, during the excavation work, safety measures will be put in place such as usage of danger lighting, sight rails, safety barricades, signage of retro-reflective sheet of high intensity grade, to prevent any mishaps to the commuters and pedestrians.

- In locations such as narrow streets and crowded market places where the usage of machines is not feasible, the work will be carry out manually. The concessionare will put in place necessary precautions such as bracing / shoring for the excavated trenches.
- The concessionaire will carry out replacement of sewer lines in stretches.On each day, the maximum stretch at one location for the construction work which includes trench excavation, replacement and backfilling will be 25-25 m. Thefore the total duration of all stages which include excavation, laying & back-fillin, for one day will be 10-12 working hours. The construction work will be carried out during off-business hours from 1:00 pm to next morning 6:00 am.

Mitigation Measures:

- One time compensation will be paid to the affected persons for the temporary loss of income)for the period of disruption(as per the entitlements detailed out in the Livelihood Restoration Framework;
- The Concessionnnaire will ensure that compensation for the income loss is paid to the affected persons before start of any physical work.
- The Concessionaire has to establish an effective grievance redress mechanism, which should be properly communicated to all the affected persons and stakeholders; this will be there platform to raise their concerns and complaints.
- The contractor should ensure that construction work to take place during lean business hours and during the night to avoid major disruption
- During the laying of the rising main near the MPS, contractor should provide proper barricading during construction to ensure that temple is not impacted and accordingly provide safe access for people to visit the temple.
- The contractor should inform all the stakeholders well in advance)at least 30 days(before the start of the construction work to enable shop owners to stock up and remain unaffected if goods vehicles are unable to reach them during construction.
- Contractor during construction should ensure that structure near the RoW are not affected and excavation should be carried out to the possible extend to avoid any damages to residential and commercial structure.
- In case any the approach or access is built by the residents over drains, in case, is disturbed, then the approach will be rebuilt, if needed, at the end of construction in that region/ location. Until that time, temporary approach may be provided, if feasible.

Impact	Temporary Loss of Income for Shops, Road Side Vendors and Kiosks.			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Temporary	Short-term	Long-term	Permanent
Impact Extent	Local	Regional	International	
Impact Scale	Within the RoW of the existing government roads within which the sewer pipelines will be laid.			
Frequency	During the construction phase			

Impact Magnitude	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	Medium		High
Impact Significance (Without Mitigations)	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations)	Significance of impact is considered **Minor**			

Residual impact:

Considering the implementation of above mentioned mitigation measures, the residual impact disturbance/ discomfort to impacted shops due to temporary income loss for access disruption is assessed to be minor.

5.5.3 Influx of Labour, Child Labour and Conflict with Local people

Construction Phase

During the construction period, labour will be required for construction work for STP, and for laying and excavation work. Reportedly, in the first year of the construction, when majorly civil work will be undertaken, on an average 300-350 man power will be required and in the second year, when majorly technical work will be undertaken, the man power requirement will be reduced to 100-150. These includes unskilled, semi-skilled and skilled workers. Reportedly, 80% of the labour is expected to be sourced from outside the district and only 20% will be sourced locally.

The intra state migration of labour may affect the project area in terms of additional burden on public infrastructure such as water supply, electricity, and other social dynamics, which may potentially have an impact on local communities.

Moreover, there is a possibility of conflict with local people residing near the project footprint. The influx of labour may potentially lead to conflict with local people residing near the project footprint due to cultural differences. The conflict can also arise with shop owners and business entities operating their businesses near the project footprint due to access disruption, in case no proper mitigation measure is put in place. This can take place especially during the excavation and replacement work of the pipelines. The construction of the STP will be within closed premises and the labour camp will also be situated within the site.

As this impact is restricted to the construction phase, measures such as proper orientation to workers on gender and cultural sensitivity and prior information dissemination before construction starts is evaluated to be of ***Minor*** significance,

Mitigation Measures***:***

- Communication to local community, shops and vendors prior to the start of the construction

- Migrant labours would be provided training on local culture and traditions through daily tool box talk.
- Local Community to be made aware of the grievance mechanism and provide access to the local community and labourers to the grievance redressal mechanism for the project
- The Contractor are responsible for providing adequate accommodation facilities for the labourers. The camp is understood to be mobile camp and will be shifted to the movement of the construction activities along the sewer line.

- The contractor would require to develop labour management procedures and mitigation measures before the start of works and monitor and update the labour management Plan as necessary during the course of the project

5.5.4 Labour Accommodation

Construction Phase

Approximate 100-150 workers will be employed during the construction phase of the project. The demand for workers will keep on changing depending on the requirement of the work to be undertaken. It has been reported that 80% of the workers will be non-locals [39]. As a result, a labour camp will be required during the construction period. Mobile camps are required to be set up at every location during construction work. As observed during the site visit, the alignment of the existing sewer line for the proposed work passes through congested areas, thus haphazard establishment of the camp will aggravate the congestion. Moreover, improper sanitation facilities in the construction labour camps can also trigger vector borne diseases and impact the health and safety of the workers and the nearby community. Measures such as proper collection, storage and disposal of wastes, Proper sanitation facilities to prevent contamination of water resources from sanitary effluents generated from labour camps will be implemented. Taking these measures into account, the impact to public health and safety is evaluated to be of ***Minor*** significance.

Mitigation Measures:

- The proximity of the camp should be located away from the congested, market and densely residential areas.
- The community are to be made aware of the camps and local community. Movement of migrant labourer with in the villages should be restricted and Local residence/village should be restricted from the labour Camp;
- In the labour camp, minimum space allocated for each person. Separate accommodation for men and women. The labour camp (including mobile camp) to be set up should meet the requirement of IFC and EBRD;
- Provision of safe drinking water, adequate sewage and garbage disposal systems;
- The camp should be appropriate to protect the workers against heat, cold, damp, noise, fire, and disease-carrying animals, and, in particular, insects ;
- Camps should be equipped with adequate lighting, sanitary and washing facilities for both men and women;
- Waste and Waste water generated from labour camp should not dump with in the villages;
- Nearby Pond/Surface water should not be polluted;
- For dismantling of the mobile camp after completion of construction work, the contractor should ensure that all residual materials are collected to avoid any unnecessary lasting impacts of the accommodations on the communities (garbage, equipment etc).
- Grievance mechanism should be made aware and accessible to the local people in case of any complaints and issues. The mechanism should also be made available to the workers to register their grievances.

[39] Non-locals in this context is defined as an intra state migrants who are non-residents of Howrah Municipal Corporation (HMC), but are residents of West Bengal belonging to other districts.

5.6 Gender Empowerment Impacts

The project is found to have least adverse impact on women. As per the baseline survey conducted as part of the SIA in Arupara project area of influence only two woman-headed HHs which are both located near the Arupara STP site. However, both these two households are not projet affected person.

Review of female workforce participation reveal that the surveyed population indicates that majority of the women are not participating in the workforce and the consultations also revealed that majority of the women are engaged in unpaid domestic work. Similarly, a review of the workforce participation at the Arupara STP and linked facilities reveal that all the workers are male workers, with the exception of one female employee at LS 2 Foreshore Road. As a result, there is need to promote gender equality in all aspects of economic development. Women's roles in construction are mainly confined to supply of unskilled labour and vending of foodstuffs to the construction workers. As civil construction work will take place at the proposed Arupara STP site, including at the linked facilities during the construction phase, the participation of women in the construction workforce should be ensured to reduce gender disparity and enhance gender mainstreaming. Accordingly, detailed methods of engagement for women in the project area are presented in the Gender Action Plan (GAP) developed for the Project.

Embedded control measure

- The Project Concessionaire has put in place a policy for Prevention of Sexual Harassment (POSH)
- The project concessionaire has a HR Policies which mandated equal employment opportunity for both gender

Mitigation Measure:

- Ensure the implementation of the Gender Action Plan (GAP) for the project.
- Ensure equitable distribution of employment opportunities between men and women through encouraging contractors to employ local workers including women for labour-based work.
- GSPPL to ensure that the company level policy on Prevention of Sexual Harassment (POSH) in the Workplace is also extended to the project level. HR Policy should have provisions on anti-gender based violence.
- Trainings on anti-sexual harassment, anti-gender based violence and social protection benefits to be imparted to all employees.
- Ensure availability of gender sensitive facilities such as toilets, resting areas, crèches for children, and a policy against sexual harassment.
- Women should be encouraged to participate in public meetings, discussions and consultations especially with regard to their entitlements.
- GSPPL can also develop CSR Projects which include initiatives around the following aspects: Improving the health conditions of women in the project area, such as improving water supply, health and sanitation; Improving access to education for girls in the project area through school donations and provision of scholarships;
- GSPPL can also develop CSR programmes and trainings focussed on improving the health conditions of women and well as access to education for girls.
- Women should be made aware of the Grievance Redressal Mechanism (GRM) and the Grievance Redressal Committee should also comprise 50% of women members

5.7 Loss of Employment of Existing Workers

At present there are 63 contractual workers employed at the Arupara STP as well as the linked lifting stations, under the man-power supply contractors Associated Cooperative Labour Contractor and Construction Society Ltd and MCE Construction.

Post the construction, the project will be operated and maintained by the new O&M entity engaged by the Concessionaire, therefore, there is a potentiality of retrenchment scenario of the existing contracted workers, which may lead to a loss of livelihood for these workers. Consultation with the existing workers during site visit revealed that some of the workers have been employed for over 25 years. Thus, the project will impact the employment and livelihood of the existing contractual workers who may get laid off during the new O&M contract regime.

Based on the review of existing contracting arrangement between KMDA and the respective man-power supply contracting agencies, it is observed that KMDA has assigned the compliance liability against all applicable labour regulations (viz. Employees State Insurance Act, 1948; Employees Provident Fund and Miscellaneous Provisions Act, 1952; *Wages Act, 1936; Minimum Wages Act, 1948;* [40]*Employee Liability Act, 1938; Industrial Dispute Act, 1947 and Contract Labour (Regulation and Abolition) Act, 1970* or the modifications thereof or any other Laws relating thereto and the Rules made thereunder from time to time.) fully on the respective contractor agencies as the part of the contract agreement. As well as the condition on contractor shall indemnify KMDA against payment to be made under and the observance of the laws aforesaid and the CPWD Contractor's Labour Regulations having application within the State of West Bengal without prejudice to his right to claim indemnity from his sub-contractors.

It was also noted that as per Clause 18B of the said contract agreement, in every case in which by virtue of the provisions of Section 12, Sub-section (1) of the Workmen's Compensation Act, 1923 (i.e *principal employer's liability to pay compensation in case of bodily injury and disablement caused or death of any contracted worker in the execution of the work*) KMDA is obliged to pay compensation to a workmen employed by the contractor, in execution of the work. However KMDA will recover such amount of compensation so paid from the contractor as per the legal provision under Section 12, Sub-section (1) of the Workmen's Compensation Act, 1923.

Moreover, as per *Industrial Dispute Act, 1947* the term "retrenchment" is defined as "….*termination by the employer of the service of a workman for any reason whatsoever, otherwise than as a punishment inflicted by way of disciplinary action, but does not include: termination of the service of the workman as a result of the non-renewal of the contract of employment between the employer and the workman concerned on its expiry or of such contract being terminated under a stipulation in that behalf contained therein*…."

In absence of actual agreement in place between the O&M Agencies and KMDA, the date of expiry of the contract between them could not be ascertained.

The concern related to the contractual workers had been in discussion between the NMCG, KMDA and the Concessionaire. In the second Review Meeting of the progress of achievement of conditions precedent by the stakeholders of Howrah, Bally and Baranagar and Kamarhati STP Projects under HAM held on 22nd October 2019 under the chairmanship of Director General, NMCG, the employability of the workers deployed by KMDA for the operating facilities were discussed. It was decided that a consultative meeting would be conducted by KMDA and the Concessionaire with the existing workers and a necessary action plan would be submitted to the lender (IFC).

Based on the second review meeting held on 22nd October, 2019, the Concessionaire held a meeting with the Chief Executive Officer, KMDA on 27th November, 2019, following which the Concessionaire

[40] As of 2nd August, 2019, the Code on Wages, 2019 has been enacted which subsumes the Payment of Wages Act, 1936, the Minimum Wages Act, 1948, the Payment of Bonus Act, 1965 and the Equal Remuneration Act, 1976. However, this is subject to the adoption of the Act by the Government of West Bengal.

(VA Tech Wabag) submitted a letter number KMDA-NMCG/Proj/016/19-20 dated 27th November, 2019. Issues related to the existing workers were discussed and the letter mentions that, Wabag shall facilitate re-engagement of around 25 numbers of existing workers and that KMDA to identify alternate sites for rest of them from the list of workers provided by KMDA. KMDA was requested to kindly advice the concerned workers to provide age/ identify proof for the chosen ones. The documents are appended as **Appendix L** and **Appendix M**.

Additionally, a meeting was held on 10th February, 2020 between KMDA and GSPPL and subsequently on 14th February, 2020, regarding the re-engagement of the existing contractual workers. As a mitigation measure, it was decided by KMDA they will re-deploy the existing contractual workers from Arupara and Baranagar facilities to other facilities of KMDA, while GSPPL will be responsible for re-engaging 32 existing contractual workers from Bally MPS and the linked facilties.

Mitigation Measures:

- As per IFC PS 2 guidelines, viable alternatives to retrenchment should be analysed.
- If retrenchment is necessary, to reduce the adverse impacts of retrenchment on the workers, a Retrenchment Plan should be developed, meeting the following IFC PS 2 provisions on retrenchment:
  - As per the IFC Performance Standards 2, the retrenchment plan should be based on the principle of non-discrimination and should reflect the client's consultation with workers, their organizations, and, where appropriate, the government, and comply with collective bargaining agreements if they exist.
  - The client should comply with all legal and contractual requirements related to notification of public authorities, and provision of information to, and consultation with workers and their organizations.
  - The client should ensure that all workers receive notice of dismissal and severance payments mandated by law and collective agreements in a timely manner.
  - All outstanding payments and social security benefits and pension contributions and benefits should be paid:
    - on or before termination of the working relationship to the workers,
    - where appropriate, for the benefit of the workers, or
    - Payment will be made in accordance with a timeline agreed through a collective agreement.
    - Where payments are made for the benefit of workers, workers will be provided with evidence of such payments.
- The abovementioned mitigations have been presented in a Labour Management Framework (LMF).
- The Retrenchment Plan is required to be prepared prior to the closure of the contract of the workers, which has to be conducted in consultation with the affected parties and the Concessionaire.
- It should be noted that if the existing workers are redeployed into other alternate sites of KMDA and by the Concessionaire, then the impact would be reduced. Failing to which the Labour Management Plan would be effective
- A monitoring plan should be put in place to monitor the redeployment of labour to other facilities. The monitoring plan will be effective from the date of financial closure and handover of the project

to GSPPL. A third party audit should be conducted to monitor the redeploymnet of workers to other facility.

- It may be considered to provide retrenchment compensation as mandated by the following provision under Industrial Disputes Act, 1947.
  - The Conditions precedent to retrenchment of workmen outlined as per Industrial Dispute Act, 1947 Section 25F as "No workman employed in any industry who has been in continuous service for not less than one year under an employer shall be retrenched by that employer until (a) the workman has been given one month's notice in writing indicating the reasons for retrenchment and the period of notice has expired, or the workman has been paid in lieu of such notice, wages for the period of the notice; (b) the workman has been paid, at the time of retrenchment, compensation which shall be equivalent to fifteen days' average pay for every completed year of continuous service or any part thereof in excess of six months; and (c) notice in the prescribed manner is served on the appropriate Government or such authority as may be specified by the appropriate Government by notification in the Official Gazette."
- The existing workers (if they wish to continue work) may be accommodated or deputed into other such facilities (if there is such scope available) run by KMDA.
- Alternatively, these workers may be considered or given priority by the then O&M Agency, based on their selection and recruitment criteria, during the O&M phase.

6. ALTERNATIVE ANALYSIS

Analysis of alternatives involves a thorough study of the possible future conditions in the project study area of the possible future conditions in the project area in response to a set of alternatives without the project or status quo condition.

6.1 Project Rationale

The proposed project activity will involve building a new 65 MLD capacity sewage treatment plant. Limited environmental impacts are expected during construction. Little air, water and noise pollution is expected from the proposed construction activities; however these are localized impacts and can be minimized with proper construction schedule and precautionary approach. Since the project is in an existing piece of land, no alternate sites were considered. Moreover, he proposed plant site is in accordance with MoEF guidelines:

- There are no National Parks/Sanctuaries within 10 km radius;
- There are no Historical places/places of tourist importance within 10 km radius.

6.2 Alternative Treatment Plant Technology

Comparative statement of different STP technology and corresponding environmental and social impacts are highlighted below:

Table 6.1: Comparison between Treatment Plant Technologies

Technology	Merits	Demerits
Conventional Activated Sludge Process (ASP)	■ Land requirement is less compared to others ■ Reduced flies and odour nuisance ■ Better control possible	■ High Capital cost ■ High Power requirements ■ Skilled labour is required for O & M.
Extended Aeration (EA)	■ High quality effluent ■ Lesser complicated design ■ and operation ■ Capable of treating shock loads ■ Well stabilized sludge	■ Higher power requirements for aeration ■ Relatively larger tanks ■ Mainly used for smaller plants
Sequencing Batch Reactor (SBR)	■ Simplified process ■ Final clarifiers and Return ■ Sludge pumping not required. ■ Compact ■ Operation is flexible; nutrient ■ removal possible ■ Better SS settling and high effluent quality ■ Batch system eliminates peak surges ■ Automatic control of MLSS and SRT through sludge wasting.	■ High Peak flows can disrupt operation ■ Skilled labour required ■ Batch discharge may require equalization prior to disinfection ■ Frequent sludge disposal ■ Higher specific energy consumption
Cyclic Activated Sludge (CAS)	■ External clarifiers, sludge scrappers, recycle pumps not required.	■ Extensive piping and valves/gates required.

Technology	Merits	Demerits
	■ Well settle able sludge flocks. ■ Control in time enables flexibility by adapting times for nitrification, Denitrification, ■ Biological phosphorous removal, sedimentation, depending on influent characteristics. ■ Easy & compact construction. ■ No moving mechanical parts ■ Less head loss	■ Higher maintenance skill required
Membrane Bio Reactor (MBR)	■ High quality nitrified effluent Compact ■ Plant expansion is simple ■ Capable of absorbing hydraulic and organic shock loads. ■ No secondary clarifier required	■ High capital & O&M cost ■ Extensive piping and valves ■ Higher maintenance skill required
Trickling filter	■ Capacity to handle shock loads ■ Dependable performance ■ Minimum supervision. ■ Lesser land requirement in comparison with other conventional systems.	■ Capital costs and power requirements are high. ■ Mosquito and odour nuisance is high. ■ Equipment is prone to heavy corrosion

Sewage treatment plant based on sequential batch reactor (SBR) is a proven technology and has some specific advantages compared to other conventional technology.

6.3 Alternative Alignment for Sewer lines and Rising Main

The proposed work for replacement of sewer line and laying of rising main will be carried out in the existing RoW; hence, no alignment route will be required. As a result, the scope for analysing the alternative alignment/site for sewer line is very limited. However as reported by the site representative of the Project Concessionaire, the following alternatives will be adopted.

Alternative A: in case the stretches for carrying out the proposed work is found to have any sort of displacement (physical or economical), the alignment of the sewer line, will be adjusted either shifting the alignment of the existing sewer line from the flank of the roads towards the centre of the road or likewise. Such approach will not cause any physical displacement by the project.

Alternative B: In case the stretches for undertaken the work were found to have any severe impact such as displacement (physical or economical), the proposed work will be revisited to avoid major impacts. Moreover, for impacts that are unavoidable, including temporary impacts, consultation will be undertaken and mitigation measures will be taken meeting the safeguard requirements of IFC.

6.4 No Project

By doing nothing, it may mean that the City of Kolkata remains at the worrying sewer coverage status, while the large part of the sewage generated flows into River Hooghly. This shows that doing nothing will not only continue worsening the local sanitation challenges but also regional environmental problems as pollution loading into River Hooghly increases.

Establishment of new STP at will have positive environmental impacts. It is unlikely that it will pollute the air, the soil, or contaminate the aquifers in the area. However, if the proposed STP is not established, the wastewater of many area of HMC region from the septic tanks and the sewerage collection system will continue discharging raw sewage into the nature and this will exert negative effects on the local environment and continue to create health problems. The No Action Alternative would see the continued release of untreated sewage into nearby available area, exacerbating the deterioration of soil and water quality. This is due to the acceleration load of organic and inorganic substances, which are streaming to the river and groundwater with the increasing wastewater flow. The existing living environmental problems will become more sever and may inhibit economic and social development of the area in the medium and long term:

- Degradation of the environment and reverse negative developments;
- Depletion of the aquifer;
- Dramatic decrease of both quantity and quality of the groundwater;
- Degradation of the river water bathing quality and biodiversity; and
- Degradation of health situation and increase of water related diseases due to poor sanitation system.

7. STAKEHOLDER ENGAGEMENT

7.1 Introduction

A stakeholder is defined as "an individual, group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project". Stakeholder Analysis is the process of categorising identified stakeholder groups according to their impact on the project and the impact the project will have on them. This information is then used to assess the manner in which the interests of the stakeholders or the project's impact on them should be addressed in the project development plan or its operation.

The importance of stakeholder analysis lies in the assessment and understanding of the socio-political environment surrounding the project. It allows for:

- Identification of the interests, concerns and societal risks surrounding the stakeholders, as well as conflicts of interests (if any);
- Identification of relations between stakeholders that may enable "coalitions" of project sponsorship, ownership and co-operation as well as the mechanisms which may influence other stakeholders;
- Key groups/ individuals to be identified who need to be informed about the project during the execution phase;
- Identifying stakeholders (those who might have an adverse impact on the project) and taking appropriate measures to mitigate their influence; and;
- Development of a framework for participatory planning and implementation of various project activities including interventions for community development.

The identification of stakeholders and their inclusion in the decision-making process is thus essential in the process of prioritizing, analysing and addressing issues; and in creating management systems and strategies to address the concerns/ expectations of various stakeholders.

The following sub-sections thus provide a profile for the various stakeholders in the project as well as their concerns and relative influence with regard to the project.

7.1.1 Identification of Stakeholders

The stakeholders who would directly impact or are directly impacted by the project are known as Primary Stakeholders and those who have an indirect impact or are indirectly impacted are known as Secondary Stakeholders. Keeping in mind the nature of the project and its setting, the stakeholders have been identified and listed in the table below.

The significance of a stakeholder group is categorized considering the magnitude of impact of the Project on the stakeholder or degree of influence (power, proximity) of a stakeholder group on the Project functioning. The significance of the stakeholder group importance for the Project and the requirement for engaging with them is identified as an interaction of the impact and influence. The list of key stakeholders is presented in **Table 7.1**.

Table 7.1: List of Key Stakeholders

Sl. No.	Stakeholder Group	Description
Primary Stakeholders		
1	Project Affected Persons (PAPs) which includes Commercial and Residential Structures	▪ This stakeholder group comprises of the Project Affected Persons (PAPs) residing and operating their businesses along the Right of Way (RoW) of the project area and may be potentially impacted by the laying and/or replacement of the sewer pipelines.
2	Local Community in Project Area	▪ This stakeholder group comprises of the community residing in the project area. ▪ This group is not expected to be directly impacted by the Project activities but may be indirectly impacted.
3	Religious Institutions	▪ This stakeholder group includes a temple located in the RoW and/or in proximity to the Project area.
4	Project Workforce	▪ This stakeholder group refers to the existing workers who are currently engaged for the STP and its linked facilities. ▪ This stakeholder group refers to the direct workers (payroll staff) and indirect workers (third-party or contractual workers) who will be engaged in the Project.
5	M/s Ganga STP Projects Private Ltd. (GSPPL) and sub-contractors	▪ This stakeholder group i.e. GSPPL, is the Special Purpose Vehicle (SPV) that has been incorporated for the Project. ▪ GSPPL will be subcontracting the Designing, Building, as well as Operations and Maintenance (O&M) scope for the project to M/s VA Tech Wabag Limited (Wabag)
6	Kolkata Metropolitan Development Authority (KMDA)	▪ KMDA is the Project Proponent Moreover, in this project context, KMDA is the client of the concessionaire and will be the owner of all assets after the end of the concessionaire period of 15 years.
Secondary Stakeholders		
7	National Mission for Clean Ganga (NMCG) &	▪ NMCG is the governing authority for the Project, on behalf of the Government of India
8	Project Financing Agencies/Institutions	▪ This stakeholder group includes International Finance Corporation (IFC) that is evaluating a potential investment opportunity into the Project.

Sl. No.	Stakeholder Group	Description
9	Regulatory Authorities	■ This stakeholder group comprises of regulatory authorities at the district, state and national level that are responsible for various permits and licenses pertaining to the Project.
10	Urban Local Bodies/ Municipality	■ This stakeholder group refers to the jurisdiction under which the STP and its linked facilities are located in i.e. Howrah Municipal Corporation. ■ This group is responsible for the development of their respective urban areas.

7.1.2 Stakeholder Mapping

Stakeholder Mapping is a process of examining the relative influence that different individuals and groups have over a project as well as the influence of the project over them. The purpose of a stakeholder mapping is to;

- Study the profile of the stakeholders identified and the nature of the stakes;
- Understand each group's specific issues, concerns as well as expectations from the project that each group retains;
- Gauge their influence on the project.

On the basis of such an understanding, the stakeholders are categorized into High Influence/ Priority, Medium Influence/ Priority and Low Influence/ Priority. The stakeholders who are categorized as high influence are those who have a high influence over the project or are likely to be heavily impacted by the project activities, and are thus high up on the project proponent's priority list for engagement and consultation.
Similarly, the stakeholders categorized as medium influence are those who have a moderate influence over the project or even though they are to be impacted by the project, it is unlikely to be substantial and these stakeholders are thus neither high nor low in the project proponent's list for engagement. On the other hand, the stakeholders with low influences are those who have a minimal influence on the decision-making process or are to be minimally impacted by the project and are thus low in the project proponent's engagement list.

The significance of a stakeholder group is categorized considering the magnitude of impact (type, extent, duration, scale, frequency) or degree of influence (power, proximity) of a stakeholder group and urgency/likelihood of the impact/influence associated with the particular stakeholder group in the project context. The magnitude of stakeholder impact/influence is assessed taking the power/responsibility and proximity of the stakeholder group and is categorized as negligible, small, medium and large. The Urgency or likelihood of the impact on/influence by the stakeholder is assessed in a scale of low, medium and high. The overall significance of the stakeholder group is assessed as per the matrix provided below:

Table 7.2: Stakeholder Impact Matrix

		Sensitivity /Vulnerability / Important Resource / Receptor		
		Low	Medium	High
Magn	Negligible	Negligible	Negligible	Negligible

	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

The following section provides brief profiles of the various stakeholders in the project as discussed in the previous sub section along with their degree of influence. The details are provided in **Table 7.3.**

Table 7.3: Stakeholder Profiles and Influence Mapping

Stakeholder Group	Stakeholder Profile	Impact/Influence of the Project on this Stakeholder Group (Negligible, Small, Medium, Large)		Urgency/Likelihood of Influence of Stakeholder Group on Project (Low, Medium, High)		Level of Influence of Stakeholder
Project Affected Persons (PAPs) which includes Commercial and Residential Structures	▪ This stakeholder group comprises of the Project Affected Persons (PAPs) residing and operating their businesses along the Right of Way (RoW) of the project area and may be potentially impacted by the laying and/or replacement of the sewer pipelines. This group mainly consists of commercial and residential structures.	▪ This group constitutes as one the most important stakeholder groups as it will be temporarily impacted by the laying and/or replacement of the sewer pipelines. ▪ The entire process for the laying/replacement of a sewer pipeline will take approximately 30 days therefore causing temporary traffic congestion and access disruption to these commercial and residential structures situated along congested areas of the project RoW. ▪ The commercial structures which include kiosks and vendors may be impacted by temporary income loss due to potential closure of their shops during the proposed work.	Medium	▪ This stakeholder group will play an important role in allowing for smooth functioning of the Project, as well as shaping public opinion towards the Project. ▪ The Project impacts on this stakeholder group are however temporary and can be mitigated through proper traffic management, road signage, barricading and undertaking work during off-peak hours. ▪ Additionally, it was reported to the ERM team during the site visits that to avoid adverse impacts particularly income loss for the commercial structures, a new alignment traversing through the centre of the road will be proposed for laying of the pipelines. ▪ In addition, the Project Affected Persons (PAPs) may potentially be engaged	Medium	Moderate

Stakeholder Group	Stakeholder Profile	Impact/Influence of the Project on this Stakeholder Group (Negligible, Small, Medium, Large)		Urgency/Likelihood of Influence of Stakeholder Group on Project (Low, Medium, High)		Level of Influence of Stakeholder
				as local resources during the construction phase of the project, in the form of construction labourers, mason workers and drivers, etc. ■ This stakeholder group can also provide goods and services required for the construction of the Project in the form of truck services and construction material suppliers etc.		
Local Community in Project Area	■ This stakeholder group comprises of the community residing in the project area. ■ This group is not expected to be directly impacted by the Project activities but may be indirectly impacted.	■ The laying and replacement of the pipelines may potentially affect the local community residing in the project area, but are not expected to be directly impacted by the Project activities. ■ As mentioned above, the entire process for the laying/replacement of a sewer pipeline will take approximately 30 days therefore this stakeholder group may temporarily and indirectly be affected by	Small	■ The project impacts on this stakeholder group are indirect, temporary and can be mitigated through proper traffic management, road signage as well as barricading. ■ Similarly, this stakeholder group may potentially be engaged as local resources during the construction phase of the project, in the form of construction labourers, mason workers and drivers, etc.	Medium	Minor

Stakeholder Group	Stakeholder Profile	Impact/Influence of the Project on this Stakeholder Group (Negligible, Small, Medium, Large)		Urgency/Likelihood of Influence of Stakeholder Group on Project (Low, Medium, High)		Level of Influence of Stakeholder
		congestion and access disruption, caused by the Project activities.		■ This stakeholder group can also provide goods and services required for the construction of the Project in the form of truck services and construction material suppliers etc.		
Kolkata Metropolitan Development Authority (KMDA)	■ KMDA is the Project Proponent Moreover, in this project context, KMDA is the client of the concessionaire and will be the owner of all assets after the end of the concessionaire period of 15 years.	■ KMDA is the Project Proponent under the Project governing authority i.e. National Mission for Clean Ganga (NMCG).	Large	■ Being the Project proponent who will own all assets after the end of the concessionaire period, this stakeholder group is important for the smooth functioning and implementation of the Project. ■ This stakeholder group is also responsible for acquiring the licenses and permits for the Project as well as for the implementation of the Livelihood Restoration Plan (LRP) ■ This group may also play an important role in the formation of public opinion towards the Project.	High	Major

Stakeholder Group	Stakeholder Profile	Impact/Influence of the Project on this Stakeholder Group (Negligible, Small, Medium, Large)		Urgency/Likelihood of Influence of Stakeholder Group on Project (Low, Medium, High)		Level of Influence of Stakeholder
Project Workforce	■ This stakeholder group refers to the existing workers who are currently engaged for the STP and its linked facilities ■ This stakeholder group refers to the direct workers (payroll staff) and indirect workers (third-party or contractual workers) who will be engaged in the Project.	■ A total of 63 workers are currently engaged for the STP and its linked facilities. The project will thus cause loss of employment/retrenchment of the existing workers at the Arupara STP and its linked facilities. ■ The Project will engage manpower for the civil construction work during the construction phase comprising of approximately 100-150 workers, therefore providing employment opportunities. ■ This group will include unskilled, semi-skilled and skilled workers. ■ Reportedly, 80% of the workforce will be from outside the district and 20% will be local workers.	Medium	■ This stakeholder group is important for the smooth functioning and timely implementation of the Project which can be considered through Labour Management Framework (LMF). ■ This stakeholder group is important for the smooth functioning and timely implementation of the Project, which can be ensured through a Labour Management Plan (LMP). ■ This group has an important role in the ormation of public opinion and in case their labour requirement and health and safety are not complied, this group may affect the image of the concessionaire.	Low	Minor

Stakeholder Group	Stakeholder Profile	Impact/Influence of the Project on this Stakeholder Group (Negligible, Small, Medium, Large)		Urgency/Likelihood of Influence of Stakeholder Group on Project (Low, Medium, High)		Level of Influence of Stakeholder
M/s Ganga STP Projects Private Ltd. (GSPPL) and sub-contractors	■ This stakeholder group i.e. GSPPL, is the Special Purpose Vehicle (SPV) that has been incorporated for the Project. ■ GSPPL will be subcontracting the Designing, Building, as well as Operations and Maintenance (O&M) scope for the project to M/s VA Tech Wabag Limited (Wabag)	■ As this stakeholder is the SPV for the Project, the Project is providing it with a sustained business opportunity.	Large	■ This stakeholder group is critical for the smooth functioning and timely implementation of the management plans formulated for the Project. ■ The manner of functioning of this group will influence the opinions of the local stakeholders about the Project.	High	Major
National Mission for Clean Ganga (NMCG) &	■ NMCG is the governing authority for the Project.	■ NMCG is the governing authority for the Project.	Large	■ As the governing authority, this stakeholder group is important for the smooth functioning and implementation of the Project. This includes being responsible for overall escrow mechanism and payments to the Concessionaire.	High	Major
Project Financing Agencies/Institution s	■ This stakeholder group includes International Finance Corporation (IFC) that is evaluating a potential investment	■ The influence of the Project on the stakeholder group will primarily relate to the impact that the Project's performance will have on	Large	■ This stakeholder group's influence on the Project will primarily relate to the determination of the	High	Major

Stakeholder Group	Stakeholder Profile	Impact/Influence of the Project on this Stakeholder Group (Negligible, Small, Medium, Large)		Urgency/Likelihood of Influence of Stakeholder Group on Project (Low, Medium, High)		Level of Influence of Stakeholder
	opportunity into the Project.	public opinion on the financing agency, locally, nationally and internationally.		Project's financial feasibility. ■ In addition to the national rules and regulations, the project is required to comply with the applicable standards and guidelines of these financing institutions.		
Regulatory Authorities	■ This stakeholder group comprises of regulatory authorities at the district, state and national level that are responsible for various permits and licenses pertaining to the Project.	■ The impact of the Project on this stakeholder group is negligible as it is one of many projects being implemented in the state and the country.	Small	■ This stakeholder group's influence on the Project is high as this group provides the licenses and permits essential for the functioning of the Project. ■ This stakeholder group can enable Project shut down, temporary stoppage, or levy of penalties and fines, in the event of non-compliance.	Medium	Minor

Stakeholder Group	Stakeholder Profile	Impact/Influence of the Project on this Stakeholder Group (Negligible, Small, Medium, Large)		Urgency/Likelihood of Influence of Stakeholder Group on Project (Low, Medium, High)		Level of Influence of Stakeholder
Urban Local Bodies/ Municipality	▪ This stakeholder group refers to the jurisdiction under which the STP and its linked facilities are located in i.e. Howrah Municipal Corporation. ▪ This group is responsible for the development of their respective urban areas.	▪ As KMDA is the Project Proponent, the impact of the Project on this stakeholder group is negligible.	Small	▪ The impact of the stakeholder group on this Project is high as their cooperation in required especially during the mitigation of potential social impacts cause by Project activities such as addressing traffic congestion and access disruption. ▪ Additionally, the cooperation of the respective municipalities are required during the identification of the Project Affected Persons (PAP).	High	Moderate

7.2 Stakeholder Consultation

7.2.1 Public Consultation Meeting on NGRBA ESMF

On December 2010, a public consultation was conducted at Unnayan Bhawan, Kolkata with the presence of the Urban Development Department, representatives of the municipalities and educational institutes. The objective of the meeting was to brief on the objectives of the Environment and Social Management Framework (ESMF) of the National Ganga River Basin Authority (NGRBA), including the future activities planned as part of the project. The structure of the NGRBA as well as matters related to land acquisition, entitlements, resettlement and rehabilitation were also discussed. It was also highlighted that the improvement of the sewerage system through the project, will improve public health as a whole, thereby having a positive impact.

The participants from Panihati Municipality shared their thoughts about the status of the structures constructed under the Ganga Action Plan Phase 1 and Phase 2, and highlighted that some of them are not functioning properly due to various reasons. Participants from Mahestala, Bhatpara and Gayeshpur Municipalities highlighted that there is a lot pollution being caused by both small scale and large-scale industries. Representatives from Chandan Nagar also indicated that untreated sewage from the municipality is also being discharged into the river.

7.2.2 Stakeholder Consultation during Previous ESIA Process

The previous ESIA-MP report for Arupara STP, prepared by Centre for Studies in International Relations and Development) highlights the need for engagement with stakeholders and defines the medium for dissemination of project information to the affected people. However no meaningful consultation with the affected communities and local authorities, to provide information about the Project, its design, as well as provide and obtain feedback on mitigation measures, has been observed in the report. Additionally, observations made during joint visit with KMDA and GSPPL/ Wabag team at the proposed project locations has revealed that no local stakeholder consultation process has been carried out with the local community.

7.2.3 Stakeholder Consultation during Current ESIA Process

Consultations have been conducted with stakeholders of the Arupara STP project which include the existing contractual workers at the STP and linked facilities, as well as those stakeholders who are situated in congested locations within the project area. The details are presented in Table 7.4 below. The minutes of the stakeholder consultations along with participants list are provided in **Appendix F***.*

Table 7.4: Details of Stakeholder Consultation

Sl. No	Stakeholder Group	Details of Consultation	Stakeholder Concerns
1.	**Existing STP Contractual Workers** *Location:* Arupara STP *Date:* 5th of July, 2019	■ The consultations with the existing contractual workers at Arupara STP revealed that there are approximately 32 workers working under the contractor, Associated Cooperative Society. ■ The workers have three shifts, which include the morning shift, day shift and the night shift. There is also a general shift. ■ None of the existing contractual workers indicated having received any training on Health & Safety and they were also not seen to be utilizing any Personal Protective Equipment (PPE). ■ Consultation with the workers revealed that they are aware of the proposed Project but are not clear on the exact details. ■ They however agreed that the proposed is required in order to improve the services and benefit the locality as a whole. ■ They further mentioned that waterlogging takes place at the location of the housing quarters near the Arupara STP site and therefore mentioned that if the proposed work takes place, this issue will be addressed. ■ They also mentioned that the area near the railway gate, which is also situated in proximity the Arupara STP is a congested area. ■ The STP has been functioning for approximately 20 years.	The workers at the Arupara STP and associated facilities expressed the following concerns during the stakeholder consultations: ▪ They strongly expressed their apprehension of losing their jobs due to the onset of this project. ▪ They also requested the authorities for their reasonable consideration to protect their livelihood and current earnings, as many of them have been engaged for more than 20 years.
2.	**Existing MPS Contractual Workers** *Location:* Itchapur MPS *Date:* 5th of July, 2019	■ A consultation was conducted with the existing contractual workers at the Ichapur Main Pumping Station (MPS). ■ The consultation revealed that there are 8 staff working at the MPS and they are employed by the contractor Associate Cooperative Society. ■ They presently work in shifts i.e. morning, day, night and the general shift. ■ None of the existing contractual workers at the MPS were also not seen to be utilizing any Personal Protective Equipment (PPE). ■ Consultation with the workers at the MPS revealed that they are aware of the proposed Project but do not have clarity on the Project. ■ The workers are receiving benefits such as Provident Fund (PF) and earn an average income of Rs. 10,000. ■	
3	**Existing Contractual Worker at Round Tank Lifting Station** *Location:* Roundtank Road, Howrah *Date:* 18th of July, 2019	■ A discussion was conducted with a contractual worker at Roundtank Lifting Station, Howrah. ■ There working hours at the LS are divided into three shifts, as well as a general shift from 10am to 6pm. ■ The workers are working under the contractor, Associated Cooperative Society and their approximate salary is Rs. 12,000. They have been working at the pumping station for over 20 years. ■ Currently, there are five machines at the pumping station but only two are operational. ■ The worker indicated that water intake is from the Ramkrishnapur.	
4	**Existing Contractual Worker at Foreshore Lifting Station** *Location*: Foreshore Road, Howrah *Date:* 18th of July, 2019	■ A discussion was conducted with a contractual worker at Foreshore Lifting Station, Howrah. ■ According to the Operators of this lifting station, water comes from the Chouri Basti and B E College area. ■ This Lifting Station has three shifts i.e. 6 to 2 pm, 2 to 10 pm and 10-6 am. ■ Many of the present workers joined the Lifting Station approximately 20 years ago and are working under the contractor, Associated Cooperative Society. There are earning an average income of Rs. 10,000. ■ The Lifting Station has a total of five machines out of which only three are operations. No waterlogging was observed in the area.	
6.	**Existing Contractual Worker at BESU Lifting Station** *Location*: BESU, Howrah *Date:* 18th of July, 2019	■ Consulted with pump operator of BESU Lifting Station and it was informed that there are five workers presently working. ■ All of the five machines in the Lifting Station are out of order therefore the Lifting Station in non-functioning. ■ The water intake for this facility is from Botanical Garden and Swarnamoyee area and it was informed that waterlogging used to take place at Narayana Hospital area. ■ The discussion revealed that the workers have been working at the Lifting Station for the last 20 years, and they are presently engaged under the contractor MCE Construction.	
7.	**Joint Consultation between Existing Workers at Arupara STP and Lifting Stations and KMDA, VA Tech Wabag & ERM** *Location*: Chittaranjan Bayam Samiti, Howrah *Date:* 17th of September 2019	■ The discussion revealed that the contractors at these facilities are engaged by three different agencies i.e. Associated Cooperative Labour Contractor and Construction Society Ltd; M.C.E Construction since 2009, 2008 and 2006 respectively. ■ The list of workers shared by KMDA (hereinafter stated as "KMDA list) mentions Ganga Action Plan Contract Workers Co-operative Society Ltd. as the only O&M agency engaged at these facilities. ■ The workers of Associated Cooperative Labour Contractor and Construction Society Ltd and Ganga Action Plan Contract Workers Co-operative Society Ltd. present during the consultation indicated that they have been receiving their salary, ESI, PF, Bonuses as well as some increase in their salary proportionate to Dearness Allowance (DA) increase, during the government pay scale change. However, the workers at M.C.E Construction do not avail this D.A benefit. ■ The Arupara STP was commissioned in 1970, after which it was handed over to K.M.W & SA in 1983 in a non-functional state. Reportedly, the STP has not been functioning since March 2019.	

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<tr><th>Sl. No</th><th>Stakeholder Group</th><th>Details of Consultation</th><th>Stakeholder Concerns</th></tr>
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Furthermore, the names mentioned in the KMDA list were verified against the names of the workers present during the consultation. Those who could not attend the consultation, were verified by the representatives of their respective agencies as well as their co-workers at their respective locations. This exercise thus revealed the following facts:

The name of Mr. Achinta Roy who was recently engaged at Arupara MPS, (as confirmed by his co-workers) was not included in the KMDA list. Therefore there are a total of nine (9) workers at the Arupara MPS, not eight (8) workers, as reported in the KMDA list.
Mr. Dip Adhikari has been engaged at the Ichapur MPS in place of his recently demised father Mr. Samir Adhikary. This engagement has been confirmed by the KMDA as per their letter to the Secretary of Associated Cooperative Labour Contractor and Construction Society Ltd, dated 26th of June, 2019. Therefore, there are a total of eight (8) workers at the Ichapur MPS, not seven (7) workers, as reported in the KMDA list.
The name Mr. Pratap Karmakar, who is engaged as an operator at Arupara MPS is incorrect as per the KMDA list. His actual name is Mr. Pratip Karmakar.
As stated earlier, the KMDA list only mentions the name of one O&M agency i.e. Ganga Action Plan Contract Workers Co-operative Society, for the Arupara site. The verification however revealed that Associated Cooperative Labour Contractor and Construction Society Ltd and M.C.E Construction are also engaged as O&M agencies at these two sites.
Therefore as per the verification, there are a total of sixty-three (63) workers at the Arupara STP and linked facilities.
Reportedly, the security guards working at the Arupara facilities are engaged directly by KMDA, and KMDA has its own plan to relocate the guards, as per their requirement.

Representative from KMDA indicated that the correct list of workers' names should be shared by the respective O&M agencies along with their personal details, duration of service and documentary evidence in support of their work, under the specified contractor at the site, to the Executive Engineer at KMDA Head Office.
The workers shared the following opinions on the project:

They strongly expressed their apprehension of losing their jobs due to the onset of this project.
They also requested the authorities for their reasonable consideration to protect their livelihood and current earnings.

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<tr><td>8.</td><td>Consultation with local community at GIP Colony Arupara
Location: GIP Colony
Date: 11th of February. 2019</td><td>

A consultation was conducted with the local community residing at the GIP colony situated near the Arupara Sewage Treatment Plant (STP). There are approximately 150-200 HHs and 80-100 commercial shops.
The purpose of the consultation is to provide awareness to the community at the GIP Colony about the proposed upgradation works of the brick sewer line. The team further explained that the replacement work will not cause any damage to their residential structures as machinery will be used to replace the pipelines.
Reportedly, majority of the residents are engaged in daily wage labour whereby they earn an approximate income of Rs. 5000 per month. The women are mainly engaged in domestic work.
The residents indicated that during the rainy season, the area gets waterlogged as a result of the clogged pipelines, particularly from a manhole near one of the dwellings, which often causes the houses in the area to flood.
The team also shared with the community, the toll free number for the project, in case they would like to convey any grievances during the construction phase.
The names and signatures of all the participants could not be attained.

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The residents indicated that during the rainy season, the area gets waterlogged as a result of the clogged pipelines, particularly from a manhole near one of the dwellings, which often causes the houses in the area to flood.

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7.3 Stakeholder Engagement Plan

GSPPL will establish a stakeholder engagement program for all three project sites which includes a comprehensive suite of stakeholder's consultation, disclosure activities and engagement exercises and media interactions. The objective of the communication plan includes:

- Identification and analysis of the stakeholder groups and their profiles, interests, issues/impacts and concerns relevant to the Project;
- Ensure the inclusion of women and vulnerable groups in all phases of stakeholder engagement;
- Identification of specific measures to allow meaningful engagement with the different stakeholder groups in a manner that is transparent and accessible using culturally appropriate communication methods with a specific focus on vulnerable groups;
- Allow for a relationship to be built with the various stakeholders of the Project based on mutual respect and trust;
- Facilitate adequate and timely dissemination of information to the stakeholder groups in a culturally appropriate manner;
- Provide systems for prior disclosure/dissemination of information and consultation, including seeking inputs from affected persons, incorporation of inputs, as applicable, and Principles of Stakeholder and Engagement
- Providing feedback to affected persons/groups on whether and how the input has been incorporated;
- Providing mechanisms for feedback and dispute resolution;
- To enable proof of resolution of all grievances;
- Provide a mechanism for documentation of the activities undertaken and the reporting and monitoring of the same.

A detailed Stakeholder Engagement Plan (SEP) has been prepared for all three sites.

7.3.1 Resource and Responsibility

GSPPL has overall responsibility for the implementation of the Stakeholder Engagement Plan (SEP). GSPPL's CSR department will also be engaged in implementing the SEP. However, KMDA will also be involved with regard to the disclosure and implementation of activities related to the Resettlement Action Plan (RAP). GSPPL's main activities include:

- Responding to the concerns and issues expressed during public consultations.
- Allocating sufficient funds to implement a viable Stakeholder Engagement Plan.
- Ensuring that all public consultation and information disclosed is documented.

The detailed activities to be undertaken are included in the detailed SEP.

7.3.2 Methods for Stakeholder Engagement

The methods of engagement incorporate individual profiles, concerns, and expectations of the groups. The need for different modes of engagement is primarily because the utilization of a common modus operandi for all the stakeholders and that too for the whole project duration may result in the failure of the engagement process to achieving its goals.

- *Public Meetings:* These meetings and consultations not only form a part of certain regulatory requirements (such as public hearing) but also serve as useful tools for gathering information from larger groups. These meetings and consultations typically involve a notification (to publicize the matter to be consoled upon) and a consultation (a two way flow of information) at a larger community level; such as at the ward or municipality level.

- *Focus Group Discussions:* An FGD refers to a discussion carried out amongst a group of people (6 to 8) from a similar background/profile on a specific topic while being guided by a moderator. The primary purpose of such discussions is to gather insight into the thought process of the group in regards to a particular issue. Apart from FGDs, general discussions with either the community or individual representatives are also part of the engagement process. This method allows for the collective opinion of these groups to be captured and assessed.
- *One on One Meeting:* This form of engagement is typically a structured or semi-structured interview/discussion with one or few stakeholder representatives. These allow for an in-depth qualitative issue with stakeholder groups that are likely to be knowledgeable.

7.4 Information Disclosure

This section provides an understanding of the information disclosure and consultation plan put in place for the project. This plan shall guide the engagement with the external stakeholders through the life of the project. Ongoing public consultation, meeting minutes and records will be kept in record. A summary report of all public consultation issues, grievances and redressal will be prepared at project level.

The information disclosure will be undertaken primarily through two means; preparation and dissemination of briefing material and organization of community consultations or group meetings. The primary purpose of the disclosure process will be to make information accessible and available to all in a simple and easy to understand manner. The briefing material shall be in the local language i.e Bengali. Following communication tools shall be designed for effective dissemination of relevant information.

Table 7.5: Information Disclosure Plan

Topic	Documents to be Disclosed	How & Where	Frequency
Disclosure of the Proposed projects	Project related information	The project will developed an ESIA which will detail out the project impacts and the proposed mitigation measure of the proposed. The information will be shared with the community during consultation. ■ Municipality Office ■ Site Office of the EPC	At the time of preparing the ESIA
Disclosure of the draft ESIA	Draft ESIA	The project will prepare an ESIA and made available to affected persons and local NGOs in the local language; Bengali in the following offices: ■ Project Website	At the time of finalizing of the ESIA

Topic	Documents to be Disclosed	How & Where	Frequency
		■ DC's Office ■ Local Gram Panchayat office ■ Site Office of the EPC Contractor	
Rehabilitation and Resettlement Entitlements	Livelihood Restoration Plan (LRP).	The project will make the RAP available to affected persons and local NGOs in the local language; Bengali in the following offices: ■ Project Website ■ DC's Office ■ District Libraries ■ Local Gram Panchayat office ■ Site Office of the EPC Contractor	At time of finalization of RAP
Livelihood Restoration Framework	Information regarding impacted people and their entitlements in local language	■ Soft copy in Web-site ■ Letter to each local ULBswebsite of project	At the time of Within 20 days of Draft LRF Report is submitted
Grievance Redressal	SEP and GRM	■ Local Gram Panchayat office ■ Site Office of the EPC Contractor	Prior to start of construction
Environmental & Social Management Plan	Construction schedule including transportation and movement of heavy machinery	■ Project Website ■ Hard copies in Bengali in the following offices: ■ Local gram panchayat office ■ Office of the contractor	Prior to start of construction.
Regular Disclosure	Meetings with the stakeholders to provide them an update on the status of the project, the next steps and the possible impacts on the stakeholders	■ Local village gram panchayat office	As per demand or request from specific stakeholders

7.4.1 Information Disclosure with ULB

KMDA had informed all the concerned ULBs for the 'Pollution Abatement (Interception & Diversion with STP) Works for River Ganga at Howrah, Bally and Baranagar-Kamarhati Municipal Town in West Bengal including 15 years of Operation and Maintenance under Hybrid Annuity Based PPP Mode' and that execution of the work may temporarily cause inconvenience in certain stretches and impacts are being assessed by ERM.

A disclosure meeting was conducted on the 18th of November, 2019, between the officials of Howrah Municipal Corporation (HMC) and ERM, to disclose about the KMDA project on the upgradation of the Arupara STP and its linked facilities at HMC. The Executive Engineer, HMC; Executive Engineer, PWD and Councillor of Ward 39 were present at the meeting. The following are the main points discussed:

- The ERM team apprised the ULB officials about the purpose of the meeting including the potential environmental and social impacts, which include impacts on air quality as well as community health and safety during the construction phase. Other potential social impacts include temporary livelihood loss and access disruption, during the laying and replacement of the sewer pipelines.
- The ERM team also informed about the potential short-term disturbance in the neighbourhood of the STP, during the de-commissioning and construction phase. However, it was highlighted that these impacts are temporary and will be addressed through proper mitigation measures that is discussed in the environment and social management plan (ESMP).
- The Howrah Municipal Corporation (HMC) members present indicated that they understand the purpose and value of the project and mentioned that since it is in the public interest of the community, they have agreed to offer their full cooperation during the project implementation phase.
- It was informed to them that during the construction phase for the Arupara STP project, there will be some road side kiosks and vendors who will potentially be impacted by temporary income loss, due to the rehabilitation and relaying of the sewer pipelines. A survey will be conducted to identify the potentially affected persons and the information on the affected persons will be further updated on finalisation of the design and detail measurement survey. If any person/s is assessed to be impacted, he/she will be compensated for the loss as per the Livelihood Restoration Framework (LRF).
- The HMC members present requested for information prior to the commencement of the project activities and also requested that once the excavation works are completed, the roads should be repaired to its original state. They also requested that the STP project design as well as the timeline of the project to be shared with them before commencement of the construction work.
- After the discussion, the Executive Engineer, HMC; Executive Engineer, PWD and Councillor of Ward 39, conducted a joint visit to the project area, to understand the potential areas for disruption. The minutes of the meetings are provided in the **Appendix K.**

7.4.2 *Disclosure with Community*

A disclosure meeting was conducted on the 23rd of November, 2019 between the community at Howrah Municipal Corporation (HMC) and ERM representatives, to disclose about the KMDA project on the upgradation of the STP and sewerage system at HMC.

- The members present include the potentially affected persons, near the BESU Lifting Stations, where the sewer pipeline replacement work would be undertaken.
- The ERM team explained to the community about the purpose of the disclosure meeting and explained about the proposed upgradation works.
- The ERM team further highlighted that there will be potential temporary impacts particularly related to access disruption and temporary livelihood loss during the laying or replacement of the sewer pipelines.

- The community members present at the meeting indicated that they were not previously aware of the proposed works but they indicated that they will cooperate with the project activities as they view it as beneficial to the area.
- They however requested that they be informed about the implementation works in advance, and requested that the work be completed in a manner where there is minimum access disruption. The minutes of the meetings are provided in the **Appendix K.**

A disclosure meeting was conducted on the 4th of December, 2019, with the community in Panchanantala locality situated on the left side of the Ichapur- Arupara Road, near the railway gate. The purpose of the meeting was to disclose about the KMDA project on the upgradation of the Arupara STP and sewerage system at the Howrah Municipal Corporation.

- It was also highlighted that the upgradation works would improve the water flow the Ichapur MPS to the Arupara STP.
- The team further highlighted that there will be potential temporary disturbances during the construction period of the project, such as access disruption, particularly during the pipeline upgradation works.
- The community members present at the meeting indicated that they will cooperate with the project activities as they view it as a public good.
- They however requested that they be given prior information before starting of the proposed works and also requested that the road be repaired after completion of the works.

7.4.3 Reporting and Monitoring

It is recommended during the construction phase of the project, the performance of the SEP will be reviewed on a bi-annual basis. For the purpose of the review, the Environmental and Social Specialists for the Project, will prepare reports on public consultation issues, grievances and redressal, to be submitted to the project management, on a quarterly basis. During the operations phase, the reports will be submitted on an annual basis. Subsequently, a Stakeholder Engagement Report and Monitoring Report should be prepared and disclosed annually on the IFC website. This report will include a summary of the issues raised by the stakeholders, the numbers of grievances, a summary of key actions taken to address the grievances, an analysis of trends, as well as plans for further engagement.

7.5 Livelihood Restoration Plan (LRP)

Though the proposed project does not involve any land acquisition, business and shops will be temporarily affected on account of the rehabilitation of the sewer pipelines. The affected businesses are thus entitled to compensation for their loss of income, for each day of disturbance on fully closed roads. Therefore, a Livelihood Restoration Plan (LRP) is required to be prepared for compensating the identified affected persons. The RAP will be based on the Livelihood Restoration Framework (LRF) that has been developed based on international safeguards (IFC) for resettlement and rehabilitation.

The Livelihood Restoration Plan (LRP) will be prepared comprising the database of all the affected persons, prior to the start of the construction work. The LRP will include the types of loss, entitlement to restore the losses, the implementation mechanism, the grievance mechanism as well as schedule for implementation and budget. The approved LRP will be disclosed with the concerned stakeholders.

A socio economic survey of the businesses and structures present along the relevant sections, will be conducted. All businesses identified in the project-impacted areas (sections ready for construction) before the cut-off date will be entitled to compensation for loss of income. For shops such as hawkers, and street vendors, the actual income earned in the project area will be considered. Compensation in the case of loss of structure will be calculated based on the replacement cost.

The compensation for loss of business for titleholders will be determined based on the income tax declaration to be provided during the census survey. For non-titleholders and squatters, the daily income sales will be considered for determining the compensation.

8. GRIEVANCE REDRESS MECHANISM

8.1 Introduction

The implementation of a project is a complex time and labour intensive process involving multitude of lifecycle phases and processes. Over the duration of the project, it encounters numerous instances of conflicts, allegation and dissatisfaction within the working and associated human capital and their interactions. Some of these issues could be related to+1500+

- compensation payment,
- improper estimation of affected assets,
- failure to fulfil commitments,
- poor management of construction activities,
- accidents due to inappropriate planning of vehicle movement, and
- Cultural conflicts between migrant workers and local communities etc.

Most of the conflicts and allegations may not appear to be of serious nature but if not managed appropriately from the beginning may snowball into a bigger issue. In order to manage these risks, an internal mechanism is required to be in place where the aggrieved party(s) can lodge their complaints and get it amicably settled prior to approaching the formal mode of solution available to them i.e. access to legal system through courts. In order to provide a formal forum to the aggrieved party(s) i.e. deal with issues arising out of project, it is proposed that a joint grievance redress mechanism be instituted for both environmental and social related issues.

8.2 Objectives of the Grievance Redressal Mechanism

The basic objective of the GRM shall be to provide an accessible mechanism for addressing both internal and external grievances. Internal grievances include grievances from both direct and indirect employees such as local workers and migrant workers, through contractors. External grievances include complaints from affected people, community or any stakeholder(s) having a stake in the project. The GRM thus aims to resolve any social (including labour, contractor, and community amongst others) and environmental related grievances locally in consultation with the aggrieved party to facilitate smooth implementation of project related work activities. The other important objective is to democratize the development process at the local level and to establish accountability towards the stakeholders.

The Grievance Redress Mechanism will also cover grievances/concern of the existing workers in relation to the potential loss of employment. All existing workers have the right to initiate the procedures as laid down in the following section. Moreover, the GRM does not prevent the complainant from bringing his/her concerns to the courts or other relevant government bodies.

8.3 Process of Grievance Redressal Mechanism

A project Grievance Redressal Mechanism (GRM) will be established to receive, evaluate and facilitate the resolution of the affected and displaced persons concerns, complaints and grievances. The grievance mechanism will aim to provide a time bound and transparent mechanism to voice and resolve concerns linked to the project.

A Grievance Redress Cell will be established by the concessionaire for reporting and addressing grievances of the affected communities and workers. The Grievance will comprise of key members from GSPPL, District Magistrate (if required) KMDA, Local Authority, Local NGOs and key members of the local Municipal ward. Involvement of at least 2 female members in the GRC is mandatory.

During the project preparation, as part of the public consultation process, information regarding the GRM will be disclosed to the affected persons. Grievances related compensation will be acknowledge, evaluated and responded through the GRM. The GRM will continue to function, for the benefit of the affected person and the community, during the entire life of the project including the maintenance period.

For ensuring the effective implementation of GRM, GSPPL will have an E&S Manager, who will have the overall responsibility for addressing timely grievance including keeping and maintaining the complaint and redress records. At the site level the E&S manager will be supported by site supervisor, site engineer of the respective location for managing grievance.

A three tier mechanism have been proposed for addressing grievances:-

Tier 1: The first level and immediate contact for of resolution grievances will be the GSPPL site Supervisor of E&S Manager. The complaints /grievances may be received either verbally or through written applications. A Toll Free number: 03340055688/689 has been put in place for receiving complaint and grievances. Prior to construction of any works, the E&S team under the supervision of the Environment & Social Manager should notify the workers and the local residents and community of the projects and the potential impacts and temporary disturbance of the project. In case the aggrieved person/workers has any complaint with he/she can lodge a complaint to the site supervisor which will then be passed on to the E&S Manager. For addressing complaints, the E&S Manager if required, can take the assistance of the urban local bodies/municipality. Grievance can also be registered anonymously in wriiten form to the onsite Supervisor/E&S Manager A grievance register will be kept at each project facility, Lifting station, Main Pumping Station and STP. At the 1st Level the Project Manager, Resident Engineer and on site E&S Manager will make efforts to resolve the grievance/ complaint within a period of 10 days from the date of receipt of the complaint. In case the aggrieved is not satisfied with the solution provided during Tier 1, he may escalate it to Tier 2.

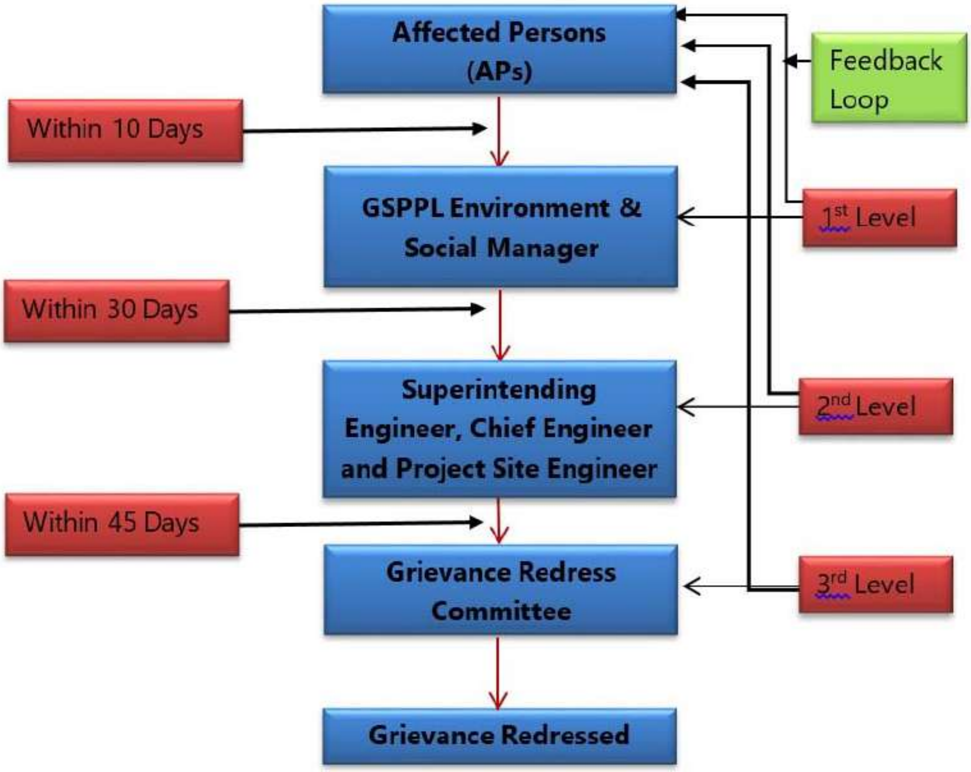
Tier2: Complaints and grievances which remain unresolved, will be escalated to the next tier comprising of the Superintending Engineer, Chief Engineer and Project Site Engineer. Representatives from urban local bodies comprising of both men and women will also be included as members of the committee. Such cases should be resolved within 30 days from the day the escalation of the issue take place. In case the complainants are not satisfied with the decision of the committee, the issue can be escalated to the next Tier.

Tier 3: Should the issues remain unresolved, the complaints can be escalated to the third level the Grievances Redress Committee (GRC) Such cases should be resolved within 45 days from the day the escalation of the issue take place. The GRC comprises of the District Magistrate as under 'Namami Gange' program. Other members comprise of the following:

1. District Magistrate Chair Person
2. Superintending of Police
3. Executive Officer of the Municipal Corporation Member
4. Mayor of the Municipal Corporation Elected Member
5. Representatives from NGO
6. Sub Divisional Officer
7. Executive Engineer, PWD and PHED

The GRC will resolve the matter within a time period of 60 days. Figure 8.1 below presents the three tier grievance redressal mechanism for addressing external grievances.

Figure 8.1 Grievance Redressal Mechanism for Stakeholders



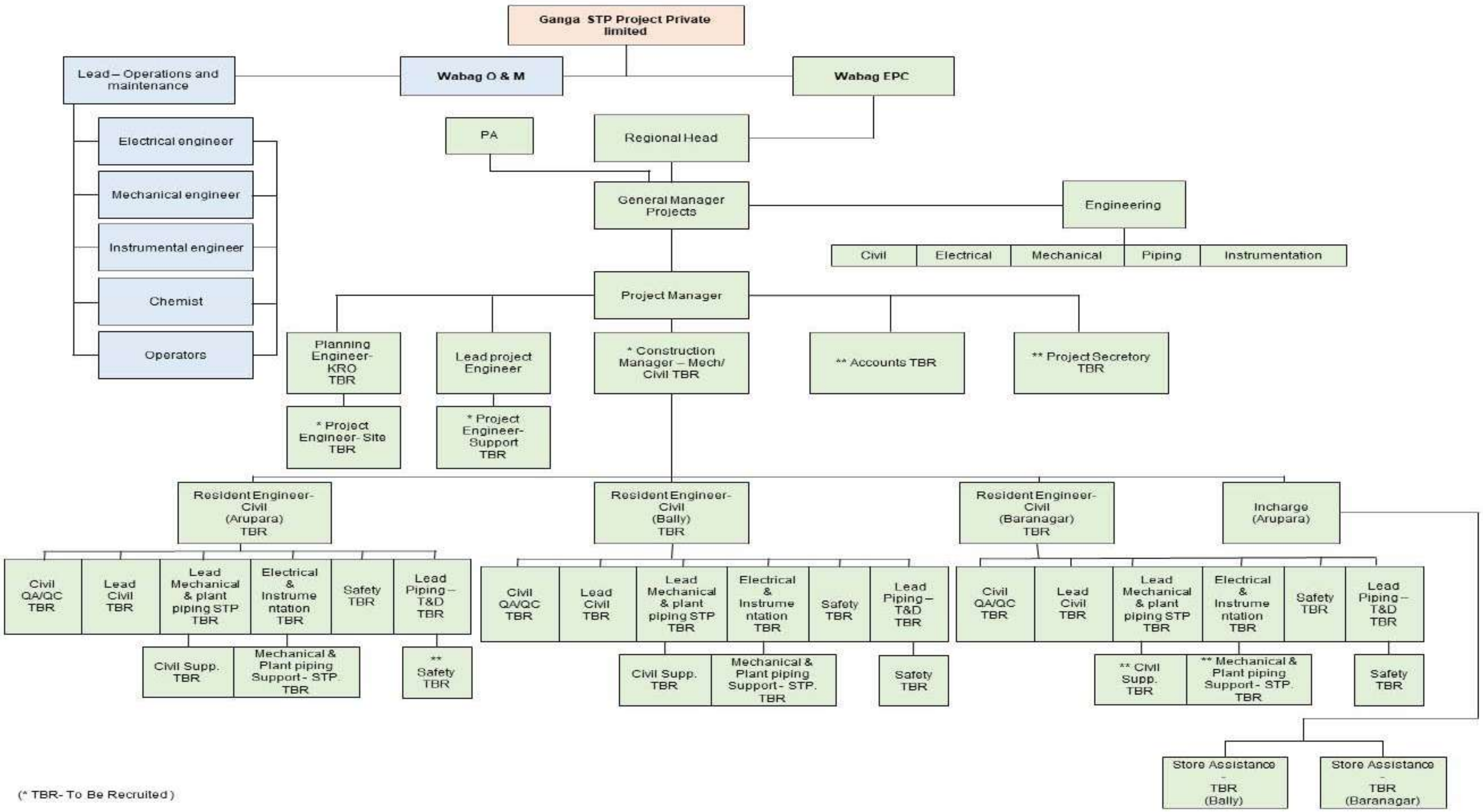
9. ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN

The ESIA for upgradation and renovation of the sewage treatment plant in Arupara STP has been undertaken to assess and report the environmental and social impacts of the project. In course of the project's planning and the ESIA, project design decision have been made taking into account the need to avoid, minimize and reduce adverse impacts. VA Tech Wabag Limited (hereinafter referred as Wabag) the EPC Contractor and operation and maintenance (O&M) provider for the project cycle of a 60 MLD STP in Arupara STP as well as the construction and rehabilitation of effluent disposal pipelines, trunk sewers and pumping stations to convey the sewage to the STP is the responsible entity for ensuring that the mitigation measures as suggested in the Environmental and Social Management Plan (ESMP). Further, this ESMP provides project and site specific mitigation measures to minimize damage to the local environment and disruption to local communities.

9.1 Implementation of ESMP

M/s VA Tech Wabag Ltd (Wabag) will have ultimate responsibility for implementing the provisions of the ESMP during de-commissioning, construction and operation phase of the project. This role will include the on-going management of environmental and social impacts, monitoring of contractor performance as well as development of mechanisms for dealing with environmental and social problems.Wabag will also ensure that the activities of its contractors are conducted in accordance with good practice measures, implementation of which will be required through contractual documentation.

Figure 9.1 Organisational Structure



9.2 EPC and O&M Contractor Management

The EPC and O&M contractor, i.e. M/s VA Tech Wabag Ltd (Wabag) will have a dedicated HSE department for the projects. VA Tech Wabag Ltd. has a well structured corporate level Occupational Health, Safety and Environmental Policy in place and also maintains an integrated management system (ISO 9001:2015, ISO 14001:2015 and ISO 45001:2018) for ensuring effective operational integration and monitoring process (***Appendix G***). The HSE department take the overall responsibility for co-ordination of the actions required for environment and social management and mitigation and for monitoring the progress of the proposed ESMP for the project.Wabag will also ensure that the project owner KMDA and SPV formed under special provision i.e GSPPL are kept well informed about the developments regarding the project. However, ultimate responsibility for implementing the provisions of the ESMP will lie with Wabag and perform the following activities:

- Preparation of required documents on environmental and social management;
- Ensuring availability of resources and appropriate institutional arrangements for implementation of ESMP;
- Implementation of the health and safety measures;
- Collection of the statistics of health of workers;
- Providing support during routine medical check-ups of workers;
- Awareness and implementing safety programmes;
- Providing job specific induction training;
- Compliance of regulatory requirements;
- Carrying out environmental audits;
- Identify unsafe acts & conditions and suggest remedies;
- Develop safety culture and comply with company's HSE policy & standards requirements;
- Encourage and enforce the use of PPE's;
- Educate all employees for the use of PPE's & safe practices;
- Direct, coordinate and orient the safety activities;
- Promulgate the spread of policy, objectives, rules and/or regulations;
- Perform a thorough investigation of all accidents and review the recommendations to avoid any repetition;
- Monitoring the progress of implementation of ESMP; and
- Reviewing and updating the ESMP as and when required for its effective implementation.

9.3 Inspection, Monitoring and Audit

Inspection and monitoring of the environmental and social impacts of the Project activities will increase the effectiveness of ESMP.Through the process of inspection and auditing, Wabag will ensure that the conditions stipulated in various permits are complied. The inspection and audits will be done by the project identified HSE staff in coordination with O & M sub-contractors and any other external agencies identified.The entire process of inspections and audits should being documented.The inspection and audit findings are to be implemented by the site In-charge in their respective areas. To ensure contractor compliance to the H&S requirements, the E&S Manager shall conduct daily checks and inspections. Findings from such inspections will be documented in the monthly monitoring reports. Independent audits shall be conducted during construction and once during the operation stage, to monitor the implementation of the ESMP and management plan, which also includes the Livelihood Restoration Plan (LRP).

9.4 Reporting and Documentation

Wabag shall develop and implement a programme of reporting through all stages of the project cycle. Delegated personnel shall require to fully complying with the reporting programme in terms of both timely submissions of reports as per acceptable level of detail. Reporting will be done in form of environmental check list, incident record register, environmental and social performance reports (weekly, monthly, quarterly, half yearly, yearly etc.).

9.4.1 Documentation

Documentation is an important step in implementing ESMP. Wabag will establish a documentation and record keeping system to ensure recording and updating of documents per the requirements specified in ESMP. The documents should be kept as hardcopies as well as in electronic format. Responsibilities have to be assigned to relevant personnel for ensuring that the ESMP documentation system is maintained and that document control is ensured through access by and distribution to, identified personnel in form of the following:

- Master Environment Management System document;
- Legal Register;
- Operation control procedures;
- Work instructions;
- Incident reports;
- Emergency preparedness and response procedures;
- Training records;
- Monitoring reports;
- Auditing reports; and
- Complaints register and issues attended/closed.
- Contractor H&S Performance Reports

9.4.2 Internal Reporting and Communication

Inspection and audits finding along with their improvement program are to be regularly reported to the senior management for their consideration. The same are also to be communicated within the staff working on the project. To maintain an open communication between the staff and management on HSE and social issues the followings are being used:

- Team Briefings,
- On-site work group meetings;
- Work Specific Instructions; and
- Meeting with stakeholders.

9.4.3 External Reporting and Communication

HSE In-charge is the responsible person for ensuring that communication with regulatory agencies and stakeholders are maintained as per the requirement. All complaints and enquiries are to be appropriately dealt with and records be maintained in a Complaint/Enquiry Register by the designated staff of Wabag. All communications made to regulatory agencies should also be reported to Wabag corporate HSE Head.

9.4.4 ESMP Review and Amendments

The ESMP act as an environment and social management tool which needs to be reviewed periodically to address changes in the organisation, process or regulatory requirements. Following a review, HSE In-charge will be responsible for making the amendments in the ESMP and seeking approval from the senior management. The amended ESMP will be communicated to all the staff.

9.5 Training Programme and Capacity Building

Training is needed for effective implementation of ESMP. HSE Officer of EPC contractor, HSE In-charge of Wabag as well as Wabag Corporate HSE Head will ensure that Environmental health and safety induction training and job specific trainings are identified and given to the concerned personnel for construction activities and during operations of the STP.

Also general environmental awareness will be increased among the projects' teams to encourage the implementation of environmentally sound practices and compliance requirements of the project activities. This will help in minimising adverse environmental impacts, compliance with the applicable regulations and standards, and achieving performance beyond compliance. The same level of awareness and commitment will be imparted to the contractors and sub-contractors involved in the project. Some of the suggested training areas are as follows:

Table 9.1: Suggested E&S Trainings

Types of Trainings	Stakeholder	Frequency
HR Induction and Company code of Conduct	Contractor Workers and Wabag Staff	Monthly (as applicable)
Grievance Procedures and Redress Mechanism	Contractor Workers and Wabag Staff	Quarterly
Health & Safety Training	Contractor Workers and Wabag Staff	On joining (Induction training)
		Daliy (Tool Box Talk)
		Monthly and Quarterly (refresher's training)
First Aid Training	First Aid Rider	Quaterly

9.6 Environmental Monitoring

The environmental monitoring programme has been devised with the following objectives:

- To evaluate the effectiveness of the proposed mitigation measures and the protection of the ambient environment as per prescribed/ applicable standards for the Project;
- To identify the need for improvements in the management plans;
- To verify compliance with statutory and community obligations; and
- To allow comparison against baseline conditions and assess the changes in environmental quality in the Project area.

9.7 Performance Indicators and Monitoring Schedule

Physical, biological and social environmental management components of particular significance have been identified as performance indicators. A comprehensive monitoring plan for each E&S

performance indicator has been prepared for all phases of the Project and is presented in ***Table 9.2***. This includes parameters to be measured, methods to be used, sampling locations, frequency of measurements, detection limits, cost and responsibilities for implementation and supervision.

9.8 Environment and Social Management Plan

This section outlines the potential adverse impacts, mitigation measures, monitoring and management responsibilities during construction and operation phases of the Projects.

The purpose of ESMP is to:

- Provide an institutional mechanism with well-defined roles and responsibilities for ensuring that measures identified in ESIA designed to mitigate potentially adverse impacts, are implemented;
- List all suggested mitigation measures and control technologies, safeguards identified through the ESIA process;
- Provide Project monitoring program for effective implementation of the mitigation measures and ascertain efficacy of the environmental management and risk control systems in place; and
- Assist in ensuring compliance with all relevant legislations at local, state and national level for the Projects.

In order to minimize adverse impacts during different phases of project lifecycles, mitigation measures, monitoring plan and responsibilities for its implementation are given in ***Table 9.1***.

The responsibility for implementation of ESMP will primarily lies with EPC Contractor & O&M contractor HSE Department and HSE In-charge of Wabag, GSPPL and KMDA will majorly play a role of supervisor to oversee the project performance pertaining to environment, health, safety and social issues.

Note:

1. Since at some instances, detailed project design related information and specifications of the project are yet to be finalized. GSPPL will evaluate environment and social risk and impacts associated with Change in Design, in line with IFC PS requiements. This may require project component specific review or commissioning a detailed ESIA, commensurate to the risks and impacts anticpated due to such changes.

Table 9.2: Environment and Social Management Plan

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
Environmental Issues Associated with Site Construction Phase						
Drainage	Soil stripping and limited cutting, filling and levelling activities to make the site topography suitable for setting up of the STP. The removal of vegetation cover and top soil can increase the potential for soil erosion during a short period of time till the site is levelled and then stabilized with fill materials like gravel, and sand.	Surface runoff from the construction site may contain eroded earth, sand, aggregate, spilled oil, lubricant, paint residues etc., however the potential to reach drainage channel near and affecting the water quality.	Minor (Negative)	Site to develop an appropriate storm water drainage and flood water management plan, as best management practice (please refer section 5.4.4)	GSPPL	GSPPL
Visual and Aesthetics	Grading and cleaning of land Storage and disposal of demolition waste Storage and disposal of sludge/silt from decommissioned structure	Loss of topsoil producing an offensive odour and visual impact	Minor (Negative)	Stacking of soil heaps and sludge/silt to be done away from settlements with provision of covers so that odour and fugitive emissions are restricted. All the construction activities will be restricted within the designated site On completion of work, all temporary structures, surplus materials and wastes will be completely removed from the site and disposed of at a designated facility. (Please refer section 5.4.4)	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
Visual and Aesthetics	On-Site storage of excavated and construction materials; On-Site storage of construction waste; Off-Site disposal of construction waste; Earth work along the sewer pipeline route; De-silting of sewer pipelines; On-Site storage and Off-Site disposal of silt/sludge from sewer pipeline; and Renovation work at linked facilities.	The disposal of MSW in open area around the site can create odour nuisance.	Minor (Negative)	Provision of storage facility for construction materials within the site; Provision of temporary storage of wastes and collection will also be made at the site Sections excavated for pipeline route will be barricaded with tin sheets; Stacking of sections of pipeline to be done away from settlements with provision of wedges to ensure that rolling or movement of pipeline do not pose risks to passers-by; All the construction activities will be restricted within the designated site; On completion of work, all temporary structures, surplus materials and wastes will be completely removed from the site and disposed of at a designated facility; Construction and municipal solid waste temporarily stored at the site will be transported to the designated disposal facility at regular intervals; (Please refer section 5.4.4)	GSPPL	GSPPL
Soil Quality	Site clearing and preparation	Soil compaction	Minor (Negative)	Demarcation of routes for movement of heavy vehicles; Stripping and placing soils when dry, and not when wet. (Please refer section 5.4.7)	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
Soil Quality	Fuelling and operation of heavy machinery and transport vehicles	Soil contamination through spills and leaks	Minor (Negative)	Preparation of guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals; Storage areas for oil, fuel and chemicals to be surrounded by bunds or other containment devices to prevent any spilled oil, fuel or chemicals from contaminating soils, water or groundwater; Use of spill or drip trays to contain spills and leaks, and use of spill control kits to clean small spills and leaks; and Installation of oil/water separators to treat surface run-off from bounded areas prior to discharge to the storm water system.	GSPPL	GSPPL
Soil Quality	Storage and handling of chemicals	Soil contamination through spills and leaks	Minor (Negative)	Designated storage area with proper area arrangements (Please refer section 5.4.7)	GSPPL	GSPPL
Soil Quality	Storage, handling and disposal of construction waste	Soil contamination	Minor (Negative)	Design processes to prevent/ minimise quantities of wastes generated and hazards associated with the waste generated; Implement a construction materials inventory management system to minimise over-supply of the construction materials, which may lead to disposal of the surplus	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				materials at the end of the construction period; Segregate hazardous and non-hazardous waste and provide appropriate containers for the waste types generated (e.g. enclosed bins for putrescible materials to avoid attracting pests and vermin and to minimise odour nuisance); Store wastes in closed containers away from direct sunlight, wind and rain; Ensure storage area has an impermeable floor and containment, of capacity to accommodate 110% of the volume of the largest waste container; Dispose of waste by authorised vendor. (Please refer section 5.4.7)		
Soil Quality	Generation of sanitary effluent	Soil contamination	Minor (Negative)	Adequate sanitary facilities, i.e. toilets and showers, will be provided for the construction workforce; Septic tank and soak pit will be provided to treat domestic waste water. (Please refer section 5.4.7) The Waste Management Plant (including C&D waste as well as liquid waste) should also contain aspects of adequate storage, disposal, transportation routh, training and record keeping for different categories	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				of waste i.e. hazardous waste, solid waste, e-waste, bio-medical waste, municipal solid waste and chemical waste.		
Surface Water Quality	Erosion from excavation, levelling, filling and other activities	Increased sediment content of surface water	Minor (Negative)	Provision of channels, earth bunds or sand bag barriers on site to direct storm water to silt removal facilities; Protection of stockpiles by plastic sheeting to ensure that they are suitably secured against the wind at the end of each working day if rain is forecasted; Appropriate surface drainage will be designed and provided where necessary; Drainage systems, erosion control and silt removal facilities will be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rainstorms. Deposited silt and grit will be removed regularly; Any temporarily diverted drainage will be reinstated to its original condition when the construction work has finished or when the temporary diversion is no longer required; Temporary and permanent drainage pipes and culverts will be provided to facilitate runoff discharge. These will	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				be designed for the controlled release of storm flows. (Please refer section 5.4.5)		
Surface Water Quality	Fuelling and operation of heavy machinery and transport vehicles	Contamination of surface water	Minor (Negative)	Vehicle servicing areas, vehicle wash bays and lubrication bays will, as far as practical, be located within roofed and cemented areas. The drainage in these covered areas will be connected to sewers via an oil/water interceptor; Any oil leakage or spillage will be contained and cleaned up immediately. Waste oil will be collected and stored for recycling or disposal; Any surplus wastewater from the concrete batching plant will be treated to comply with discharge standards before it is discharged to the Sea; (Please refer section 5.4.5)	GSPPL	GSPPL
Surface Water Quality	Storage and handling of chemicals	Contamination of surface water	Minor (Negative)	Designated storage area with proper boundary(Please refer section 5.4.5)	GSPPL	GSPPL
Surface Water Quality	Generation of sanitary effluent from on-site labour accommodation.	Contamination of surface water by sanitary effluent generated from on-site labour accommodation.	Minor (Negative)	Provide sanitation facilities for worker accommodations (Please refer section 5.4.5)	GSPPL	GSPPL
Ground Water	Fuelling and operation of heavy machinery and transport vehicles	Contamination of groundwater	Minor (Negative)	Proper SOP has to be followed during such kind of activity(Please refer section 5.4.6)	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
Air Quality	Operation of heavy machinery and transport vehicles	Exhaust Emissions	Minor (Negative)	Minimise movement of construction vehicles and enforce a speed limit around the construction site; Regularly maintain all diesel-powered equipment and reduce idling time to avoid emissions of NOx, PM10 and SO2; Where available use low sulphur diesel (LSD) in HGVs and diesel powered equipment in collaboration with best management practices; Implement best practice procedures to control vehicle / equipment air emissions (such as turning off equipment when not in use); and Vehicle / equipment exhausts observed to be emitting significant black smoke from their exhausts should be serviced/ replaced. (Please refer section 5.4.2)	GSPPL	GSPPL
Air Quality	C&D waste management and Sludge Handling	Dust	Minor (Negative)	As far as possible, locate the concrete batching plant away from sensitive receptors; Implementation of a periodic watering and sprinkling regime in particular during the dry season, at least two times during the day; Minimise the height from which fill materials are unloaded during site backfilling as far as possible. Where	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				possible, this should be below the height of the hoarding around the Project site boundary; During construction, the approach road will be regularly maintained to keep it clean, free from mud and slurry. The approach road will be properly shaped and compacted by rolling to an even and uniform surface to receive pavement. Totally enclose any skips for material transport with impervious sheeting; and No waste will be burnt on or around the Project site. (Please refer section 5.4.2)		

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
Noise	Heavy machinery operations for construction works	Increase in ambient noise levels	Minor (Negative)	Normal working hours of the contractor will be between 06:00 and 21:00 hours from Monday to Sunday. If work needs to be undertaken outside these hours, it should be limited to activities that do not lead to exceedance of the noise criteria at nearby sensitive receptors; Regular maintenance of equipment including lubricating moving parts, tightening loose parts and replacing worn out components should be conducted; Low noise equipment should be used as far as practicable; The number of equipment operating simultaneously should be reduced as far as practicable; Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby sensitive receptors like Adarsha Nagar settlement as far as practicable; Acoustic enclosure should be erected around DG sets and other stationary noise generating equipment; (Please refer section 5.4.3)	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
Occupational Health and Safety	General construction activities	Health and safety of construction workforce	Moderate (Negative)	The Contractor will prepare and implement a Health and Safety Plan prior to commencing work. This plan will include method statements for working methods, plant utilisation, construction sequence and safety arrangements; Measures will be implemented to reduce the likelihood and consequence of the following hazards: falling from height; falling into water; entanglement with machinery; tripping over permanent obstacles or temporary obstructions; slipping on greasy oily walkways; falling objects; contact with dangerous substances; electric shock; variable weather conditions; lifting excessive weights; A Permit to Enter system will be established to ensure that only authorised persons gain entry to the site; All persons working on site will be provided information about risks on Site and arrangements will be made for workers to discuss health and safety with the Contractor;	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				All workers will be properly informed, consulted and trained on health and safety issues; Personal Protective Equipment (PPE) shall be worn at all times on the Site. Women in the region generally wear “sarees”, which is not appropriate while working in hazard prone construction areas. If women will be working in the hazard prone areas, then the contractor needs to ensure proper outfit and PPEs. Before starting work all the appropriate safety equipment and the first-aid kit will be assembled and checked as being in working order; All lifting equipment and cranes will be tested and inspected regularly. All hoist ways will be guarded; All scaffolding will be erected and inspected in conformity with the Factories Act and the appropriate records maintained by the Contractor; Safety hoops or cages will be provided for ladders with a height in excess of two metres; When there is a risk of drowning lifejackets shall be provided and it shall be ensured that personnel wear adequate buoyancy equipment or harness and safety lines, and that		

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				rescue personnel are present when work is proceeding; The Contractor shall provide appropriate safety barriers with hazard warning signs attached around all exposed openings and excavations when the work is in progress. (Please refer section 5.4.13)		
Community Health and Safety	Influx of construction workers	Increased prevalence of disease	Minor (Negative)	Barriers will be provided to prevent ingress of persons into the construction site and also to protect the public from exposure to hazards associated with the construction activities; Screening, surveillance and treatment of workers, through the provision of medical facilities and, where required, immunization programmes; Undertaking health awareness and education initiatives among workers; Avoiding collection of stagnant water; (Please refer section 5.4.9)	GSPPL	GSPPL
Community Health and Safety	Road transportation	Traffic safety	Minor (Negative)	Road safety awareness building for residents living along the transportation route. (Please refer section 5.4.9)	GSPPL	GSPPL
Social Issues Associated with Site Construction Phase						

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
Loss of Income of Existing Workers	Construction Stage	The existing workers engaged under the contracting agencies Associated Cooperative Labour Contractor and Construction Society Ltd, and MCE Construction.at the Arupara STP and MPS respectively, may be laid off during the new the new O&M phase.	Major	Refer Section 5.7 As per IFC PS 2 guidelines, viable alternatives to retrenchment should be analysed If retrenchment is necessary, to reduce the adverse impacts of retrenchment on the workers, a Retrenchment Plan should be developed, meeting IFC PS 2 requirements. The client should comply with all legal and contractual requirements related to notification of public authorities, and provision of information to, and consultation with workers and their organizations. The client should ensure that all workers receive notice of dismissal and severance payments mandated by law and collective agreements in a timely manner. All outstanding payments and social security benefits and pension contributions and benefits should be paid: (a) on or before termination of the working relationship to the workers, (b) where appropriate, for the benefit of the workers, or (c) Payment will be made in accordance with a timeline	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				agreed through a collective agreement. (d) Where payments are made for the benefit of workers, workers will be provided with evidence of such payments. The abovementioned mitigations have been presented in a Labour Management Framework (LMF), which has been attached as Appendix. The Retrenchment Plan is required to be prepared prior to the closure of the contract of the workers, which has to be conducted in consultation with the affected parties and the Concessionaire. It should be noted that if the existing workers are redeployed into other alternate sites of KMDA and by the Concessionaire, then the impact would be reduced. Failing to which the Labour Management Plan would be effective. The existing workers (if they wish to continue work) may be accommodated or deputed into other such facilities (if there is such scope available) run by KMDA.		

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				Alternatively, these workers may be considered or given priority by the then O&M Agency, based on their selection and recruitment criteria, during the O&M phase		
Access Disruption	Repair and Laying of new sewer line.	Access disruption for both residential, commercial and business operation during excavation work for laying of new rising mains, replacement and construction work.	Minor (Negative)	*Refer Section 5.5.1* ■ Inform all the stakeholders well in advance (at least 15 days) before the start of the construction work to enable shop owners to stock up and remain unaffected if goods vehicles are unable to reach them during construction; ■ Providing provision of wooden planks to ensure pedestrian access, signage with project details and contact details for grievance redress; and proper traffic management ■ Providing assistance to mobile vendors if any present during construction, to shift nearby locations if any; ■ The contractor should provide proper barricading and signage or notices to indicate the ongoing work. In case by-lanes towards the residential areas/shops are located from the replacement stretches, contractor to provide proper	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				barricading and temporary alternate route for people to access their houses/shops ■ Alternative access route to be provided for the community to access their residential places and in case of any medical emergency.		
Livelihood Restoration Plan for Affected Persons	Repair and Laying of new sewer line.	Temporary Loss of Income: Road side vendors, kiosk and shops operating their business near the project will face temporary livelihood/income loss during the laying of new sewer line, rising main and replacement along the RoW.	Minor	*Refer Section 5.5.2* One time compensation will be paid for the temporary income loss as per the entitlements detailed out in the Livelihood Restoration Framework; One time compensation will be paid for the temporary income loss as per the entitlements detailed out in the Livelihood Restoration Framework (LRF); A Livelihood Restoration Plan will be prepared for the Affected Persons. For the purpose of the Livelihood Restoration Plan (LRP) and identifying the PAHs, primary socio-economic data will be collected for the PAHs. The primary data comprised of quantitative and qualitative data collected via a range of tools and data gathering techniques. The primary data will be collected through the following methods:	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				■ *Census Survey*: A 100 percent census/enumeration of socio-economic characteristics will be carried out for all the PAHs to be impacted on account of the laying of new sewer line, renovation and replacement of sewer line. ■ *Inventory of losses*: An inventory of all structures and immovable assets, livelihood loss to be impacted for each PAH will be conducted during the LRP preparation The contractor should ensure that construction work to take place during off-peak business hour and during the night to avoid major disruption Prior to the start of the construction, the shops owners should be made aware of the construction work Contractor during construction should ensure that structure near the RoW are not affected and excavation should be carried out to a possible extend to avoid any damages to residential and commercial structure.		

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
Intra-state Migrant Workers & Labourers	Inflow of Migrant labourers & workers expected during construction phase of the project	Potential conflict with local community; Health risks due to spread of communicable diseases and sexually transmitted diseases Issue of Sanitation and hygiene	Minor (Negative)	Refer Section 5.4.10, 5.4.11 and 5.4.12) Provide adequate facilities to the workers and labourers such as properly constructed and well ventilated labour camps, clean and hygienic sanitation facilities, cooking areas etc. to minimize the health related impacts; Separate toilet and bathing facilities for men and women; Creating awareness about local tradition and culture among outside migrant and encouraging respect for same; Conducting awareness programme about sexually transmitted diseases among the migrant workers, labourers and for community around project site; Proper disposal of wastes generated from the camp and construction activity to maintain general hygiene in the area;	GSPPL	GSPPL
Gender Empowerment including Employment of Women	Civil construction during the construction phase of the project.	The civil construction work to be taken place at the STP can provide employment opportunities	Moderate (Negative)	*Refer Section 5.6* Ensure the implementation of the Gender Action Plan (GAP) for the	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
		for women residing in the project area.		project, which has been developed as a stand-alone document. Ensure equitable distribution of employment opportunities between men and women through encouraging contractors to employ local workers including women for labour-based work. Ensure availability of gender sensitive facilities such as toilets, resting areas, crèches for children, and a policy against sexual harassment. Women should be encouraged to participate in public meetings, discussions and consultations especially with regard to their entitlements. Women should be made aware of the Grievance Redressal Mechanism (GRM) and the Grievance Redressal Committee should also comprise 50% of women members		
Environmental Issues Associated with Site Operation Phase						
Visual and Asthetics	Physical presence of the STP;	Visual and Odour	Minor (Negative)	Appropriate shading of lights to prevent scattering	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
	Illumination from the STP facility. Operation and Storage of Sludge increasing the Odour			Tree plantation and odour Monitoring (Please refer section 5.4.1)		
Surface and ground water quality	Oil spills from oil tanks	Impact on soil and ground water environment Contaminated storm water runoff carrying contaminants to Howrah Drainage Channel	Moderate (Negative)	The secondary containment structures such as berms, dykes, or walls that could hold up to 110 % of the primary containment volume will be made of firm and impervious material at diesel and lubricating oil storage areas; (Please refer section 5.4.5 and 5.4.6) SOPs will be prepared to manage any oil spills, leaks seepages. SOPs will cover transport, handling, storage, use and disposal of oil/ oil wastes/ empty drums etc. Operating personnel will be trained on the SOPs and monitored in their use on a daily basis; Empty drums will be sent for reuse or for recycling in line with CPCB guidelines; At all oil and diesel storage tank locations, emergency spill kits will be provided for the operating personnel to use. Operating personnel will be trained to use such kits and dispose of them as part of hazardous waste; (Please refer section 5.4.5 and 5.4.6)	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
Surface and ground water quality	Oily water-runoff	Contaminated storm water runoff carrying contaminants to Howrah Drainage Channel	Moderate (Negative)	Oily water runoff collected in the oil handling & storage area and oil filled motors and pump bases will be collected in different sump and taken to a common oily waste water sump; The oily wastewater and storm runoff collected from specific areas mentioned above will be treated using an oil water separator; and Separated oil will be disposed of as part of oily wastes and handled as a hazardous waste stream. The treated de-oiled water will be transferred to waste water chamber (Please refer section 5.4.5 and 5.4.6)	GSPPL	GSPPL
Surface and ground water quality	Spills of fuel, oil and chemicals	Impact on soil and ground water environment Occupational health and safety hazard Contaminated storm water runoff carrying contaminants to Howrah Drainage Channel	Minor (Negative)	Acids and other hazardous materials will be stored in a dedicated room as per their MSDS specifications with adequate ventilation; All chemicals will be stored in primary containers that have in-built secondary containment of capacity that is at least 110% of primary containment; The Spill prevention and response guidance presented in Sections 1.5 and 3.7 of the General IFC EHS Guidelines (2006) will be followed and implemented. (Please refer section 5.4.5 and 5.4.6)	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
Surface and ground water quality	Discharge of domestic wastewater	Impact on Sea Water and channel water quality	Minor (Negative)	The sewage from the entire plant area will be collected and treated in septic tank/soak pit No untreated sewage will be directly discharged into Sea water or disposed of on land through the project life cycle; National and IFC Guidelines before discharge; and In order to monitor STP performance, continuous evaluation and monitoring of discharge parameters will be undertaken at the outlet point of STP. (Please refer section 5.4.5 and 5.4.6)	GSPPL	GSPPL
Surface and ground water quality	Non-oily site or storm water runoff	Impact on Sea water quality	Minor (Negative)	Storm water and non-oily surface run off will be collected separately and disposed into Sea through for this stream of wastewater; The discharge system will be periodically inspected for blockages and cleaned at least once before the monsoon season to ensure its functioning; and Operating personnel will be trained to visually inspect discharged water quality for oil and grease traces (that will be visible on the surface) periodically and take appropriate corrective action. (Please refer section 5.4.5 and 5.4.6)	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
Air Quality	Stack emissions	Impact on ambient air quality GHG emissions	Negligible (Negative)	The Project will adopt Gas Turbine system for captive power generation which has a relatively high energy-efficiency and low polluting per unit of power produced compared to other thermal power plants; Comply with the Emission guidelines for Combustion engines in given by CPC.Monitor ambient air quality in and around the Project site as per the Environment Monitoring Program formulated for the Project which will comply with National Regulatory requirements. (Please refer section 5.4.2)	GSPPL	GSPPL
Noise	Plant operations	Impact on health of workers and staff	Negligible (Negative)	Noise monitoring along with health check-up on a regular interval(Please refer section 5.4.3)	GSPPL	GSPPL
Noise	Plant operations	Impact on health of workers and staff	Negligible (Negative)	All noise generating units would be acoustically enclosed; Use of rubber padding underneath high noise and vibration generating machines; Personnel working onsite in high noise generating areas will use ear plugs /ear muffs; (Please refer section 5.4.3)	GSPPL	GSPPL
Community Health and Safety	Plant operations	Impact on community assets such as water due	Minor (Negative)	Comply with the Community health and safety guidelines presented in	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
		to water intake and cooking water discharge Increased vehicular traffic in the region Exposure to site accidents and incidents Project Security		Section 3.0 of the General EHS Guidelines published by IFC; Formulate and implement an On-site Emergency Management Plan in consultation and collaboration with local government authorities to streamline the emergency management response and strategy. Institute and operate a Community Grievance Redress System in line with IFC Performance Standard 4 that pertains to Community Health, Safety and Security aspects; and If required, Project Security personnel will be engaged and trained in line with the recommendations of IFC Performance Standard 4. (Please refer section 5.4.9)		
Occupational Health and Safety	Project Operation Phase	Risk of accident and fatality to worker	Minor (Negative)	On job training for the workers shall be carried out; Work permit system shall be followed; PPEs to be provided and use of PPEs shall be encouraged; SOPs to be developed for operation and maintenance of the project site. (Please refer section 5.4.14)	GSPPL	GSPPL
Community Health and Safety and other issues	Project Operation Phase	Traffic Movement in newly constructed site approach road	Minor (Negative)	Awareness campaign among the community residing adjacent to the road	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				Maintaining healthy relationship with community through CSR activity		
Social Issues Associated with Site Operation						
Community Health and Safety and other issues	Project Operation Phase	Traffic Movement in newly constructed site approach road	Minor	Awareness campaign among the community residing adjacent to the road Maintaining healthy relationship with community through CSR activity(Please refer section 5.4.9)	GSPPL	GSPPL
Social Issues Throughout Project Cycle						
Grievances Redress	*Entire Project Cycle*	Healh and safety risk, Non-payment of wages for workers Community Grievances Compensation and Resettlement	Minor	Awareness on the Grievance redress Mechanisn Training on the process and GRM procedures	GSPPL	GSPPL
Consultation and Information Disclosure	Entire Project Cycle	Project Impacts and potential influence of stakeholders on the projects	Minor	Sharing of Emergency Preparedness procedures with workers and community Sharing of monitoring reports for E&S compliance Continous engagement with stakeholders	GSPPL	GSPPL

The corresponding EHSS management and ESMS procedures in relation to the proposed mitigation measures as outlined in the Table 9.2 above with respect to the construction phase, needs to be developed by GSPPL prior to start of any development/ construction activity at the project sites or first disbursement by its lender, whichever is earlier. The following EHSS management plans shall be developed in accordance with the Good International Industry practice (GIIP).

- Development of ESMS Policy;
- Construction management plan for excavation/backfilling at site;
- Transportation of construction material and fugitive dust management plan;
- Noise management plan;
- Odour management plan;
- Lighting and illumination management plan;
- Construction and other solid waste management plan;
- Wastewater and sewage management plan;
- Traffic management plan;
- Hazardous materials and hazardous wastes management plan;
- Labor influx and worker accommodation management plan;
- Vectors and disease management plan;
- Occupational health and safety management plan;
- Emergency response plan;
- Security management plan;
- Contractor/sub-contractor management plan;
- Implemenation of Livelihood Restoration Plan for project affected person (as applicable).

The corresponding EHSS management and ESMS procedures in relation to the proposed mitigation measures as outlined in the Table 9.2 above with respect to the project operation phase, needs to be developed by GSPPL prior to start of operation of the Arupara STP. The following EHSS management plans shall be developed in accordance with the Good International Industry practice (GIIP) and requirement of IFC's Performance Standards.

- Noise management plan;
- Odour management plan;
- Sludge and other solid waste management and disposal plan;
- On-site drainage management plan;
- Treated water discharge management plan;
- Equipment operation and maintenance plan;
- Hazardous materials and hazardous wastes management plan;
- Vectors and disease management plan;
- Occupational health and safety management plan;
- Standard Operating Procedure related to incident and accident management, recording and reporting system;

- Onsite and offsite emergency preparedness and response plan (including for fire, toxic gas release and chemical spills, medical emergencies and natural calamities);
- Worker/labour management plan (covering all applicable national labour laws, grievance redressal, on-site accomodation)
- Security management plan;
- Contractor/sub-contractor management plan.

Table 9.3: Environmental and Social Monitoring Programme for Project Life Cycle

Project Stage / Affected Component	Potential Impact / Mitigation	Parameters to be Monitored	Measurements	Frequency	Responsibility	Monitoring Cost Source		Budget Source
						Pre-Construction and Construction	Operations Phase	
General	Inspection of mitigation compliance	General compliance with mitigation measures presented in the ESMP and operational manual	Visual inspection of all active work areas	Daily	GSPPL	Management Time	Management Time	Included in operation and maintenance (O&M) cost
Air Pollution	Stack emissions concentrations from Biogas power plant	NOx, CO, PM	CEM	Continuous	GSPPL	Rs. 100000	Rs. 100000	ESMP Budget
	Ambient air quality	NOx, CO, PM10, SO2	Standard methods	Monthly	3rd Party Environmental Consultant / GSPPL	Rs. 40000	Rs. 40000	ESMP Budget
Noise	Noise generation by Plant equipment	Sound Pressure Level	Noise monitoring	Monthly Refer section Quarterly	Monitoring done by Wabag and verification by 3rd Party Environmental Consultant	Rs. 24000	Rs. 24000	ESMP Budget

Project Stage / Affected Component	Potential Impact / Mitigation	Parameters to be Monitored	Measurements	Frequency	Responsibility	Monitoring Cost Source		Budget Source
						Pre-Construction and Construction	Operations Phase	
	Ambient noise	Ambient noise levels	Noise monitoring with data logger	24-hour observations with hourly noise levels, monthly once at each location	3rd Party Environmental Consultant/ GSPPL	Rs. 24000	Rs. 24000	ESMP Budget
Soil	Soil and Sediment Contamination	pH, salinity, NH_4^+, total P, heavy metals, oil & grease	Standard analytical methods	Half Yearly	3rd Party Environmental Consultant/ GSPPL	NA	Rs. 24000	ESMP Budget
Water	Ground water quality	Drinking water quality parameters	Standard analytical methods	Monthly	3rd Party Environmental Consultant/ GSPPL	NA	Rs. 24000	ESMP Budget
	Wastewater	Temperature, chlorine, pH, BOD5, COD, oil & grease, heavy metals, total faecal coliform	Standard methods	Monthly	3rd Party Environmental Consultant/ GSPPL	NA	Rs. 24000	ESMP Budget
	Surface water quality	Temperature, conductivity, pH, DO, TDS	Potable water quality analyser	Monthly Quarterly	Monitoring done by Wabag and verification by 3rd Party Environmental Consultant	NA	Rs. 24000	ESMP Budget

Project Stage / Affected Component	Potential Impact / Mitigation	Parameters to be Monitored	Measurements	Frequency	Responsibility	Monitoring Cost Source		Budget Source
						Pre-Construction and Construction	Operations Phase	
Occupational Health and Safety	Accidents or incidents due to operation and maintenance activities, workers' health Emergency preparedness – Mock drill record HSE training – Social Medical camp Others for HSE- June 5th Environmental day celebration National safety Day	Near-misses, incidents, occupational diseases, dangerous occurrences	As to be defined in the H&S Plan to be prepared by GSPPL for the Project	As defined in H&S Plan	GSPPL	Management Time Rs. 20000 Rs. 20000 Rs. 25000 Rs. 150000	Rs. 720000	O&M Cost
Community Health and Safety	Community disturbance and potential safety hazard due to road traffic	Accidents, incidents and complaints	Incidents, accidents and community complaints	Based on occurrence	GSPPL	Management Cost	Management Cost	ESMP Budget

Project Stage / Affected Component	Potential Impact / Mitigation	Parameters to be Monitored	Measurements	Frequency	Responsibility	Monitoring Cost Source		Budget Source
						Pre-Construction and Construction	Operations Phase	
	Community disturbance and potential safety hazard due to waterway transportation	Accidents, incidents and complaints	Incidents, accidents and community complaints	Based on occurrence	GSPPL		O&M Cost	ESMP Budget
	Public concerns	Complaints from community	As per the grievance redress mechanism	Continuous	GSPPL		O&M Cost	ESMP Budget
LRP Implementation	Temporary Income Loss: Road side vendors, kiosk and shops operating their business near the project will face temporary livelihood/income loss during the laying of new sewer line, rising main and replacement along the RoW.	All affected person are identified and consulted Affected person identified and IOL lossess documented for compensation	Records of all affected persons and IOL	Once before construction work	GSPPL	The compensation for the Affected Persons (APs) has been outlined in the budget in the Livelihood Restoration Framework (LRF) which has been developed for the Project. -		NA
		Preparation of LRF for compensation	LRF Document	Before construction work	GSPPL			NA
		Status of Affected Persons	Status of Affected Persons	Compensation Docement/Records Monitoring Reports	GSPPL			NA

Project Stage / Affected Component	Potential Impact / Mitigation	Parameters to be Monitored	Measurements	Frequency	Responsibility	Monitoring Cost Source		Budget Source
						Pre-Construction and Construction	Operations Phase	
		compensated for losses	compensated for losses					
		Disclosure of project information prior to start of project.	As per SEP/ Information Disclosure Plan	Prior to start of construction	GSPPL			
		Implementation of GRM	GRM Register	Prior to start of construction and during LRP implementation	GSPPL			
Loss of Employment for Workers	Workers working in the existing STP and linked facilities	Status of workers redeployed to othe KMDA facility Status of workers absorbed to the Project	As per Labour Management Framework	Operation	GSPPL and KMDA	Management Time and professional fees for engaging third party monitoring agency	Management Time and professional fees for engaging third party monitoring agency	N/A
Intra-state Migrant Workers & Labourers	Potential conflict with local community;	No of registered grievances and redressal status Status of implementation Labour	Incidents, accidents and community complaints	During operation of labour camp.	GSPPL	Management Cost	Management Cost	ESMP Budget

Project Stage / Affected Component	Potential Impact / Mitigation	Parameters to be Monitored	Measurements	Frequency	Responsibility	Monitoring Cost Source		Budget Source
						Pre-Construction and Construction	Operations Phase	
		Management Plan (LMP)						
	Health risks due to spread of communicable diseases and sexually transmitted diseases Issue of Sanitation and hygiene	Condition of labour camp, awareness of workers, complainant register Status of implementation of Contractor Management Plan (LMP)	Incidents, accidents and community complaints	Every 15 days during operation of labour camp.	GSPPL			ESMP Budget
Gender Empowerment including Employment of women	The civil construction work to be taken place at the STP can provide employment opportunities for women residing in the project area.	Ensure equitable distribution of employment opportunities between men and women through encouraging contractors to employ local workers including women	Number of women employed as a percentage of total persons employed in construction activities; Number of women workers earning same wage as men	Continuous	GSPPL & O&M Agency	Management Cost	Management Cost	ESMP Budget

Project Stage / Affected Component	Potential Impact / Mitigation	Parameters to be Monitored	Measurements	Frequency	Responsibility	Monitoring Cost Source		Budget Source
						Pre-Construction and Construction	Operations Phase	
		for labour-based work.	workers, as a percentage of total women workers employed in construction activities;					
		Ensure availability of gender sensitive facilities such as toilets, resting areas, crèches for children, and a policy against sexual harassment.	Availability of basic amenities and separate toilet at campsite; and	Prior to start of construction	EPC Contractor			ESMP Budget
		Women should be made aware of the Grievance Redressal Mechanism (GRM) and the Grievance Redressal	Number of women members at the Grievance Redressal Committee (GRC)	Continuous	GSPPL			ESMP Budget

Project Stage / Affected Component	Potential Impact / Mitigation	Parameters to be Monitored	Measurements	Frequency	Responsibility	Monitoring Cost Source		Budget Source
						Pre-Construction and Construction	Operations Phase	
		Committee should also comprise 50% of women members						
		Women should be encouraged to participate in public meetings, discussions and consultations especially with regard to their entitlements.	As per implementation of Stakeholder Engagement Plan (SEP) and Gender Action Plan (GAP)	Continuous	GSPPL			ESMP Budget
Stakeholder Engagement and Grievance Redress	Healh and safety risk, Non-payment of wages for workers Community Grievances Compensation and Resettlement	Awareness on the Grievance redress Mechanisn Training on the process and GRM procedures	As per implementation of Grievance Redressal Mechanism (GRM) and Stakeholder Engagement Plan (SEP)	Continuous	GSPPL	Rs. 200000	Rs. 200000	ESMP Budget

Project Stage / Affected Component	Potential Impact / Mitigation	Parameters to be Monitored	Measurements	Frequency	Responsibility	Monitoring Cost Source		Budget Source
						Pre-Construction and Construction	Operations Phase	
Total						**Rs. 603000**	**Rs. 1204000**	

10. CONCLUSION AND RECOMMENDATIONS

It is understood from the ESIA study that the Project activities related to the development of the Arupara STP may create some impacts on air quality, community health and safety during the construction phase. Limited disturbance is envisaged on the neighbouring community of Arupara, GIP Colony, Hatpukur, Kamardanga as described in environmental setting, but it is understood to be short term and only during the construction phase. Moreover, impacts related to temporary livelihood loss and access disruption will also take place along the sewer lines. However all these impacts are temporary and can be mitigated with proper mitigation measures.

Additionally, contractual workers presently engaged at the STP and linked facilities, may potentially be impacted by loss of income if they are not re-ngaged in the new O&M regime or redeployed to other facilities of KMDA. If so, a Labour Management Framework (LMF) has been developed to address the potential loss of income for these workers. Moreover, the development of the 65 MLD STP would improve the quality of Howrah Drainage Channel and prevent direct discharge of raw sewage improving the hygiene aspect also.

The Environmental and Social Management Plan (ESMP) describes mitigation measures for impacts specific to the Project activities and also discusses implementation mechanisms. The implementation of the mitigation measures suggested can help in managing the negative impacts on air quality, ground water etc. whereas the economic opportunities in terms of local employment are assessed as positive.

Key mitigation measures proposed for addressing impacts include:

- Design consideration to avoid felling of mature trees to the extent possible within the project site.
- noise reduction measures to minimize disturbance to adjacent residential structures,
- dust emissions control measures during construction phase such as water sprinkling,
- covered transportation and storage of construction materials,
- provision of peripheral site drainage channels to prevent water logging situation,
- coordination with local communities for construction schedules;
- prior information about incoming vehicles carrying construction materials,
- Deployment of traffic marshals and access restriction for local people at the construction site.
- Compensation for Affected Persons as per the entitlements detailed in the Livelihood Restoration Framework (LRF);
- If feasible, the re-engagement or re-deployment of the existing workers into the new O&M regime or other KMDA facilities may be considered. In the event re-engagement or re-deployment of the workers does not take place, a Labour Management Framework (LMF) has been developed to address the potential loss of income.
- Ensure equitable participation of women in the workforce and decision-making. Gender specific mitigation measures have been detailed in the Gender Action Plan (GAP) developed for the project.
- Development of grievance redressal mechanism to receive and address any issues or concerns that might be reported by the neighbouring community.

To conclude, implementation of ESMP will help the Project to comply with national/state regulatory framework as well as to meet IFC requirements on the environmental and social performance.

APPENDIX A WABAG OCCUPATIONAL HEALTH, SAFETY AND ENVIRONMENTAL POLICY

OCCUPATIONAL HEALTH, SAFETY AND ENVIRONMENTAL POLICY

VA TECH WABAG LTD., as a market leader in the Indian water technology offers portfolio in the areas of municipal, industrial water and wastewater treatment, besides offering a full fledged state-of-the-art engineering services in line with global standards both in terms of quality and delivery.

VA TECH WABAG LTD., will undertake every reasonable effort to eliminate the hazards that cause incidents and injuries and aim to control or reduce wastage of natural resources, energy, materials and chemicals.

We shall strive to continually improve our Occupational Health, Safety and Environmental performance in our activities, products and services by implementing and maintaining the HSE Management Systems and by,

- Ensuring compliance with applicable legal and other requirements.
- Avoidance of incidents through prevention and safety awareness.
- Promotion of activities that could minimise environmental pollution.
- Optimising the utilisation of natural resources like energy, construction materials and reducing the waste generation.
- Promotion of measures aimed at enhancing the physical and emotional health of the people who work with or for our company.
- Creating awareness amongst our employees and stake holders by proactive communication, training and felicitation.
- Increasing green cover in and around the operational sites.

Mittal

Date : 23.08.2010 **RAJIV MITTAL**

APPENDIX B WABAG PROCESS DESIGN SPECIFICATIONS

sustainable solutions. for a better life. WABAG

PROJECT

POLLUTION ABATEMENT (INTERCEPTION AND DIVERSION WITH STP) WORKS FOR RIVER GANGA AT HOWRAH, BALLY AND BARANAGAR - KAMARAHATI MUNICIPAL TOWN IN WEST BENGAL INCLUDING 15 YEARS O&M BASED ON HYBRID ANNUITY BASED PPP MODE

IMPLEMENTING AGENCY

NATIONAL MISSION FOR CLEAN GANGA (NMCG)

PROJECT NO. & TENDER NO.

KMDA/WS/GAP/SE(N)/NIT-6/18-19 &
28 / SE (N)/GAP/W&S/KMDA of 2018-2019

CLIENT

KOLKATA METROPOLITAN DEVELOPMENT AUTHORITY (KMDA)

PROJECT ENGINEER

-

CONCESSIONAIRE

GANGA STP PROJECTS PRIVATE LIMITED

DOCUMENT TITLE

PROCESS DESIGN CALCULATION

ARUPARA SEWAGE TREATMENT PLANT

DOC. NUMBER **10P153 - B0001 - 301** REV **0**

DISCIPLINE **PROCESS**

STAMPING AREA

REV. NO	DATE	DESCRIPTION	PREPARED	CHECKED	APPROVED
0	2-Jul-19	Submitted for Approval	LK	RH	GG

REVISION HISTORY

TOTAL NO. OF SHEETS (INCLUDING THIS COVER) : 58

LIST OF HOLDs

HOLD N^{o}	PAGE N^{o}	DESCRIPTION

NOTES:

KOLKATA METROPOLITAN DEVELOPMENT AUTHORITY	sustainable solutions. for a better life. WABAG						REVISION
	PROCESS DESIGN CALCULATION ARUPARA SEWAGE TREATMENT PLANT						
DEVELOPMENT OF SEWAGE TREATMENT PLANTS KOLKATA CITY AREA	Location	Project No	Doc. Code	Serial No	Rev	Page No	
	ARUPARA	10P153	B0001	301	0	2 / 57	

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NOTES:

1.0 INTRODUCTION

KOLKATA METROPOLITAN DEVELOPMENT AUTHORITY (KMDA) IN ASSOCIATION WITH NATIONAL MISSION FOR CLEAN GANGA (NMCG), HAS DECIDED TO IMPLEMENT THE **PROJECT** TITLED **"DEVELOPMENT OF SEWAGE TREATMENT PLANTS - KOLKATA CITY AREA"** WHICH COMPRISES OF THE FOLLOWING COMPONENTS.

(I) CONSTRUCT, OPERATE AND MAINTAIN ONE STP AT BALLY WITH A PROPOSED CAPACITY OF 40 MLD

(II) RENOVATE, OPERATE AND MAINTAIN ONE EXISTING BALLY STP WITH A CAPACITY OF 22 MLD ALONG WITH BALLY ASSOCIATED INFRASTRUCTURE

(III) CONSTRUCT, OPERATE AND MAINTAIN ONE STP AT ARUPARA WITH A PROPOSED CAPACITY OF 65 MLD AND A SEPTAGE MANAGEMENT FACILITY OF 150 m^3/d CAPACITY

(IV) RENOVATE, OPERATE AND MAINTAIN ARUPARA ASSOCIATED INFRASTRUCTURE

(V) CONSTRUCT, OPERATE AND MAINTAIN ONE STP AT BARANAGAR WITH A PROPOSED CAPACITY OF 60 MLD

(VI) RENOVATE, OPERATE AND MAINTAIN BARANAGAR ASSOCIATED INFRASTRUCTURE.

THIS DOCUMENT COVERS THE PROCESS DESIGN CALCULATIONS FOR ARUPURA SEWAGE TREATMENT PLANT TO BE CONSTRUCTED AS PART OF THIS **PROJECT.**

THE OBJECTIVE OF THE DOCUMENT IS TO

- IDENTIFY THE SIZING CRITERIA CONSIDERED FOR EACH UNIT
- CALCULATE THE SIZE FOR EACH ITEM OF THIS SEWAGE TREATMENT PLANT

NOTES:

2.0 REFERENCES

1 **MANUAL ON SEWERAGE AND SEWAGE TREATMENT, 3RD EDITION**
CENTRAL PUBLIC HEALTH AND ENVIRONMENTAL ENGINEERING ORGANISATION (CPHEEO),
MINISTRY OF URBAN DEVELOPMENT, GOVERNMENT OF INDIA.

2 **WASTE WATER ENGINEERING – TREATMENT AND REUSE, 4TH EDITION**
METCALF & EDDY.
TATA MCGRAW HILL EDITION

3 **HANDBOOK OF ENVIRONMENTAL ENGINEERING CALCULATIONS, 2ND EDITION**
C. C. LEE AND SHUN DAR LIN
MC GRAW HILL EDITION

4 **WASTEWATER TREATMENT PLANT - PLANNING, DESIGN AND OPERATION**
SYED R QASIM
CRC PRESS

5 **INDIAN STANDARD 14371 : 1996**
MEASUREMENT OF LIQUID FLOW IN OPEN CHANNELS - PARSHALL AND SANIIRI FLUMES
BUREAU OF INDIAN STANDARDS

6 **SCHEDULE 1-15 TENDER DOCUMENT**

NOTES:

3.0 ACRONYMS, ABBREVATIONS AND DEFINITIONS

3.1 GENERAL ABBREVIATIONS

BOP	BOTTOM OF PIPE
C/S	CROSS SECTIONAL
CSA	CROSS SECTIONAL AREA
D/S	DOWNSTREAM
ID	INNER DIAMETER
I/L	INVERT LEVEL
KMDA	KOLKATA METROPOLITAN DEVELOPMENT AUTHORITY
LD	LIQUID DEPTH
MOC	MATERIAL OF CONSTRUCTION
MLSS	MIXED LIQUOR SUSPENDED SOLIDS
MLVSS	MIXED LIQUOR VOLATILE SUSPENDED SOLIDS
RAS	RETURN ACTIVATED SLUDGE
STP	SEWAGE TREATMENT PLANT
TS	TOTAL SOLIDS
U/S	UPSTREAM
WABAG	VA TECH WABAG LTD.
WAS	WASTE ACTIVATED SLUDGE
SOR	SURFACE OVERFLOW RATE

3.2 ACRONYMS FOR WASTEWATER CHARACTERISTICS

BOD	BIOCHEMICAL OXYGEN DEMAND
sBOD	SOLUBLE BIOCHEMICAL OXYGEN DEMAND
pBOD	PARTICULATE BIOLOGICAL OXYGEN DEMAND
COD	CHEMICAL OXYGEN DEMAND
DO	DISSOLVED OXYGEN
MPN	MOST PROBABLE NUMBER
TSS	TOTAL SUSPENDED SOLIDS
iTSS	INERT TOTAL SUSPENDED SOLIDS
VSS	VOLATILE SUSPENDED SOLIDS

3.3 ACRONYMS FOR WASTEWATER CHARACTERISTICS

°	ANGLE IN DEGREES
^{o}C	DEGREE CELCIUS
atm	ATMOSPHERE
cm	CENTIMETER
cm^2	SQUARE CENTI METER
d	DAY
g	GRAM
h	HOUR
J	JOULE
K	KELVIN
kg	KILO GRAMS

NOTES:

kJ	KILOJOULE
kN	KILO NEWTON
kPa	KILO PASCAL
kW	KILOWATT
L	LITER
LPH	LITRE PER HOUR
m	METRE
m²	SQUARE METER
m³	CUBIC METER
mg	MILLI GRAM
min	MINUTES
ML	MILLION LITRES
mL	MILLI LITRE
MLD	MILLION LITRES PER DAY
mm	MILLIMETER
mmWC	MILLIMETER OF WATER COLUMN
MT	METRIC TONNE
mWC	METER OF WATER COLUMN
Nos	NUMBERS
ppm	PARTS PER MILLION
s	SECONDS

NOTES:

4.0 CONVERSION FACTORS USED

ENERGY				
	1 Watt - hour (W-h)	=	3.60	kiloJoule (kJ)
	1 Watt - Second (W-s)	=	1.00	Joule (J)
FLOW				
	1 Cubic Feet per Sec (ft^3/s)	=	0.03	Cubic metre per second (m^3/s)
LENGTH				
	1 foot	=	0.30	metre (m)
	1 inch	=	0.03	meter (m)
POWER				
	1 horsepower (hp)	=	0.75	kilowatt (kW)
PRESSURE				
	1 atmosphere (atm)	=	101.33	kilo Pascal (kPa)
	1 atmosphere (atm)	=	101.33	kilo Newton per Sq.m (kN / m^2)
	1 metre Water Column (mWC)	=	9810.00	N/m^2
	1 milli metre Water Column (mmWC)	=	9.81	N/m^2
	1 pound per square inch (psi)	=	6.89	kilo Pascal (kPa)
TEMPERATURE				
	1 degree Celcius (^oC)	=	C + 273.15	degree Kelvin (^oK)
	1 degree Fahrenheit(^oF)	=	0.555 (F-32)	degree Celcius (^oC)

5.0 DESIGN BASIS

5.1 FLOW DATA

Reference:

AVERAGE FLOW		=	65	MLD
		=	65000	m³/d
		=	2708.34	m³/h
		=	0.7524	m³/s
PEAK FACTOR		=	2.25	
PEAK FLOW		=	146.25	MLD
		=	146250	m³/d
		=	6093.75	m³/h
		=	1.6928	m³/s
MINIMUM FLOW		=	32.5	MLD
		=	32500	m³/d
		=	1354.17	m³/h
		=	0.3762	m³/s

5.2 RAW SEWAGE PARAMETERS

Reference: Schedule 10 : KPI

pH		=	5.5 - 9.0	
TOTAL SUSPENDED SOLIDS, TSS		=	< 600	
		=	600	mg/L
		=	39000	kg/d
BIOLOGICAL OXYGEN DEMAND, BOD		=	80 - 250	
		=	250	mg/L
		=	16250	kg/d
CHEMICAL OXYGEN DEMAND, COD		=	< 500	
		=	500	mg/L
		=	32500	kg/d
VOLATILE SUSPENDED SOLIDS, VSS		=	360	mg/L
		=	23400	kg/d
FECAL COLIFORMS	NOTE-1	=	10^7-10^8	MPN/100 mL
MINIMUM SEWAGE TEMPERATURE		=	20	^oC
MAXIMUM SEWAGE TEMPERATURE		=	30	^oC

NOTES:

1 AS PER CPHEEO MANUAL

5.3 TREATED SEWAGE PARAMETERS

Reference: Schedule 10 : KPI

pH	=	6.5 - 9.0	
TOTAL SUSPENDED SOLIDS, TSS	<=	50	mg/L
BIOLOGICAL OXYGEN DEMAND, BOD	<=	20	mg/L
CHEMICAL OXYGEN DEMAND, COD	<=	100	mg/L
FECAL COLIFORMS	<=	1000	MPN/100 mL

5.4 DEWATERED SLUDGE CHARACTERISTICS

Reference: Schedule 10 : KPI

SLUDGE CONSISTENCY	>=	20%	
FECAL COLIFORMS	<=	2000000	MPN/g

5.5 SITE INFORMATION

AMBIENT TEMPERATURE	NOTE-1	MIN	=	15	deg C
	NOTE-1	MAX	=	45	deg C
	NOTE-1	AVE	=	25	deg C
RELATIVE HUMIDITY	NOTE-1	MIN	=	58	%
	NOTE-1	MAX	=	85	%
SITE ELEVATION			=	6	m

DETERMINATION OF ATMOSPHERIC PRESSURE

$$P_{atm,H} = P_{atm,O} \times \exp\left\{\frac{-gM(H-0)}{RT}\right\}$$

WHERE

$P_{atm,0}$	=	ATMOSPHERIC PRESSURE AT ZERO ALTITUDE	=	101325	N/m²
g	=	ACCELERATION DUE TO GRAVITY	=	9.81	m/s²
M	=	MOLAR MASS OF AIR	=	28.97	kg/kg mole
H	=	SITE ELEVATION	=	6.00	m
R	=	UNIVERSAL GAS CONSTANT	=	8314.00	N.m/kgmole K
T	=	SITE TEMPERATURE			

ATMOSPHERIC PRESSURE PREVAILING AT SITE (AT MINIMUM TEMPERATURE)	=	101253.0	N/m²
ATMOSPHERIC PRESSURE PREVAILING AT SITE (AT AVERAGE TEMPERATURE)	=	101255.4	N/m²
ATMOSPHERIC PRESSURE PREVAILING AT SITE (AT MAXIMUM TEMPERATURE)	=	101259.8	N/m²

NOTES:

1 AS PER METEROLOGICAL DATA FOR KOLKATTA

6.0 INLET CHAMBER

INLET CHAMBER IS PROVIDED TO ARREST TURBULENCE

AVERAGE FLOW	=	65000	m^3/d
	=	0.7524	m^3/s
PEAK FLOW	=	146250	m^3/d
	=	1.6928	m^3/s
RETENTION TIME AT PEAK FLOW	=	10	s
VOLUME OF INLET CHAMBER REQUIRED	=	16.93	m^3

DIMENSIONS OF INLET CHAMBER ARE ARRIVED TO ACCOMMODATE THE FINE SCREENS AND ISOLATION GATES

LIQUID DEPTH	**=**	**2.00**	**m**
LENGTH OF CHAMBER	**=**	**4.85**	**m**
WIDTH REQUIRED	=	1.75	m
WIDTH PROVIDED	**=**	**2.00**	**m**
FREEBOARD CONSIDERED	=	0.50	m
VOLUME PROVIDED	=	19.40	m^3
RETENTION TIME PROVIDED	=	11.5	s

NOTES:

7.0 SCREEN CHAMBER

7.1 MECHANICAL SCREEN CHAMBER

TYPE **MECHANICAL BAR, STEP TYPE SCREEN**

DESIGN AVERAGE FLOW		=	65000	m^3/d	
DESIGN PEAK FLOW		=	146250	m^3/d	
DESIGN BASIS					
NO. OF WORKING UNITS		**=**	**2**	**Nos.**	
NO. OF STANDBY UNITS		**=**	**0**	**No.**	
ANGLE OF INCLINATION		=	40	°	
BAR WIDTH		=	2	mm	
BAR SPACING		=	6	mm	
MAX. VELOCITY THROUGH SCREENS		=	1.20	m/s	
SCREEN SIZING					
DESIGN PEAK FLOW THROUGH EACH SCREEN		=	0.8464	m^3/s	
VELOCITY THROUGH SCREENS		=	1.2	m/s	
NET CLEAR AREA REQUIRED		=	0.71	m^2	
LIQUID DEPTH CONSIDERED		=	1.10	m	
NET CLEAR WIDTH REQUIRED		=	0.6455	m	
NO. OF OPENINGS REQURIED		=	108	Nos.	
NO. OF OPENINGS CONSIDERED	NOTE-1	=	130	Nos.	HOLD-1
INSIDE WIDTH OF SCREEN		=	1.040	m	
SCREEN CHANNEL WIDTH REQUIRED		**=**	**1.500**	**m**	
FREE BOARD CONSIDERED		=	0.300	m	
TOTAL DEPTH OF SCREEN CHANNEL		=	1.400	m	
HORIZONTAL PROJECTION OF SCREEN	NOTE-1	=	3.800	m	
LENGTH UPSTREAM OF SCREEN		=	4.500	m	
LENGTH DOWNSTREAM OF SCREEN		=	1.500	m	
TOTAL LENGTH OF SCREEN CHANNEL REQUIRED		**=**	**9.800**	**m**	
DESIGN VALIDATION					
DESIGN PEAK FLOW		=	0.8464	m^3/s	
NET CLEAR AREA FOR SCREENS		=	0.858	m	
VELOCITY THROUGH SCREENS		=	0.99	m/s	
		<=	1.2	m/s	Hence OK
VELOCITY IN APPROACH CHANNEL		=	0.52	m/s	
		>=	0.3	m/s	Hence OK

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 30

NOTES:

1 MANUFACTURER DATA TO BE FINALISED AS PER VENDOR RECOMMENDATION

HEAD LOSS THROUGH SCREEN AT CLEAN CONDITIONS

$$h_f = 0.0729\,({V_1}^2 - {v_2}^2)$$

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 31

WHERE

V_1	=	VELOCITY THROUGH SCREENS	=	0.99	m/s
V_2	=	VELOCITY IN APPROACH CHANNEL	=	0.52	m/s

SUBSTITUTING THE VALUES,

HEAD LOSS THROUGH SCREEN AT CLEAN CONDITIONS = 52 mm

HEAD LOSS THROUGH SCREEN AT 50% CLOGGED CONDITIONS

$$h_f = 0.0729\,({V_1}^2 - {v_2}^2)$$

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 31

WHERE

V_1	=	VELOCITY THROUGH SCREENS	=	1.98	m/s
V_2	=	VELOCITY IN APPROACH CHANNEL	=	0.52	m/s

SUBSTITUTING THE VALUES,

HEAD LOSS THROUGH SCREEN AT 50% CLOGGED CONDITIONS = 267 mm

NOTES:

7.2 MANUAL SCREEN CHAMBER

TYPE **MANUAL BAR SCREEN**

DESIGN AVERAGE FLOW	=	32500	m³/d	
DESIGN PEAK FLOW	=	73125	m³/d	
DESIGN BASIS				
NO. OF WORKING UNITS	**=**	**1**	**No.**	
NO. OF STANDBY UNITS	**=**	**0**	**No.**	
ANGLE OF INCLINATION	=	45	°	
BAR WIDTH	=	5	mm	
BAR SPACING	=	6	mm	
MAX. VELOCITY THROUGH SCREENS	=	1.20	m/s	
SCREEN SIZING				
DESIGN PEAK FLOW THROUGH EACH SCREEN	=	0.8464	m³/s	
VELOCITY THROUGH SCREENS	=	1.2	m/s	
NET CLEAR AREA REQUIRED	=	0.71	m²	
LIQUID DEPTH CONSIDERED	=	1.10	m	
NET CLEAR WIDTH REQUIRED	=	0.6455	m	
NO. OF OPENINGS REQURIED	=	108	Nos.	
NO. OF OPENINGS CONSIDERED	=	127	Nos.	
INSIDE WIDTH OF SCREEN	=	1.402	m	
SCREEN CHANNEL WIDTH REQUIRED	**=**	**1.450**	**m**	
FREE BOARD CONSIDERED	=	0.300	m	
TOTAL DEPTH OF SCREEN CHANNEL	=	1.400	m	
HORIZONTAL PROJECTION OF SCREEN	=	1.400	m	
LENGTH UPSTREAM OF SCREEN	=	6.900	m	
LENGTH DOWNSTREAM OF SCREEN	=	1.500	m	
TOTAL LENGTH OF SCREEN CHANNEL REQUIRED	**=**	**9.800**	**m**	
DESIGN VALIDATION				
DESIGN PEAK FLOW	=	0.8464	m³/s	
NET CLEAR AREA FOR SCREENS	=	0.8382	m	
VELOCITY THROUGH SCREENS	=	1.01	m/s	
	<=	1.2	m/s	Hence OK
VELOCITY IN APPROACH CHANNEL	=	0.54	m/s	
	>=	0.3	m/s	Hence OK

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 30

NOTES:

1 MANUFACTURER DATA TO BE FINALISED AS PER VENDOR RECOMMENDATION

HEAD LOSS THROUGH SCREEN AT CLEAN CONDITIONS

$$h_f = 0.0729\,(V_1{}^2 - v_2{}^2)$$

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 31

WHERE

V_1	=	VELOCITY THROUGH SCREENS	=	1.01	m/s
V_2	=	VELOCITY IN APPROACH CHANNEL	=	0.54	m/s

SUBSTITUTING THE VALUES,

HEAD LOSS THROUGH SCREEN AT CLEAN CONDITIONS = 54 mm

HEAD LOSS THROUGH SCREEN AT 50% CLOGGED CONDITIONS

$$h_f = 0.0729\,(V_1{}^2 - v_2{}^2)$$

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 31

WHERE

V_1	=	VELOCITY THROUGH SCREENS	=	2.02	m/s
V_2	=	VELOCITY IN APPROACH CHANNEL	=	0.54	m/s

SUBSTITUTING THE VALUES,

HEAD LOSS THROUGH SCREEN AT 50% CLOGGED CONDITIONS = 277 mm

NOTES:

8.0 GRIT CHAMBER

TYPE : **DETRITOR TYPE WITH INTEGRAL GRIT CLASSIFIER**

DESIGN BASIS

DESIGN PEAK FLOW	=	146250	m³/d
DESIGN AVERAGE FLOW	=	65000	m³/d
NO. OF WORKING UNITS	**=**	**2**	**Nos.**
NO. OF STANDBY UNITS	**=**	**0**	**No.**
MINIMUM SEWAGE TEMPERATURE	=	20	°C
SIZE OF GRIT PARTICLE	=	0.20	mm
REMOVAL EFFICIENCY REQUIRED	=	95%	
SPECIFIC GRAVITY OF GRIT PARTICLE	=	2.65	

SURFACE OVERFLOW RATE

FOR PARTICLE SIZE OF PARTICLE TO BE REMOVED BETWEEN 0.15 mm TO 0.20 mm HAZEN'S MODIFIED FORMULA TO BE USED

$$V_s = 60.6 \times (S_s - 1) \times d \times \frac{3T+70}{100}$$

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 40

WHERE

S_s	=	SPECIFIC GRAVITY OF PARTICLE	=	2.65	
d	=	DIA OF PARTICLE	=	0.02	cm
T	=	MINIMUM TEMPERATUER OF SEWAGE	=	20	°C

SUBSTITUTING THE VALUES

V_S = 60.6 x (2.65 - 1) x 0.02 x [(3 x 20 + 70) / 100]

SETTLING VELOCITIES OF PARTICLES, V_s	=	2.60	cm/s
	=	2246.4	m³/m²/d

HOWEVER, PERFORMANCE OF GRIT CHAMBER VARIES DUE TO TURBULENCE AND SHORT CIRCUITING RESULTING FROM EDDY, WIND AND DENSITY CURRENTS. HENCE ACTUAL PERFORMANCE OF GRIT CHAMBER IS TO BE CORRECTED BASED ON BASIN PERFORMANCE AS GIVEN BELOW

$$\eta = 1 - \left(1 + \frac{nV_S}{V_o}\right)^{-1/n}$$

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 42

WHERE

h	=	EFFICIENCY REQUIRED	=	95%	
n	=	BASIN PERFORMANCE INDEX (VERY GOOD)	=	0.125	

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 42

V_s	=	SETTLING VELOCITIES OF PARTICLES	=	2246.4	m³/m²/d

SUBSTITUTING AND REARRANGING THE VALUES

V_o = [0.125 x 2246.4] / { [(1 - 0.95) ^ (- 0.125)] - 1 }

SURFACE OVERFLOW RATE REQUIRED, V_o	=	618.3	m³/m²/d

NOTES:

DETRITOR SIZING

DESIGN FLOW PER UNIT	=	73125	m³/d
SURFACE OVERFLOW RATE REQUIRED	=	618.3	m³/m²/d
HENCE,			
SURFACE AREA REQUIRED	=	118.27	m²
SIZE OF GRIT CHAMBER REQUIRED	=	10.88	m
SIZE OF GRIT CHAMBER PROVIDED	**=**	**11.00**	**m**
LIQUID DEPTH CONSIDERED	**=**	**0.80**	**m**
FREEBOARD CONSIDERED	**=**	**0.30**	**m**

CRITICAL DISPLACEMENT VELOCITY

CRITICAL DISPLACEMENT VELOCITY TO INITIATE RE-SUSPENSION OF GRIT IS DERIVED FROM MODIFIED SHIELD'S FORMULA

$$V_c = K_c \times \sqrt{g \times (S_s - 1) \times d}$$

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 42

WHERE

K_c	=	CRITICAL DISPLACEMENT CO-EFFICIENT	=	4	
g	=	ACCELERATION DUE TO GRAVITY	=	9.81	m/s²
S_s	=	SPECIFIC GRAVITY OF GRIT PARTICLE	=	2.65	
d	=	DIA OF GRIT PARTICLE	=	0.00020	m

SUBSTITUTING THE VALUES

V_c = 4 x { [9.81 x (2.65 - 1) x 0.0002] ^ 0.5 }

CRITICAL DISPLACEMENT VELOCITY, V_c = 0.23 m/s

HORIZONTAL VELOCITY OF FLOW

HORIZONTAL VELOCITY OF FLOW SHOULD BE LESS THAN CRITICAL DISPLACEMENT VELOCITY

DESIGN FLOW	=	73125	m³/d	
SIZE OF GRIT CHAMBER	=	11.00	m	
LIQUID DEPTH OF GRIT CHAMBER	=	0.80	m	
HORIZONTAL VELOCITY OF FLOW, V_h	=	0.097	m/s	
	<	0.23	m/s	Hence OK

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 42

NOTES:

9.0 PARSHALL FLUME

Reference : Measurement of Liquid Flow in open channels - Parshall and Saniiri Flumes - IS 14371:1996

DESIGN BASIS

NO. OF WORKING UNITS	**=**	**1**	**No.**
NO. OF STANDBY UNITS	**=**	**0**	**No.**
FREEBOARD CONSIDERED	=	0.30	m
THROAT WIDTH CONSIDERED	**=**	**1.20**	**m**

DESIGN FLOW		MIN	NOR	MAX	
FLOW	=	32.5	65	146.25	MLD
	=	32500	65000	146250	m³/d
	=	0.3762	0.7524	1.6928	m³/s
NO. OF WORKING UNITS	=	1	1	1	No.
DESIGN FLOW PER UNIT	=	0.3762	0.7524	1.6928	m³/s

DISCHARGE RANGE OF PARSHALL FLUME > = 0.04 m³/s < = 2 m³/s
FOR SELECTED THROAT WIDTH

DISCHARGE EQUATION OF PARSHALL FLUME

$$Q = C\,H_a^{\,n}$$

Reference : Measurement of Liquid Flow in open channels - Parshall and Saniiri Flumes - IS 14371:1996

WHERE

Q	= FREEFLOW DISCHARGE THROUGH FLUME, m³/s		
C	= DISCHARGE CONSTANT	=	2.904
n	= DISCHARGE CO-EFFICIENT	=	1.577
H_a	= LIQUID DEPTH IN CONVERGING SECTION OF FLUME, m		

SUBTITUTING THE VALUES IN DISCHARGE EQUATION FOR VARIOUS FLOW SCENARIOS

		MIN	NOR	MAX	
FREE FLOW DISCHARGE THROUGH FLUME	=	0.3762	0.7524	1.6928	m³/s
LIQUID DEPTH IN CONVERGING SECTION OF FLUME	=	0.274	0.425	0.711	m
RATIO OF LIQUID DEPTH, H_b/H_a RATIO	=	0.70	0.70	0.70	

Reference : Measurement of Liquid Flow in open channels - Parshall and Saniiri Flumes - IS 14371:1996

LIQUID DEPTH DOWNSTREAM	=	0.190	0.290	0.490	m

NOTES:

APPROACH CHANNEL

WIDTH OF APPROACH CHANNEL	=	2.00	m
LIQUID DEPTH IN APPROACH CHANNEL	=	0.810	m
MAXIMUM DESIGN FLOW PER UNIT	=	1.6928	m³/s

FROUDE NUMBER OF THE APPROACH CHANNEL SHOULD BE LESS THAN 0.5

Reference : Measurement of Liquid Flow in open channels - Parshall and Saniiri Flumes - IS 14371:1996

$$\textit{Froude Number} = \frac{V}{\left(g \times \frac{A}{w}\right)^{0.5}}$$

WHERE

V	=	VELOCITY OF FLOW IN APPROACH CHANNEL	=	1.05	m/s
g	=	ACCELERATION DUE TO GRAVITY	=	9.810	m/s²
A	=	AREA OF FLOW IN APPROACH CHANNEL	=	1.620	m²
W	=	WIDTH OF APPROACH CHANNEL	=	2.00	m

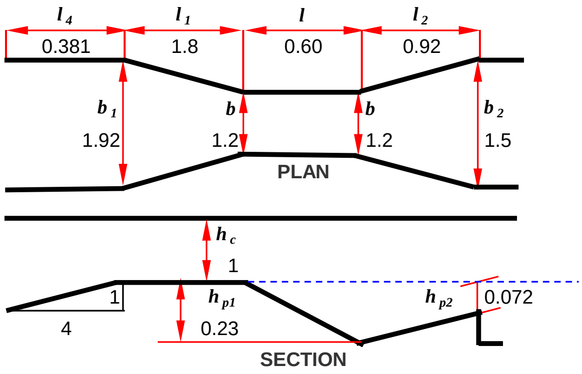
SUBSTITUTING THE VALUES,

FROUDE NUMBER	=	0.38	
	<=	0.5	Hence OK

DESIGN SUMMARY

FLUME FLOW RANGE, m³/s			
Min	0.040	**Max**	2.00
FLUME DIMENSIONS, m			
l_e	1.836	l	0.600
l_1	1.800	l_2	0.920
b_2	1.500	h_{p2}	0.072
b_1	1.920	h_{p1}	0.230
h_c	1.000	l_4	0.381
b	1.200	FL	1.288
CHANNEL DIMENSIONS, m			
	U/S	FLUME	D/S
LD	0.810	--	0.810
WIDTH	2.00	1.20	2.00
LENGTH	12.00	3.32	6.00

PARSHALL FLUME DIMENSIONAL SKETCH



Reference : IS 14371:1996

TOTAL LENGTH OF PARSHALL FLUME CHANNEL	**=**	**21.40**	**m**

NOTES:

10.0 PRIMARY TREATMENT

PRIMARY TREATMENT IS PROVIDED TO REMOVE THE SETTABLE SOLIDS.
RETURN FLOW FROM DIGESTER AND CENTRIFUGE ARE RECEIVED AT PRIMARY CLARIFIER
EXCESS SLUDGE FROM SECONDARY TREATMENT IS ALSO RECEIVED AT PRIMARY CLARIFIER

MASS BALANCE

RAW SEWAGE AVERAGE FLOW	=	65000.00	m³/d
RETURN FLOW	=	525	m³/d
EXCESS SLUDGE FLOW	=	1722	m³/d
PRIMARY INLET AVERAGE FLOW	=	67247.00	m³/d
RAW SEWAGE PEAK FLOW	=	146250.00	m³/d
RETURN FLOW	=	525	m³/d
EXCESS SLUDGE FLOW	=	1722	m³/d
PRIMARY INLET PEAK FLOW	=	148497.00	m³/d

		RAW SEWAGE	RETURN FLOW	EXCESS SLUDGE	PRIMARY INLET
AVG. FLOW	m³/d	65000.00	525.00	1722.00	67247.00
TSS	mg/L	600.00	5834.29	8040.07	831.39
	kg/d	39000	3063.00	13845.00	55908.0
BOD	mg/L	250.00	1415.24	2001.17	303.94
	kg/d	16250	743.00	3446.00	20439.0
VSS	mg/L	360.00	2139.05	3186.42	446.27
	kg/d	23400	1123.00	5487.00	30010.0

10.1 PRIMARY DISTRIBUTION CHAMBER

DISTRIBUTION CHAMBER IS INTEGRAL PART OF PRIMARY CLARIFIER ARRANGEMENT.
FLOW ENTERS PRIMARY CLARIFIER THROUGH OPENING PROVIDED IN THE FEED CHANNEL.
ISOLATION GATES ARE PROVIDED AT THE INLET OF EACH CLARIFIER TO FACILITATE MAINTENANCE

NOTES:

10.2 PRIMARY CLARIFIER

TYPE **LAMELLA CLARIFIER WITH INTEGRAL THICKENER ARRANGEMENT**

DESIGN AVERAGE FLOW	=	67247.00	m^3/d
DESIGN PEAK FLOW	=	148497.00	m^3/d
NO. OF UNITS	**=**	**2**	**Nos.**
SURFACE LOADING RATE ON PLATES AT AVERAGE FLOW	=	30	$m^3/m^2/d$
SURFACE LOADING RATE ON PLATES AT PEAK FLOW	=	60	$m^3/m^2/d$

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 53

PLATE AREA REQUIRED PER UNIT AT AVERAGE FLOW	=	1120.784	m^2
PLATE AREA REQUIRED PER UNIT AT PEAK FLOW	=	1237.475	m^2
HENCE, DESIGN PLATE AREA REQUIRED PER UNIT	=	1237.475	m^2

PLATE DIMENSIONS

LENGTH OF PLATE	**=**	**2.00**	**m**
WIDTH OF PLATE	**=**	**1.22**	**m**
THICKNESS OF PLATE	**=**	**2**	**mm**
MATERIAL OF CONSTRUCTION	=	PVC	
ANGLE OF INCLINATION FOR PLATE	=	55	Deg
PROJECTED AREA OF ONE PLATE	=	2 X 1.22 X Cos 55°	
	=	1.3995	m^2

LENGTH OF CLARIFIER

NO. OF PLATES REQUIRED PER UNIT	=	884.3	Nos.
NO. OF ROWS CONSIDERED	=	8	Nos.
NO. OF PLATES REQUIRED PER ROW	=	111	Nos.
VERTICAL SPACING PROVIDED BETWEEN PLATES	=	80	mm
HORIZONTAL CENTRE-TO-CENTRE PLATE SPACING	=	(80 + 2) / Sin 55°	
	=	100.2	mm
CLEARANCE PROVIDED TO ACCOMMODATE PLATES	=	1.4	m
INCLINATION SPACE FOR PLATES	=	2 X Cos 55°	
	=	1.15	m
LENGTH OF THE UNIT REQUIRED	=	13.57	m
LENGTH OF THE UNIT CONSIDERED	**=**	**13.70**	**m**
NO. OF PLATES CONSIDERED	=	112	Nos.
SURFACE LOADING RATE PROVIDED	=	26.81	Nos
SURFACE LOADING RATE PROVIDED	=	59.21	Nos.

NOTES:

WIDTH OF CLARIFIER

WIDTH OF THE CLARIFIER CONSIDERED	**=**	**13.70**	**m**
WALL THICKNESS OF LAUNDERS	=	0.23	**m**
WIDTH OF LAUNDER	=	0.64	**m**
NO. OF SUPPORTS	=	7	Nos.
WIDTH OF SUPPORT	=	0.23	**m**
WIDTH OF CENTRAL SUPPORT	=	0.82	**m**

DEPTH OF CLARIFIER

HORIZONTAL VELOCITY BELOW PLATES	=	0.03	m/s
HORIZONTAL AREA REQUIRED BELOW PLATES	=	12.97	m^2
WIDTH OF THE CLARIFIER PROVIDED	=	13.70	m
HENCE, DEPTH REQUIRED BELOW PLATES	=	1.00	m
SPACE REQUIRED ABOVE PLATES	=	0.90	m
VERTICAL HEIGHT OF PLATES	=	2 X Sin 55°	
	=	1.64	m
SPACE PROVIDED FOR SLUDGE COMPRESSION	=	2.35	m
SPACE REQUIRED FOR SLUDGE SCRAPPER	=	0.20	m
HENCE, TOTAL SIDE WATER DEPTH REQUIRED	=	6.09	m
SIDE WATER DEPTH PROVIDED	**=**	**6.10**	**m**
FREEBOARD CONSIDERED	=	0.30	m
TYPE OF SLUDGE COLLECTION	=	CENTRAL SCRAPPER	
DIA OF SLUDGE HOPPER AT BOTTOM	=	1	m
SLOPE OF HOPPER	=	1 in	12
HEIGHT OF HOPPER PROVIDED	**=**	**0.53**	**m**

NOTES:

SLUDGE BALANCE

DESIGN AVERAGE FLOW	=	67247.00	m³/d
TSS FROM RAW SEWAGE	=	39000.0	kg/d
TSS FROM RETURN FLOWS	=	3063.0	kg/d
TSS FROM EXCESS SLUDGE	=	13845.0	kg/d
TSS REDUCTION FROM RAW SEWAGE AND RETURN FLOWS	=	60%	
TSS REDUCTION FROM EXCESS SLUDGE	=	60%	
THICKENED SLUDGE CONSISTENCY	=	6%	
THICKENED SLUDGE DENSITY	=	1020	kg/m³
THICKENED SLUDGE SOLIDS	=	33545	kg/d
HENCE, THICKENED SLUDGE FLOWRATE	=	548.13	m³/d
BOD FROM RAW SEWAGE	=	16250.0	kg/d
BOD FROM RETURN FLOWS	=	743.0	kg/d
BOD FROM EXCESS SLUDGE	=	3446.0	kg/d
BOD REDUCTION FROM RAW SEWAGE AND RETURN FLOWS	=	30%	
BOD REDUCTION FROM EXCESS SLUDGE	=	60%	
BOD IN THICKENED SLUDGE	=	7166.00	kg/d
VSS FROM RAW SEWAGE	=	23400.0	kg/d
VSS FROM RETURN FLOWS	=	1123.0	kg/d
VSS FROM EXCESS SLUDGE	=	5487.0	kg/d
VSS REDUCTION FROM RAW SEWAGE AND RETURN FLOWS	=	60%	
VSS REDUCTION FROM EXCESS SLUDGE	=	60%	
VSS IN THICKENED SLUDGE	=	18006.00	kg/d

MASS BALANCE		**PRIMARY INLET**	**THICKENED SLUDGE**	**PRIMARY OUTLET**
FLOWRATE	m³/d	67247.00	548.13	66698.87
TSS	mg/L	831.39	61198.99	335.29
	kg/d	55908.00	33545.00	22363.0
BOD	mg/L	303.94	13073.55	199
	kg/d	20439.00	7166.00	13273.0
VSS	mg/L	446.27	32849.88	179.98
	kg/d	30010.00	18006.00	12004.0

NOTES:

NO. OF BATCHES FOR SLUDGE WITHDRAWAL	=	24	Nos.
TIME INTERVALE BETWEEN EACH BATCH	=	60.00	min
BATCH VOLUME	=	11.42	m^3
DURATION OF SLUDGE WITHDRAWAL PER BATCH	=	5.00	min
HENCE,			
SLUDGE WITHDRAWAL FLOWRATE	=	137.04	m^3/h
SLUDGE PIPE SIZE	=	250	mm
VELOCITY IN SLUDGE PIPELINE	=	0.78	m/s

SLUDGE WITHDRAWAL FROM CLARIFIER WILL BE CONTROLLED BASED ON TIMER.

NOTES:

11.0 AERATION TANK

AVERAGE FLOW		=	66698.87	m³/d
PEAK FLOW		=	147948.87	m³/d

INFLUENT CHARACTERISTICS

BOD	=	199	mg/L
TSS	=	335.29	mg/L
VSS	=	179.98	mg/L

EFFLUENT CHARACTERISTICS DESIRED

BOD	=	20	mg/L
TSS	=	30	mg/L
VSS	=	18	mg/L

DESIGN BASIS

TYPE CONVENTIONAL ACTIVATED SLUDGE PROCESS

NO. OF BASINS	**=**	**2**	**Nos.**
MLSS CONCENTRATION	=	3000	mg/L
MLVSS / MLSS RATIO	=	0.80	
MLVSS CONCENTRATION	=	2400	mg/L

VOLUME OF AERATION TANK

$$\mathbf{V} = \frac{\mathbf{Y} \times \mathbf{Q} \times (\boldsymbol{S_O} - \boldsymbol{S}) \times \boldsymbol{\theta_C}}{\{(\mathbf{1} + \boldsymbol{k_d} \times \boldsymbol{\theta_c}) \times \boldsymbol{X_V}\}}$$

WHERE

Y	=	YIELD CO-EFFICIENT	=	0.5	g VSS / g BOD
Q	=	DESIGN FLOW	=	66698.87	m³/d
S_o	=	INLET BOD CONCENTRATION	=	199	mg/L
S	=	OUTLET BOD CONCENTRATION	=	20	mg/L
θ_c	=	SLUDGE RETENTION TIME	=	6	d
k_d	=	DECAY COEFFICIENT	=	0.06	d^{-1}
X_v	=	MLVSS CONCENTRATION IN AERATION TANK	=	2400	mg/L

SUBSTITUTING THE VALUES

V = [0.5 x 66698.87 x (199 - 20) x 6] / [(1 + 0.06 x 6) x 2400]

TOTAL VOLUME OF AERATION TANK REQUIRED	=	10973.44	m³
NO. OF TANKS	=	2	Nos.
VOLUME OF EACH TANK REQUIRED	=	5487	m³
LIQUID DEPTH	**=**	**5.65**	**m**
WIDTH OF AERATION TANK	**=**	**38.50**	**m**
LENGTH OF AERATION TANK REQUIRED	=	25.23	m
LENGTH OF AERATION TANK PROVIDED	**=**	**25.50**	**m**
FREEBOARD CONSIDERED	**=**	**0.50**	**m**
TOTAL DEPTH OF AERATION TANK PROVIDED	=	6.15	m

NOTES:

VOLUME OF EACH AERATION TANK PROVIDED			=	5546.89	m^3
HYDRAULIC RETENTION PROVIDED			=	4	h

FOOD TO MICROORGANISM RATIO

$$F/M = \frac{Q\,S_0}{V\,X}$$

WHERE

Q	=	DESIGN FLOW	=	66698.87	m^3/d
S_o	=	INLET BOD CONCENTRATION	=	199	mg/L
V	=	VOLUME OF AEARATION TANK	=	11093.78	m^3
X	=	MLSS CONCENTRATION IN AERATION TANK	=	3000	mg/L

SUBSTITUTING THE VALUES

F/M = (66698.87 x 199) / (11093.78 x 3000)

F/M RATIO	=	0.3989	kg BOD / kg MLSS . d

OBSERVED YIELD

$$Y_{OBS} = \frac{Y}{(1 + k_d \theta_c)}$$

WHERE

Y	=	YIELD CO-EFFICIENT	=	0.5	g VSS / g BOD
θ_c	=	SLUDGE RETENTION TIME	=	6	d
k_d	=	DECAY COEFFICIENT	=	0.06	d^{-1}

SUBSTITUTING THE VALUES

Y_{OBS} = 0.5 / [1 + (0.06 x 6)]

OBSERVED YIELD	=	0.3680	g VSS / g BOD

BIOMASS GENERATED

$$P_{X,TSS} = \frac{Y_{OBS} \times Q \times (S_0 - S)}{0.8} + Q \times (TSS_{in} - VSS_{in})$$

WHERE

Y_{OBS}	=	OBSERVED YIELD	=	0.3680	g VSS / g BOD
Q	=	DESIGN FLOW RATE	=	66698.87	m^3/d
S_o	=	INLET BOD CONCENTRATION	=	199	mg/L
S	=	OUTLET BOD CONCENTRATION	=	20	mg/L
TSS_{in}	=	INLET TSS CONCENTRATION	=	335.29	mg/L
VSS_{in}	=	INLET VSS CONCENTRATION	=	179.98	mg/L

SUBSTITUTING THE VALUES

$P_{X,TSS}$ = { { [0.368 x 66698.87 x (199 - 20)] / 0.8 } + { 66698.87 x (335.29 - 179.98) } } / 1000

$P_{X,TSS}$	=	15850.99	kg/d

NOTES:

OXYGEN REQUIREMENT

$$R_O = \frac{Q \times (S_0 - S)}{f} - 1.42 \times Q \times Y_{OBS} \times (S_0 - S)$$

WHERE

Q	=	DESIGN FLOW RATE	=	66698.87	m³/d
S_o	=	INLET BOD CONCENTRATION	=	199	mg/L
S	=	OUTLET BOD CONCENTRATION	=	20	mg/L
f	=		=	0.68	
Y_{OBS}	=	OBSERVED YIELD	=	0.3680	g VSS / g BOD

SUBSTITUTING THE VALUES

R_O = { { [66698.87 x (199 - 20)] / 0.68 } - { 1.42 x 66698.87 x 0.368 x (199 - 20) } } / 1000

OXYGEN REQUIRED	=	11319	kg/d
INLET BOD	=	199.00	mg/L
OUTLET BOD	=	20.00	mg/L
BOD REMOVED	=	11940.00	kg/d
OXYGEN REQUIRED FOR BOD REMOVAL	=	1.00	kg O_2 / kg BOD
OXYGEN REQUIRED FOR BOD REMOVAL	=	11940	kg/d
OXYGEN PROVIDED	=	11940	kg/d

DESIGN VALIDATION

MLSS CONCENTRATION	=	3000	mg/L
		1500-3000	mg/L
SOLIDS RETENTION TIME	=	6.00	d
		5-8	d
HYDRAULIC RETENTION TIME	=	4.00	h
		4-6	h
F/M RATIO	=	0.3989	kg BOD / kg MLSS.d
		0.3-0.4	kg BOD / kg MLSS.d
OXYGEN PROVIDED	=	1.00	kg O_2 / kg BOD_r
		0.8-1.0	kg O_2 / kg BOD_r

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 64

TREATED SEWAGE FROM AERATION TANK OVERFLOWS THROUGH A WEIR INTO AERATION EFFLUENT CHANNEL WHICH IN TURN ACTS AS DISTRIBUTION CHAMBER FOR SECONDARY CLARIFIER

NOTES:

12.0 AERATION AIR REQUIREMENT

OXYGEN REQUIRED	=	11940.00	kg/d	
AERATION TIME	=	24.00	h	
NO. OF BASINS	=	2	Nos.	
AERATION REQUIRED PER BASIN	=	248.75	kg/h	

DESIGN DATA

MAXIMUM LIQUID TEMPERATURE	=	20.00	30.00	°C
PERCENT OXYGEN CONCENTRATION IN BASIN	=	17.95	17.95	%

Reference : Waste Water Engineering – Treatment and Reuse, 4th Edition, Metcalf & Eddy, Page no. 429

SITE TEMPERATURE	=	15.00	45.00	°C
ALTITUTE OF THE PLANT SITE	=	6.00	6.00	m
ATMOSPHERIC PRESSURE AT ZERO ALTITUDE, $P_{atm,0}$	=	101.30	101.30	kPa
DO CONCENTRATION IN TANK, C_L	=	1.00	1.00	mg/L

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 69

ALPHA	=	0.65	0.65

Reference : Waste Water Engineering – Treatment and Reuse, 4th Edition, Metcalf & Eddy, Page no. 430

BETA	=	0.95	0.95

Reference : Waste Water Engineering – Treatment and Reuse, 4th Edition, Metcalf & Eddy, Page no. 430

FOULING FACTOR	=	0.90	0.90

Reference : Waste Water Engineering – Treatment and Reuse, 4th Edition, Metcalf & Eddy, Page no. 430

DETERMINATION OF ATMOSPHERIC PRESSURE AT ALTITUDE

$$\mathbf{P_{atm,H} = P_{atm,O} \times exp\left\{\frac{-gM(H-0)}{RT}\right\}}$$

Reference : Waste Water Engineering – Treatment and Reuse, 4th Edition, Metcalf & Eddy, Page no. 1738

WHERE

$P_{atm,0}$	=	ATMOSPHERIC PRESSURE AT ZERO ALTITUDE	=	101	101	kPa
g	=	ACCELERATION DUE TO GRAVITY	=	9.81	9.81	m/s²
M	=	MOLAR MASS OF AIR	=	28.97	28.97	kg/kg mole
H	=	SITE ELEVATION	=	6.00	6.00	m
R	=	UNIVERSAL GAS CONSTANT	=	8314.00	8314.00	N.m/kgmole K
T	=	SITE TEMPERATURE	=	288.15	318.15	deg K

SUBSTITUING THE VALUES

$P_{atm,H}$ = 101.3 x exp { [- 9.81 x 28.97 x (6 - 0)] / [8314 x 288.15] }

$P_{atm,H}$ = 101.3 x exp { [- 9.81 x 28.97 x (6 - 0)] / [8314 x 318.15] }

ATMOSPHERIC PRESSURE AT SITE ALTITUDE, $P_{atm,H}$	=	101.23	101.24	kPa

NOTES:

KOLKATA METROPOLITAN DEVELOPMENT AUTHORITY	sustainable solutions. for a better life. WABAG					REVISION
	PROCESS DESIGN CALCULATION ARUPARA SEWAGE TREATMENT PLANT					
DEVELOPMENT OF SEWAGE TREATMENT PLANTS KOLKATA CITY AREA	Location	Project No	Doc. Code	Serial No	Rev	Page No
	ARUPARA	10P153	B0001	301	0	28 / 57

DETERMINATION OF ATMOSPHERIC PRESSURE AT POINT OF RELEASE

LIQUID DEPTH IN AERATION TANK	=	5.650	5.650	m
DIFFUSER SUBMERGENCE	=	0.300	0.300	m
EFFECTIVE AERATION DEPTH	=	5.350	5.350	m
PRESSURE EQUIVALENT TO WATER COLUMN	=	5.35 x 9810 / 1000		
	=	52.48	52.48	kPa
PRESSURE AT DEPTH OF RELEASE, P_d	=	153.71	153.72	kPa

DETERMINATION OF DISSOLVED OXYGEN SATURATION CONCENTRATION IN CLEAN WATER

OXYGEN SATURATION CONCENTRATION $C_{s,T}$	=	9.08	7.54	mg/L

Reference : Waste Water Engineering – Treatment and Reuse, 4th Edition, Metcalf & Eddy, Page no. 1745

$$C_{S,T,H} = C_{S,T} \times \exp\left\{\frac{-gM(H-0)}{RT}\right\}$$

Reference : Waste Water Engineering – Treatment and Reuse, 4th Edition, Metcalf & Eddy, Page no. 430

WHERE

$C_{s,T}$	=	OXYGEN SATURATION CONCENTRATION	=	9.08	7.54	mg/L
g	=	ACCELERATION DUE TO GRAVITY	=	9.81	9.81	m/s²
M	=	MOLAR MASS OF AIR	=	28.97	28.97	kg/kg mole
H	=	SITE ELEVATION	=	6.00	6.00	m
R	=	UNIVERSAL GAS CONSTANT	=	8314.00	8314.00	N.m/kgmole K
T	=	SITE TEMPERATURE	=	288.15	318.15	deg K

SUBSTITUING THE VALUES

$C_{s,T,H}$ = 9.08 x exp { [- 9.81 x 28.97 x (6 - 0)] / [8314 x 288.15] }

$C_{s,T,H}$ = 7.54 x exp { [- 9.81 x 28.97 x (6 - 0)] / [8314 x 318.15] }

DISSOLVED OXYGEN SATURATION CONCENTRATION IN CLEAN WATER AT ALTITUDE H AND TEMPERATURE T, $C_{s,T,H}$	=	9.08	7.54	mg/L

DETERMINATION OF AVERAGE DISSOLVED OXYGEN SATURATION CONCENTRATION IN AERATION TANK

$$C_{\hat{S},T,H} = C_{S,T,H} \times \left(\frac{1}{2}\right) \times \left\{\left(\frac{P_d}{P_{atm,H}}\right) + \left(\frac{O_t}{21}\right)\right\}$$

Reference : Waste Water Engineering – Treatment and Reuse, 4th Edition, Metcalf & Eddy, Page no. 430

WHERE

$C_{s,T,H}$	=	OXYGEN SATURATION CONCENTRATION	=	9.08	7.54	mg/L
P_d	=	PRESSURE AT DEPTH OF RELEASE	=	153.71	153.72	kPa
$P_{atm,H}$	=	ATMOSPHERIC PRESSURE AT SITE ALTITUDE	=	101.23	101.24	kPa
O_t	=	PERCENT OXYGEN LEAVING THE TANK	=	17.95	17.95	%

SUBSTITUTING THE VALUES

$C_{\hat{s},T,H}$ = 9.08 x (1 / 2) x { (153.7135 / 101.23) + (17.95 / 21) }

$C_{\hat{s},T,H}$ = 7.54 x (1 / 2) x { (153.7235 / 101.24) + (17.95 / 21) }

AVERAGE OXYGEN CONCENTRATION AT DEPTH OF RELEASE	=	10.78	8.95	mg/L

NOTES:

DETERMINATION OF STANDARD OXYGEN TRANSFER RATE

$$SOTR = \frac{AOTR}{\left\{\left(\frac{\beta . C_{\hat{S},T,H} - C_L}{C_{S,20}}\right) \times 1.024^{T-20} \times \alpha \times F\right\}}$$

Reference : Waste Water Engineering – Treatment and Reuse, 4th Edition, Metcalf & Eddy, Page no. 430

WHERE

AOTR	= ACTUAL OXYGEN TRANSFER RATE REQUIRED	248.75	248.75	kg/h
β	= SALINITY SURFACE TENSION CORRECTION FACTOR	0.95	0.95	
$C_{\hat{s},T,H}$	= AVERAGE OXYGEN CONCENTRATION	10.78	8.95	mg/L
C_L	= OPERATING DISSOLVED OXYGEN CONCENTRATION	1.00	1.00	mg/L
$C_{s,20}$	= DISSOLVED OXYGEN CONCENTRATION AT 20 DEG C	9.08	9.08	mg/L
T	= OPERATING TEMPERATURE	20.00	30.00	deg C
α	= OXYGEN TRANSFER CORRECTION FACTOR FOR WASTWATER	0.65	0.65	
F	= FOULING FACTOR	0.90	0.90	

SUBSTITUTING THE VALUES

SOTR = 248.75 / { [((0.95 x 10.78) - 1) / 9.08] x [1.024 ^ (20 - 20)] x 0.65 x 0.9 }

SOTR = 248.75 / { [((0.95 x 8.95) - 1) / 9.08] x [1.024 ^ (30 - 20)] x 0.65 x 0.9 }

STANDARD OXYGEN TRANSFER RATE REQUIRED		=	417.81	405.97	kg/h

DETERMINATION OF AERATION AIR REQUIRED

STANDARD OXYGEN TRANSFER RATE REQUIRED		=	417.81	405.97	kg/h
STANDARD OXYGEN TRANSFER EFFICIENCY		=	26.75%	26.75%	
FRACTION OF OXYGEN IN AIR		=	23.18%	23.18%	
DENSITY OF AIR	1 atm 20 deg C	=	1.21	1.21	kg/m³
AIR REQUIRED	[1 atm , 20 deg C]	=	5568.80	5411.00	m³/h

12.1 AERATION AIR BLOWER

DESIGN FLOW RATE	[1 atm , 20 deg C]	=	5568.80	m³/h
NO. OF DUTY BLOWERS PER BASIN		=	1	No.
TOTAL NO. OF BASINS		=	2	Nos.
TOTAL NO. OF DUTY BLOWERS		**=**	**2**	**Nos.**
TOTAL NO. OF STANDBY BLOWERS		**=**	**1**	**No.**
CAPACITY REQUIRED	[1 atm , 20 deg C]	=	6125.68	m³/h
CAPACITY PROVIDED	**[1 atm , 20 deg C]**	**=**	**6680.00**	**m³/h**
MASS FLOWRATE OF AIR PROVIDED		=	8082.80	kg/h
TYPE		**=**	**POSITIVE DISPLACEMENT**	
OPERATION		=	CONTINUOUS	
FLUID HANDLED		=	AIR	
VFD OPERATION		=	YES	

NOTES:

SUCTION CONDITIONS:

TEMPERATURE	MAX	=	45.00	deg C
	MIN	=	15.00	deg C
ATMOSPHRIC PRESSURE		=	1.00	kg/cm²
RELATIVE HUMIDITY	MAX	=	85%	
	MIN	=	58%	

12.2 AERATION DIFFUSERS

TYPE	=	TUBE

FURTHER DETAILS WILL BE FURNISHED WITH DIFFUSER MANUFACTURER DOCUMENTATION

NOTES:

13.0 SECONDARY CLARIFIER

DESIGN AVERAGE FLOW	=	66698.87	m^3/d
DESIGN PEAK FLOW	=	147948.87	m^3/d
RAS RATIO CONSIDERED	=	0.60	
RAS FLOWRATE	=	40019.33	m^3/d
MLSS CONCENTRATION IN AERATION TANK	=	3000	mg/L
DESIGN INFLUENT SOLIDS AT AVERAGE FLOW	=	320155	kg/d
DESIGN INFLUENT SOLIDS AT PEAK FLOW	=	563905	kg/d

DESIGN BASIS

TYPE **SQUARE TYPE CLARIFIER**

NO. OF UNITS	**=**	**2**	**Nos.**
SURFACE OVERFLOW RATE AT AVERAGE FLOW	=	35	$m^3/m^2/d$
SURFACE OVERFLOW RATE AT PEAK FLOW	=	50	$m^3/m^2/d$
SOLIDS LOADING RATE AT AVERAGE FLOW	=	140	$kg/m^2/d$
SOLIDS LOADING RATE AT PEAK FLOW	=	210	$kg/m^2/d$
AREA REQUIRED AT AVERAGE FLOW BASED ON SOR	=	952.85	m^2
AREA REQUIRED AT PEAK FLOW BASED ON SOR	=	1479.49	m^2
AREA REQUIRED AT AVERAGE FLOW BASED ON SOLIDS LOADING	=	1143.42	m^2
AREA REQUIRED AT PEAK FLOW BASED ON SOLIDS LOADING	=	1342.64	m^2
HENCE,			
SURFACE AREA OF CLARIFIER REQUIRED	=	1479.49	m^2

INLET COLUMN

FLOW FROM AERATION TANK ENTERS CLARIFIER THROUGH A CENTRAL COLUMN.

DESIGN INFLUENT FLOWRATE PER UNIT	=	93984.10	m^3/d
VELOCITY THROUGH COLUMN	=	1.2	m/s
DIA OF COLUMN REQUIRED	=	1.08	m
DIA OF COLUMN PROVIDED	=	1.10	m
WALL THICKNESS	=	250	mm
OD OF COLUMN PROVIDED	=	1.6	m
SURFACE AREA OF COLUMN PROVIDED	=	2.02	m^2

NOTES:

KOLKATA METROPOLITAN DEVELOPMENT AUTHORITY	sustainable solutions. for a better life. WABAG **PROCESS DESIGN CALCULATION** **ARUPARA SEWAGE TREATMENT PLANT**

DEVELOPMENT OF SEWAGE TREATMENT PLANTS KOLKATA CITY AREA	Location	Project No	Doc. Code	Serial No	Rev	Page No	REVISION
	ARUPARA	**10P153**	**B0001**	**301**	**0**	**32 / 57**	

CLARIFIER SIZING

PLAN AREA OF CLARIFIER REQUIRED	=	1481.51	m^2
SIZE OF CLARIFIER REQUIRED	=	38.5	m
SIZE OF CLARIFIER PROVIDED	**=**	**38.50**	**m**
SIDE WATER DEPTH	**=**	**3.5**	**m**
FREE BOARD CONSIDERED	=	0.3	m
VOLUME OF CLARIFIER PROVIDED	=	5187.88	m^3
HYDRAULIC RETENTION TIME PROVIDED	=	3.74	h
TYPE OF SLUDGE COLLECTION	=	CENTRAL SCRAPPER	
DIA OF SLUDGE HOPPER AT BOTTOM	=	1	m
SLOPE OF HOPPER	=	1 in	12
HEIGHT OF HOPPER PROVIDED	**=**	**1.57**	**m**

OVERFLOW WEIR

TYPE PERIPHERAL INSIDE, DOUBLE WEIR

WIDTH OF LAUNDER	=	0.50	m
WALL THICKNESS	=	0.20	m
CLERANCE FROM WALL	=	1.00	m
NO. OF SIDES OF OVERFLOW	=	2	Nos.
LENGTH OF WEIR	=	284.8	m
WEIR LOADING RATE	=	117.1	$m^3/m.d$

DESIGN VALIDATION

SURFACE LOADING RATE AT AVERAGE FLOW	=	22.53	$m^3/m^2/d$
	<=	15-35	
SURFACE LOADING RATE AT PEAK FLOW	=	49.98	$m^3/m^2/d$
	<=	40-50	
SOLIDS LOADING RATE AT AVERAGE FLOW	=	108.15	$kg/m^2/d$
	<=	70-140	
SOLIDS LOADING RATE AT PEAK FLOW	=	190.48	$kg/m^2/d$
	<=	210	
WEIR LOADING RATE	=	117.1	$m^3/m/d$
	<=	185	

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 53

NOTES:

13.1 RAS SUMP AND PUMPS

SLUDGE FROM SECONDARY CLARIFIER IS RETURNED TO AERATION TANK AS RAS

RETURN SLUDGE RATIO

$$Q_R = \frac{X}{(X_R - X)}$$

WHERE

X	=	MLSS CONCENTRATION IN AERATION TANK	=	3000	mg/L
X_R	=	MLSS CONCENTRATION IN RETURN SLUDGE	=	8000	mg/L

SUBSTITUTING THE VALUES

Q_R = 3000 / (8000 - 3000)

RETURN SLUDGE RATIO REQUIRED	=	0.60	unitless
RETURN SLUDGE RATIO PROVIDED	=	0.60	unitless
DESIGN AVERAGE FLOW	=	66698.87	m³/d
RETURN SLUDGE FLOW	=	40019.33	m³/d

EXCESS SLUDGE

BIOMASS GENERATED FROM AERATION TANK	=	15850.99	kg/d
DESIGN AVERAGE FLOW	=	66698.87	m³/d
TSS IN SECONDARY CLARIFIER OUTLET	=	30	mg/L
HENCE, TSS IN EXCESS SLUDGE	=	13850.03	kg/d
MLSS CONCENTRATION	=	8000	mg/L
HENCE, EXCESS SLUDGE FLOW RATE	=	1722.65	m³/d

EXCESS SLUDGE WILL BE BLED TO PRIMARY CLARIFIER THROUGH A VALVE PROVIDED IN THE RAS HEADER

13.2 RAS SUMP

RAS FLOW RATE	=	40019.33	m³/d
EXCESS SLUDGE FLOW RATE	=	1722.65	m³/d
TOTAL SLUDGE FLOW RATE	=	41741.98	m³/d
RETENTION TIME CONSIDERED	=	5	min
VOLUME OF SUMP REQUIRED	=	145	m³
TYPE	=	ATMOSPHERIC, OPEN	
SHAPE	=	RECTANGULAR	
LIQUID DEPTH	**=**	**3.00**	**m**
LENGTH OF THE SUMP CONSIDERED	**=**	**5.00**	**m**
WIDTH OF THE SUMP REQUIRED	=	9.67	m
WIDTH OF THE SUMP PROVIDED	**=**	**10.00**	**m**
VOLUME OF SUMP PROVIDED	=	150.00	m³

NOTES:

13.3 RAS PUMP

DAILY SLUDGE FLOW RATE	=	41741.98	m^3/d
OPERATING HOURS PER DAY	=	24.0	h
NO. OF DUTY PUMPS	**=**	**2**	**Nos.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	869.63	m^3/h
CAPACITY OF PUMP PROVIDED	**=**	**870.00**	**m^3/h**
TYPE	**=**	**SUBMERSIBLE**	
OPERATION	=	CONTINUOUS	
FLUID HANDLED	=	0.8 % RAS SLUDGE	
VFD OPERATION	=	NO	

MASS BALANCE

EXCESS SLUDGE	=	1722.65	m^3/d
DESIGN AVERAGE FLOW TO AERATION TANK	=	66698.87	m^3/d
DESIGN PEAK FLOW TO AERATION TANK	=	147948.87	m^3/d
AVERAGE FLOW FROM SECONDARY CLARIFIER	=	64976.22	m^3/d
PEAK FLOW FROM SECONDAY CLARIFIER	=	146226.22	m^3/d
TSS IN TREATED SEWAGE	=	30.00	mg/L
	=	1949.29	kg/d
BOD IN TREATED SEWAGE	=	20.00	mg/L
	=	1299.53	kg/d
pBOD IN TREATED SEWAGE	=	18.83	mg/L
(0.65 x 1.42 x 0.68 x TSS)	=	1223.45	kg/d
sBOD IN TREATED SEWAGE	=	1.17	mg/L
	=	1299.53	kg/d
TSS IN EXCESS SLUDGE	=	13850.03	kg/d
VSS IN EXCESS SLUDGE	=	5491.9885	kg/d
SOLIDS DUE TO BIOMASS	=	5491.989	kg/d
pBOD IN EXCESS SLUDGE	=	3446.99	kg/d
(0.65 x 1.42 x 0.68 x BIOMASS SOLIDS)			
sBOD IN EXCESS SLUDGE	=	2.02	kg/d
BOD IN EXCESS SLUDGE	=	3449.01	kg/d

NOTES:

		AERATION INLET	EXCESS SLUDGE	SECONDARY OUTLET
AVG. FLOW	m^3/d	66698.87	1722.65	64976.22
TSS	mg/L	335.30	8040	30
	kg/d	22363.00	13850.03	1949.29
BOD	mg/L	199.00	2002.2	20
	kg/d	13273.00	3449.01	1299.53
VSS	mg/L	180.00	3188.2	24
	kg/d	12004.00	5491.99	1559.43

NOTES:

14.0 DISINFECTION SECTION

DISINFECTION OF TREATED SEWAGE IS ACHIEVED THROUGH CHLORINATION.
A CHLORINE CONTACT TANK IS PROVIDED TO ACHIEVE EFFECTIVE MIXING OF CHLORINE IN TREATED SEWAGE AND PROVIDE SUFFICIENT CONTACT TIME TO ACHIEVE DISINFECTION

14.1 CHLORINE CONTACT TANK

DESIGN AVERAGE FLOW	=	65000.00	m³/d
RETENTION TIME	=	30	min
NO. OF UNITS	**=**	**1**	**No.**
VOLUME OF TANK REQUIRED	=	1354.17	m³
LIQUID DEPTH CONSIDERED	**=**	**3.90**	**m**
PASS WIDTH	=	3.90	m
NO. OF BAFFLES	=	8	Nos.
HENCE, NO. OF PASSES	=	9	Nos.
EFFECTIVE LENGTH OF PASS	=	35.1	m
BAFFLE WALL THICKNESS	=	0.2	m
TOTAL LENGTH OF CHLORINE CONTACT TANK	**=**	**36.7**	**m**
WIDTH OF TANK REQUIRED	=	9.893	m
WIDTH OF TANK PROVIDED	**=**	**9.90**	**m**
FREEBOARD CONSIDERED	=	0.3	m

14.2 CHLORINATION

DESIGN AVERAGE FLOW	=	65000	m³/d
CHLORINE DOSAGE CONSIDERED	=	10.00	mg/L
CHLORINATION CAPACITY REQUIRED	=	27.09	kg/h
NO. OF WORKING UNITS	=	1	No.
NO. OF STANDBY UNITS	=	1	No.
CAPACITY OF EACH CHLORINATOR REQUIRED	=	28	kg/h
CAPACITY OF EACH CHLORINATOR PROVIDED	**=**	**30**	**kg/h**

NOTES:

15.0 SLUDGE DIGESTION SYSTEM

THICKENED SLUDGE WILL BE ANAEROBICALLY DIGESTED IN SLUDGE DIGESTER.
SLUDGE FROM PRIMARY CLARIFIER IS RECEIVED AT DIGESTER FEED SUMP

15.1 DIGESTER FEED SUMP

THICKENED SLUDGE FLOWRATE	=	548.13	m^3/d
BATCH VOLUME OF SLUDGE FROM THICKENER	=	11.42	m^3
NO. OF BATCHES CONSIDERED FOR STORAGE	=	3	Nos.
WORKING VOLUME OF SUMP REQUIRED	=	34.26	m^3
TYPE	**=**	**ATMOSPHERIC, OPEN**	
SHAPE	=	SQUARE	
LIQUID DEPTH	**=**	**3.00**	**m**
LENGTH OF THE TANK CONSIDERED	**=**	**3.60**	**m**
WIDTH OF THE TANK REQUIRED	=	3.17	m
WIDTH OF THE TANK PROVIDED	**=**	**3.20**	**m**
VOLUME OF EACH TANK PROVIDED	=	34.56	m^3

15.2 DIGESTER FEED SUMP AGITATOR

A LOW SPEED AGITATOR IS PROVIDED IN THE TANK TO KEEP THE SOLIDS IN SUSPENSION.

TYPE	**=**	**LOW SPEED TURBINE**	
		VERTICAL MOUNTED	
NO. OF AGITATOR PER TANK	=	1	No.
SIZE OF TANK	**=**	**3.20**	**m**

15.3 DIGESTER FEED PUMPS

THICKENED SLUDGE FLOWRATE	=	548.13	m^3/d
OPERATING HOURS	=	24.0	h
NO. OF DUTY PUMPS	**=**	**2**	**Nos.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	11.42	m^3/h
CAPACITY OF PUMP PROVIDED	**=**	**12.00**	**m^3/h**
TYPE	**=**	**SCREW**	
OPERATION	=	CONTINUOUS	
FLUID HANDLED	=	6 % THICKENED SLUDGE	
VFD OPERATION	=	NO	

NOTES:

15.4 SLUDGE DIGESTER

TYPE **MESOPHILIC SINGLE STAGE HIGH RATE ANAEROBIC DIGESTION**
CONTINUOUS FEED AND CONTINUOUS WITHDRAWAL

THICKENED SLUDGE FLOW RATE			=	548.13	m^3/d
TSS IN THICKENED SLUDGE			=	33545.00	kg/d
VSS IN THICKENED SLUDGE			=	18006.00	kg/d
BOD IN THICKENED SLUDGE			=	7166.00	kg/d
NO. OF DIGESTERS			**=**	**2**	**Nos.**
SLUDGE DIGESTION TEMPERATURE			=	35	deg C
SRT REQUIRED			=	10	d

Reference: CPHEEO Manual on Sewerage and Sewage Treatment Systems, 2013

DIGESTER STORAGE VOLUME REQUIRED			=	2741	m^3
SIDE WATER DEPTH CONSIDERED			**=**	**7**	**m**
GRIT ACCUMULATION SPACE			=	0.6	m
FREEBOARD CONSIDERED			=	0.6	m
TOTAL SIDE WATER DEPTH			=	8.2	m
DIA OF DIGESTER REQUIRED			=	22.33	m
DIA OF DIGESTER PROVIDED			**=**	**24.00**	**m**
DIA OF CONE AT THE TOP			=	4	m
HEIGHT OF TOP CONE PROVIDED			=	3.69	m
HEIGHT OF GAS COLLECTION DOME			=	1.2	m
DIA OF SLUDGE HOPPER AT BOTTOM			=	5	m
SLOPE OF HOPPER			=	1 in	6
HEIGHT OF HOPPER PROVIDED			**=**	**1.59**	**m**
VSS DESTRUCTION			=	50%	

Reference: CPHEEO Manual on Sewerage and Sewage Treatment Systems, 2013

THICKENED SLUDGE VSS			=	18006.00	kg/d
VSS DESTROYED			=	9003.00	kg/d
GAS PRODUCED	1 atm	20 deg C	=	0.9	m^3/kg VSS destroyed
			=	8103.00	m^3/d

Reference: CPHEEO Manual on Sewerage and Sewage Treatment Systems, 2013

NOTES:

VSS LOADING RATING	=	2.43	kg/m³/d
		1.6 - 6.5	kg/m³/d

Reference: CPHEEO Manual on Sewerage and Sewage Treatment Systems, 2013

MASS BALANCE

TSS IN THICKENED SLUDGE	=	33545.00	kg/d
VSS DESTROYED	=	9003.00	kg/d
SOLIDS IN DIGESTER AFTER DIGESTION	=	24542.00	kg/d
BOD STABILISATION IN DIGESTER	=	60%	
BOD IN DIGESTER AFTER DIGESTION	=	2866.4	kg/d

HIGH RATE DIGESTERS ARE OPERATED ON CONTINUOUS WITHDRAWAL MODE. HENCE DIGESTED SLUDGE FLOW RATE IS EQUAL TO THE DIGESTER FEED FLOWRATE.

		DIGESTER FEED	DIGESTED SLUDGE
FLOW	m³/d	548.13	548.13
TSS	mg/L	61199.00	44774.1
	kg/d	33545.00	24542.00
BOD	mg/L	13073.60	5229.5
	kg/d	7166.00	2866.40
VSS	mg/L	32849.90	16425
	kg/d	18006.00	9003.00

15.5 DIGESTER MIXING PUMP

VOLUME OF EACH DIGESTER	=	3709.6	m³
MIXING TURNDOWN PER DAY	=	3	Nos.
CAPACITY OF PUMP REQUIRED	=	11128.8	m³/d
OPERATING HOURS	=	24	h
NO. OF DUTY PUMPS / DIGESTER	**=**	**1**	**No.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	463.70	m³/h
CAPACITY OF PUMP PROVIDED	**=**	**520.00**	**m³/h**
TYPE	**=**	**CENTRIFUGAL, NON-CLOG**	
OPERATION	=	CONTINUOUS	
FLUID HANDLED	=	6 % DIGESTED SLUDGE	
VFD OPERATION	=	NO	

NOTES:

15.6 DIGESTER HEATING

TO MAINTAIN THE DIGESTER TEMPERATURE, FEED TO THE DIGESTER IS HEATED ALONG WITH RECIRCULATION FROM DIGESTERS. HEAD LOSSES ACROSS DIGESTER WALL AND ROOF IS ALSO COMPENSATED.

DESIGN BASIS

DIGESTER DESIGN TEMPERATURE	=	35	^oC
WINTER AVERAGE AMBIENT TEMPERATURE	=	15	^oC
SUMMER AVERAGE AMBIENT TEMPERATURE	=	45	^oC
MINIMUM SEWAGE TEMPERATURE	=	20	^oC
MAXIMUM SEWAGE TEMPERATURE	=	30	^oC
AVERAGE WINTER GROUND TEMPERATURE	=	20	^oC
AVERAGE SUMMER GROUND TEMPERATURE	=	32	^oC

DIGESTER DIMENSIONAL DATA

NUMBER OF DIGESTERS		=	2	Nos.
DIAMETER OF CYLINDRICAL PART	**D**	=	24.00	m
HEIGHT OF CYLINDRICAL PART	**h**	=	8.20	m
HEIGHT OF CYLINDER BELOW GROUND	h_3	=	2.00	m
HEIGHT OF UPPER CONE	h_1	=	3.69	m
HEIGHT OF UPPER DOME	h_2	=	1.20	m
HEIGHT OF BOTTOM CONE	h_4	=	1.59	m
DIAMETER OF BOTTOM CONE	d_b	=	5.00	m

FEED SLUDGE HEATING

		SUMMER	WINTER
FEED SLUDGE TEMPERATURE	=	30	20
DIGESTER TEMPERATURE REQUIRED	=	35	35

HEAT REQUIRED, **$Q = m\ Cp\ dT$**

WHERE

m	=	SLUDGE FEEDING FLOW RATE	=	24.00	24.00	m^3/h
C_p	=	SPECIFIC HEAT FOR SLUDGE	=	1.162	1.162	$kWh/(m^3.K)$
dT	=	DIFFERENCE IN TEMPERATURE	=	5	15	K

SUBSTITUTING THE VALUES

HEAT REQUIRED FOR FEED SLUDGE HEATING, Q	=	139.5	418.4	kW

NOTES:

HEAT LOSS FROM UPPER DOME & CONE

DIAMETER OF CYLINDRICAL PART	D	=	24.00	m
DIAMETER OF UPPER CONE	d	=	4.00	m
HEIGHT OF UPPER CONE	h	=	3.69	m

ANGLE OF UPPER CONE α = ATAN (h / [(D / 2) - (d / 2)])

= ATAN { 3.69230769230769 / [(24 / 2) - (4 / 2)] } = 20.27 °

UPPER DOME & CONE SURFACE AREA $A = \pi h [(D/2) + (d/2)] / \sin \alpha + \pi d h_1$

= PI x 3.69230769230769 x [(24 / 2) + (4 / 2)] / SIN 20.27 = 483.84 m²

HEAT TRANSFER COEFFICIENT OF UPPER DOME & CONE

LAYER	l	d	d/l	1/a	1/k	k
	W/(m.K)	m	m².K/W	m².K/W	m².K/W	W/(m².K)
SLUDGE / CONCRETE				0.130		
CONCRETE	2.50	0.40	0.160			
CONCRETE / FRESH AIR				0.040		
TOTAL			0.160	0.170	0.330	**3.04**
					∑1/a + ∑d/l	

HEAT LOSS CALCULATION, $q = k A (T_1 - T_2)$

WHERE				SUMMER	WINTER	
k	=	HEAT TRANSFER COEFFICIENT	=	3.04	3.04	W/(m².K)
A	=	SURFACE AREA OF UPPER DOME & CONE	=	483.84	483.84	m²
T_1	=	DIGESTER TEMPERATURE	=	35	35	°C
T_2	=	AMBIENT TEMPERATURE	=	45	15	°C

SUBSTITUTING THE VALUE

= 3.04 x 483.84 x (35 - 45) @ WINTER

= 3.04 x 483.84 x (35 - 15) @ SUMMER

HEAT LOSS FROM UPPER DOME & CONE	=	-14709	29418	W
	=	-14.709	29.418	kW

NOTES:

HEAT LOSS FROM CYLINDRICAL PART ABOVE GROUND

DIAMETER OF CYLINDRICAL PART	D	=	24.00	m
HEIGHT OF CYLINDER ABOVE GROUND	h	=	6.20	m
SURFACE AREA OF CYLINDER ABOVE GROUND	$A = \pi D h$	=	467.47	m²

HEAT TRANSFER COEFFICIENT OF CYLINDER ABOVE GROUND

LAYER	l	d	d/l	1/a	1/k	k
	W/(m.K)	m	m².K/W	m².K/W	m².K/W	W/(m².K)
SLUDGE / CONCRETE				0.130		
CONCRETE	2.50	0.40	0.160			
CONCRETE / FRESH AIR				0.040		
TOTAL			0.160	0.170	0.330	**3.04**
					∑1/a + ∑d/l	

HEAT LOSS CALCULATION, $q = k A (T_1 - T_2)$

WHERE				SUMMER	WINTER	
k	=	HEAT TRANSFER COEFFICIENT	=	3.04	3.04	W/(m².K)
A	=	SURFACE AREA OF CYLINDRICAL PART	=	467.47	467.47	m²
T_1	=	DIGESTER TEMPERATURE	=	35	35	°C
T_2	=	AMBIENT TEMPERATURE	=	45	15	°C

SUBSTITUTING THE VALUE

HEAT LOSS FROM CYLINDRICAL PART ABOVE GROUND	=	-14212	28423	W
	=	-14.212	28.423	kW

HEAT LOSS FROM CYLINDRICAL PART BELOW GROUND

DIAMETER OF CYLINDRICAL PART	D	=	24.00	m
HEIGHT OF CYLINDER BELOW GROUND	h	=	2.00	m
SURFACE AREA OF CYLINDER BELOW GROUND	$A = \pi D h$	=	150.80	m²

HEAT TRANSFER COEFFICIENT OF CYLINDER BELOW GROUND

LAYER	l	d	d/l	1/a	1/k	k
	W/(m.K)	m	m².K/W	m².K/W	m².K/W	W/(m².K)
SLUDGE / CONCRETE				0.130		
CONCRETE	2.50	0.60	0.240			
CONCRETE / GROUND				0.130		
TOTAL			0.240	0.260	0.500	**2.00**
					∑1/a + ∑d/l	

HEAT LOSS CALCULATION, $q = k A (T_1 - T_2)$

WHERE				SUMMER	WINTER	
k	=	HEAT TRANSFER COEFFICIENT	=	2.00	2.00	W/(m².K)
A	=	SURFACE AREA OF CYLINDRICAL PART	=	150.80	150.80	m²
T_1	=	DIGESTER TEMPERATURE	=	35	35	°C
T_2	=	GROUND TEMPERATURE	=	32	20	°C

SUBSTITUTING THE VALUE

HEAT LOSS FROM CYLINDRICAL PART BELOW GROUND	=	905	4524	W
	=	0.905	4.524	kW

NOTES:

HEAT LOSS FROM BOTTOM CONE

DIAMETER OF CYLINDRICAL PART	D	=	24.00	m
DIAMETER OF BOTTOM CONE	d	=	5.00	m
HEIGHT OF BOTTOM CONE	h	=	1.59	m

ANGLE OF BOTTOM CONE $\beta = \mathrm{ATAN}\ (h / [(D/2) - (d/2)])$

= ATAN { 1.59 / [(24 / 2) - (5 / 2)] } = 9.50 °

BOTTOM CONE SURFACE AREA $A = \pi h [(D/2) + (d/2)] / \sin\beta$

= PI x 1.59 x [(24 / 2) + (5 / 2)] / SIN 9.5 = 438.84 m^2

HEAT TRANSFER COEFFICIENT OF BOTTOM CONE

LAYER	l	d	d/l	1/a	1/k	k
	W/(m.K)	m	m^2.K/W	m^2.K/W	m^2.K/W	W/(m^2.K)
SLUDGE / CONCRETE				0.130		
CONCRETE	2.50	0.35	0.140			
CONCRETE / GROUND				0.130		
TOTAL			0.140	0.260	0.400	**2.50**
					∑1/a + ∑d/l	

HEAT LOSS CALCULATION, $q = k A (T_1 - T_2)$						
WHERE				**SUMMER**	**WINTER**	
k	=	HEAT TRANSFER COEFFICIENT	=	2.50	2.50	W/(m^2.K)
A	=	SURFACE AREA OF LOWER CONE	=	438.84	438.84	m^2
T_1	=	DIGESTER TEMPERATURE	=	35	35	^oC
T_2	=	GROUND TEMPERATURE	=	32	20	^oC
SUBSTITUTING THE VALUES						
HEAT LOSS FROM BOTTOM CONE			=	3292	16457	W
			=	3.292	16.457	kW

HEAT LOSS SUMMARY

HEAT LOSS FROM UPPER DOME & CONE	=	-14.709	29.418	kW
HEAT LOSS FROM CYLINDER ABOVE GROUND	=	-14.212	28.423	kW
HEAT LOSS FROM CYLINDER BELOW GROUND	=	0.905	4.524	kW
HEAT LOSS FROM BOTTOM CONE	=	3.292	16.457	kW
TOTAL HEAT LOSS FROM DIGESTER	=	-24.724	78.822	kW
NO. OF DIGESTERS	=	2	2	Nos.
HEAT LOSS TO BE COMPENSATED FOR DIGESTER	=	-49.448	157.644	kW

NOTES:

15.7 SLUDGE RECIRCULATION PUMPS

TO MAINTAIN TEMPERATURE IN DIGESTER, A PART OF THE DIGESTER SLUDGE IS RECIRCULATED TO HEAT EXCHANGER ALONG WITH THE FEED SLUDGE. SLUDGE RECIRCULATION PUMPS ARE PROVIDED TO FACILITATE THIS RECIRCULATION.

MIXING FACTOR CONSIDERED	=	3	
FEED SLUDGE FLOW RATE	=	24.00	m^3/h
RECIRCULATION FLOW RATE REQUIRED	=	72.00	m^3/h
NO. OF DUTY PUMPS	**=**	**2**	**Nos.**
NO. OF STANDBY PUMPS	**=**	**2**	**Nos.**
CAPACITY OF PUMP REQUIRED	=	36.00	m^3/h
CAPACITY OF PUMP PROVIDED	**=**	**36.00**	**m^3/h**
TYPE	**=**	**CENTRIFUGAL**	
OPERATION	=	CONTINUOUS	
FLUID HANDLED	=	6 % DIGESTED SLUDGE	
VFD OPERATION	=	NO	

15.8 SLUDGE HEAT EXCHANGER

HEAT REQUIRED FOR FEED SLUDGE	=	139.5	418.4	kW
HEAT LOSS FROM DIGESTER	=	-49.448	157.644	kW
TOTAL HEAT REQUIRED	=	90.052	576.044	kW
SAFETY FACTOR	=	20%	20%	
HEAT EXCHANGER CAPACITY REQUIRED	=	108.1	691.3	kW
HEAT EXCHANGER CAPACITY	=	691.3	kW	

TYPE : PIPE IN PIPE HEAT EXCHANGER

NO. OF UNITS	**=**	**2**	**Nos.**
HEAT EXCHANGER CAPACITY REQUIRED	=	346	kW
HEAT EXCHANGER CAPACITY PROVIDED	**=**	**350**	**kW**

COLD FLUID

FEED SLUDGE FLOWRATE	=	24.00	m^3/h
FEED SLUDGE TEMPERATURE	=	20	^oC
RECIRCULATION SLUDGE FLOWRATE	=	72	m^3/h
RECIRCULATION SLUDGE TEMPERATURE	=	35	^oC
COLD FLUID FEED TEMPERATURE	=	31.25	^oC
COLD FLUID FLOWRATE PER EXCHANGER	=	48	m^3/h

NOTES:

FEED FLOWRATE	=	48	m³/h
SPECIFIC HEAT CAPACITY OF FEED	=	1.162	kWh/(m³.K)
HEAT EXCHANGER CAPACITY	=	350	kW
HENCE, INCREASE IN TEMPERATURE	=	6.28	^{o}C
SLUDGE TEMPERATURE AFTER HEATING	=	37.60	^{o}C

HOT WATER REQUIREMENT

HEAT EXCHANGER CAPACITY	=	350	kW
HOT WATER SUPPLY TEMPERATURE	=	80	^{o}C
HOT WATER RETURN TEMPERATURE	=	60	^{o}C
HOT WATER SPECIFIC HEAT CAPACITY	=	1.162	kWh/(m³.K)
HOT WATER FLOWRATE REQUIRED PER HEAT EXCHANGER	=	15.07	m³/h
TOTAL HOTWATER REQUIRED	=	30.14	m³/h

HEAT EXCHANGER DESIGN SUMMARY

TYPE PIPE IN PIPE HEAT EXCHANGER

NO. OF UNITS	**=**	**2**	**Nos.**
CAPACITY	**=**	**350**	**kW**
		SLUDGE	**HOTWATER**
SUPPLY TEMPERATURE	=	31.25	80.00
RETURN TEMPERATURE	=	37.60	60.00
FLOW RATE	=	48.00	15.50
SPECIFIC HEAT CAPACITY	=	1.162	1.162

15.9 HOT WATER PUMPS

A CLOSED LOOP CIRCUIT IS PROVIDED FOR HOT WATER. HOT WATER PUMPS CIRCULATE THE HOT WATER THROUGH SLUDGE HEAT EXCHANGER AND GAS ENGINE HEAT RECOVERY UNITS.

HOT WATER FLOW RATE REQUIRED	=	30.14	m³/h
NO. OF DUTY PUMPS	**=**	**1**	**No.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	30.14	m³/h
CAPACITY OF PUMP PROVIDED	**=**	**31.00**	**m³/h**
TYPE	**=**	**CENTRIFUGAL**	
OPERATION	=	CONTINUOUS	
FLUID HANDLED	=	HOT WATER (80 deg C)	
VFD OPERATION	=	NO	

NOTES:

15.10 HOT WATER BUFFER TANK

A BUFFER TANK IS PROVIDED AS MAKEUP PROVISION FOR HOT WATER CLOSED LOOP.

HOT WATER FLOWRATE	=	31	m^3/h
RETENTION TIME CONSIDERED	=	5	min
CAPACITY OF TANK REQUIRED	=	2.6	m^3
TYPE	=	**ATMOSPHERIC, CLOSED**	
	=	**INSULATED**	
SHAPE	=	CIRCULAR	
EFFECTIVE LIQUID DEPTH	**=**	**1.50**	**m**
DIA OF THE TANK REQUIRED	=	1.49	m
DIA OF THE TANK PROVIDED	**=**	**1.50**	**m**
FREEBOARD	=	0.30	m
CLEARANCE FOR LOW LEVEL	=	0.20	m
TOTAL DEPTH OF TANK PROVIDED	=	2.00	m
VOLUME OF EACH TANK PROVIDED	=	3.00	m^3

NOTES:

16.0 SLUDGE DEWATERING SECTION

16.1 DIGESTED SLUDGE SUMP

SLUDGE FROM DIGESTER IS COLLECTED IN THIS SUMP AND THEN FED TO CENTRIFUGE

DAILY SLUDGE FLOW RATE	=	548.13	m³/d
HOURLY FLOW RATE OF SLUDGE	=	22.84	Nos.
NO. OF COMPARMENTS	=	2	Nos.
RETENTION TIME	=	6	h
WORKING VOLUME OF EACH COMPARTMENT REQUIRED	=	68.52	m³
TYPE	**=**	**ATMOSPHERIC, OPEN**	
SHAPE	=	RECTANGULAR	
LIQUID DEPTH	**=**	**5.00**	**m**
LENGTH OF THE TANK CONSIDERED	**=**	**3.80**	**m**
WIDTH OF THE TANK REQUIRED	=	3.61	m
WIDTH OF THE TANK PROVIDED	**=**	**3.80**	**m**
VOLUME OF EACH TANK PROVIDED	=	72.20	m³

SLUDGE COLLECTED IN THE TANK WILL BE ALLOWED TO SETTLE. SUPERNATANT WILL BE WITHDRAWN FROM THE SUMP

MASS BALANCE

DIGESTED SLUDGE FLOWRATE	=	548.13	m³/d
TSS IN DIGESTED SLUDGE	=	24542.00	kg/d
TSS IN SUPERNATANT	=	4000	mg/L
DENSITY OF SUPERNATANT	=	1000	kg/m³
CENTRIFUGE FEED CONSISTENCY	=	6%	
DENSITY OF CENTRIFUGE FEED SLUDGE	=	1050	kg/m³

BASED ON ITERATIVE MASS BALANCE ACROSS CENTRIFUGE FEED SUMP

DIGESTED SLUDGE FLOWRATE	=	378.81	m³/d
DIGESTED SLUDGE SOLIDS	=	23866	kg/d

		DIGESTED SLUDGE	CENTRIFUGE FEED	SUPERNATANT
FLOW	m³/d	548.13	378.81	169.32
TSS	mg/L	44774.10	63002.6	3993
	kg/d	24542.00	23866.00	676.00
BOD	mg/L	5229.50	6225.9	3000
	kg/d	2866.40	2358.40	508.00
VSS	mg/L	16425.00	23111.8	1464.79419
	kg/d	9003.00	8754.98	248.02

NOTES:

16.2 DIGESTED SLUDGE SUMP AGITATOR

A LOW SPEED AGITATOR IS PROVIDED IN THE TANK TO KEEP THE SOLIDS IN SUSPENSION.

TYPE	**=**	**LOW SPEED TURBINE**	
		VERTICAL MOUNTED	
NO. OF AGITATOR PER TANK	=	2	Nos.
SIZE OF TANK	**=**	**3.80**	**m**

16.3 CENTRIFUGE FEED PUMP

DAILY SLUDGE FLOW RATE	=	378.81	m³/d
CENTRIFUGE OPERATING HOURS PER DAY	=	16.0	h
CENTRIFUGE OPERATING DAYS PER WEEK	=	7.0	d
NO. OF DUTY PUMPS	**=**	**1**	**No.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	23.68	m³/h
CAPACITY OF PUMP PROVIDED	**=**	**24.00**	**m³/h**
TYPE	**=**	**SCREW**	
OPERATION	=	INTERMITTENT	
FLUID HANDLED	=	6 % DIGESTED SLUDGE	
VFD OPERATION	=	NO	

NOTES:

16.4 CENTRIFUGE

TYPE	**=**	**SOLID BOWL**	
NO. OF DUTY UNITS	**=**	**1**	**No.**
NO. OF STANDBY UNITS	**=**	**1**	**No.**
DESIGN SLUDGE FLOWRATE	=	378.81	m³/d
DESIGN POLYMER FLOW RATE	=	75.20	m³/d
DESIGN HYDRAULIC FLOW	=	454.01	m³/d
OPERATING HOURS PER DAY	=	16.0	h
OPERATING DAYS PER WEEK	=	7.0	d
CAPACITY OF CENTRIFUGE REQUIRED	=	28.38	m³/h
CAPACITY OF CENTRIFUGE PROVIDED	**=**	**29.00**	**m³/h**
DESIGN INLET SOLIDS	=	23866.00	kg/d
SOLIDS HANDLING CAPACITY OF CENTRIFUGE	=	1491.70	kg/h
SOLIDS CAPTURE RATE	=	90%	
DEWATERED CAKE SOLIDS	=	21479.4	kg/d
DEWATERED CAKE CONCENTRATION	=	20%	
DEWATERED CAKE DENSITY	=	1100	kg/m³
DEWATERED CAKE FLOWRATE	=	97.64	m³/d
	=	107.404	T/d

MASS BALANCE

DEWATERED CAKE	=	97.64	m³/d
	=	6.110	m³/h
CENTRATE FLOW RATE	=	356.37	m³/d

		CENTRIFUGE FEED	DEWATERED CAKE	CENTRATE
FLOW RATE	m³/h	23.68	6.11	22.28
	m³/d	378.81	97.64	356.37
TSS	mg/L	63002.60	219985.67	6696.973
	kg/d	23866.00	21479.40	2386.60
BOD	mg/L	6225.90	21738.64	661.785
	kg/d	2358.40	2122.56	235.84
VSS	mg/L	23111.80	3712.26	3712.221
	kg/d	8754.98	7879.49	875.49

NOTES:

16.5 DWPE DOSING SYSTEM

PURPOSE	**=**	**DEWATERING AID**	
CHEMICAL	**=**	**DEWATERING POLYELECTROLYTE**	
FORM	=	DRY POWDER	
COMMERCIAL GRADE CONCENTRATION	=	100%	

DWPE REQUIREMENT

DESIGN SOLIDS TO CENTRIFUGE	=	23866.00	kg/d
DWPE DOSAGE CONSIDERED	=	2.5	kg/T of Solids
HENCE,			
DWPE REQUIRED (100%)	=	59.67	kg/d
DWPE REQUIRED (COMMERCIAL GRADE)	=	59.67	kg/d
SOLUTION CONCENTRATION IN PREPARATION TANK	=	0.20%	
SOLUTION DENSITY	=	1000	kg/m³
SOLUTION VOLUME IN PREPARATION TANK	=	29.835	m³/d

DWPE DOSING TANK

SOLUTION CONCENTRATION IN DOSING TANK	=	0.20%	
DENSITY OF SOLUTION	=	1000	kg/m³
STORAGE VOLUME REQUIRED	=	29.835	m³
NO. OF DUTY UNITS	**=**	**1**	**No.**
NO. OF STANDBY UNITS	**=**	**0**	**No.**
VOLUME OF EACH TANK REQUIRED	=	29.84	m³
TYPE	**=**	**ATMOSPHERIC VERTICAL TANK**	
SHAPE	**=**	**SQUARE**	
LIQUID DEPTH OF TANK PROVIDED	**=**	**3.20**	**m**
SIZE OF TANK PROVIDED	**=**	**3.60**	**m**
FREEBOARD	=	0.30	m
TOTAL DEPTH PROVIDED	=	3.50	m
VOLUME OF EACH TANK PROVIDED	=	41.48	m³

DWPE DOSING TANK AGITATOR

TYPE	**=**	**TURBINE**	
		VERTICAL MOUNTED	
NO. OF AGITATOR PER TANK	=	1	No.
SIZE OF TANK	**=**	**3.60**	**m**
TOTAL DEPTH OF TANK	**=**	**3.50**	**m**

NOTES:

DWPE DOSING PUMPS

DESIGN FLOW RATE	=	1.865	m^3/h
NO. OF DUTY PUMPS	**=**	**1**	**No.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	1865	LPH
CAPACITY OF PUMP PROVIDED	**=**	**2350**	**LPH**
TYPE	**=**	**METERING**	
OPERATION	=	INTERMITTENT	
FLUID HANDLED	=	0.2% DWPE	
VFD OPERATION	=	NO	

PE ONLINE DILUTION UNIT

INLINE DILUTION UNIT IS PROVIDED TO DILUTE THE POLYELECTROLYTE SOLUTION

SOLUTION CONCENTRATION FROM PUMP	=	0.20%	
VOLUMETRIC FLOWRATE FROM PUMP	=	2350	LPH
SOLUTION CONCENTRATION AFTER DILUTION	=	0.10%	
DILUTION RATIO	=	1 : 2	
POWER WATER REQUIRED	=	2350	LPH
VOLUMETRIC FLOWRATE AFTER DILUTION	=	4700	LPH

STORAGE REQUIRED

POLYELECTROLYTE WILL BE RECEIVED IN CARBOUYS.

STORAGE SPACE REQUIRED	=	15	d
CHEMICAL REQUIRED	=	59.67	kg/d
STORAGE REQUIRED	=	895.05	kg
NET WEIGHT OF CARBOUY	=	25	kg
NO. OF CARBOUYS TO BE STORED	=	36	Nos.

NOTES:

17.0 GAS HANDLING SECTION

17.1 BIO GAS HOLDER

BIOGAS HOLDER IS PROVIDED FOR STORAGE OF BIOGAS GENERATED FROM ANAEROBIC DIGESTION

BIOGAS GENERATED	1 atm	20 °C	=	8103.00	m^3/d

TYPE: **MEMBRANE GAS HOLDER**

NO. OF UNITS	**=**	**1**	**No.**
STORAGE TIME REQUIRED	**=**	**25%**	
VOLUME OF EACH GAS HOLDER REQUIRED	=	2026	m^3
VOLUME OF EACH GAS HOLDER PROVIDED	**=**	**2380**	**m^3**
STORAGE TIME PROVIDED	=	7.05	h

DIMENSIONS OF GAS HOLDER TO BE FINALISED AS PER MANUFACTURER STANDARD

17.2 BIO GAS FLARE

BIOGAS FLARE IS PROVIDED FOR FLARING OF EXCESS BIOGAS GENERATED OR DURING EMERGENCY CONDITIONS

TYPE: SELF ASPIRATING TYPE FLARE BURNER, WITH PILOT BURNER, STACK AND IGNITION SYSTEM

NO. OF WORKING UNITS		**=**	**1**	**No.**
NO. OF STANDBY UNITS		**=**	**1**	**No.**
FLARING CAPACITY REQUIRED		=	120%	
CAPACITY OF FLARE REQUIRED	[1 atm , 20 °C]	=	406	m^3/h
CAPACITY OF FLARE PROVIDED	**[1 atm , 20 °C]**	**=**	**425**	**m^3/h**

17.3 BIO GAS BLOWER

BIOGAS BLOWER TRANSFERS THE BIOGAS FROM HOLDER TO GAS ENGINE THROUGH GAS SCRUBBER

TYPE: TWIN LOBE BLOWER

NO. OF WORKING UNITS		**=**	**1**	**No.**
NO. OF STANDBY UNITS		**=**	**1**	**No.**
CAPACITY OF BLOWER REQUIRED	[1 atm , 20 °C]	=	338	m^3/h
CAPACITY OF BLOWER PROVIDED	**[1 atm , 20 °C]**	**=**	**340**	**m^3/h**

NOTES:

17.4 BIO GAS SCRUBBER

A SCRUBBER IS PROVIDED FOR REDUCING THE H2S CONCENTRATION IN THE BIOGAS

TYPE: CHEMICAL SCRUBBER WITH BIOLOGICAL REGENERATION OF CAUSTIC

NO. OF WORKING UNITS		**=**	**1**	**No.**
NO. OF STANDBY UNITS		**=**	**0**	**No.**
CAPACITY OF SCRUBBER REQUIRED	[1 atm , 20 °C]	=	338	m³/h
CAPACITY OF SCRUBBER PROVIDED	**[1 atm , 20 °C]**	**=**	**340**	**m³/h**

17.5 BIO GAS ENGINE

A GAS ENGINE IS PROVIDED TO GENERATE ELECTRICITY FROM BIOGAS

TYPE SINGLE FUEL GAS ENGINE

NO. OF WORKING UNITS			**=**	**1**	**No.**
NO. OF STANDBY UNITS			**=**	**0**	**No.**
CALORIFIC VALUE	1 atm	deg C	=	5200	kCal/m³
			=	6.04	kW/m³
EFFICIENCY OF GAS ENGINE			=	38%	
BIOGAS AVAILABLE		[1 atm , 20 °C]	=	8103.00	m³/d
CAPACITY OF GAS ENGINE REQUIRED			=	775	kWe
CAPACITY OF GAS ENGINE PROVIDED			**=**	**800**	**kWe**

17.6 JACKET HEAT RECOVERY UNIT

TYPE **PLATE HEAT EXCHANGER**

NO. OF UNITS	**=**	**1**	**No.**
ENGINE JACKET HEAT AVAILABLE	**=**	**542**	**kW**
ENGINE HT CIRCUIT FLOW RATE	=	23.3	m³/h
HT CIRCUIT SUPPLY TEMPERATURE	=	90	°C
HT CIRCUIT RETURN TEMPERATURE	=	70	°C
HT CIRCUIT WATER SPECIFIC HEAT CAPACITY	=	1.162	kWh/(m³.K)
HOT WATER SUPPLY TEMPERATURE	=	80	°C
HOT WATER RETURN TEMPERATURE	=	60	°C
HOT WATER SPECIFIC HEAT CAPACITY	=	1.162	kWh/(m³.K)
HOT WATER FLOWRATE	=	23.40	m³/h

NOTES:

JACKET WATER HEAT RECOVERY UNIT SUMMARY

TYPE **PLATE HEAT EXCHANGER**			
NO. OF UNITS	**=**	**1**	**No.**
CAPACITY	**=**	**542**	**kW**
		HT WATER	**HOT WATER**
SUPPLY TEMPERATURE	=	90.00	60.00
RETURN TEMPERATURE	=	70.00	80.00
FLOW RATE	=	23.30	23.40
SPECIFIC HEAT CAPACITY	=	1.162	1.162

17.7 EXHAUST HEAT RECOVERY UNIT

TYPE **FLUE GAS HEAT EXCHANGER**			
NO. OF UNITS	**=**	**1**	**No.**
TOTAL HEAT REQUIRED FOR SLUDGE HEATING	=	700	kW
HEAT AVAILABLE FROM HT CIRCUIT	=	542	kW
HEAT REQUIRED FROM EXHAUST GAS	=	158	kW
HOT WATER SUPPLY TEMPERATURE	=	80	^oC
HOT WATER RETURN TEMPERATURE	=	60	^oC
HOT WATER SPECIFIC HEAT CAPACITY	=	1.162	kWh/(m^3.K)
HOT WATER FLOWRATE	=	6.80	m^3/h
EXHAUST GAS FLOW RATE	=	4238	kg/h
EXHAUST GAS SUPPLY TEMPERATURE	=	466	^oC
EXHAUST HEAT AVAILABLE (COOLED TO 180°C)	=	410	kW

NOTES:

18.0 COMMON FACILITIES

18.1 PLANT WATER SUMP

PLANT WATER SUMP IS PROVIDED TO PUMP DISINFECTED EFFLUENT FOR DISTRIBUTION THROUGHOUT THE PLANT FOR FLUSHING PURPOSES

WATER REQUIRED AS WASH WATER AND FOR FLUSHING PURPOSES	=	35.00	m³/h
(SCREENS, DETRITOR, CLARIFIERS, CENTRIFUGE)			
WATER REQUIRED FOR ONLINE DILUTION FOR CENTRIFUGE	=	2.35	m³/h
TOTAL REQUIREMENT	=	37.35	**m³/h**
DESIGN CAPACITY	=	40	**m³/h**
HYDRAULIC RETENTION TIME PROVIDED	=	15	min
OPERATING VOLUME REQUIRED	**=**	**10**	**m³**
LIQUID DEPTH	**=**	**3.90**	**m**
LENGTH OF THE TANK CONSIDERED	**=**	**2.00**	**m**
WIDTH OF THE TANK REQUIRED	=	1.28	m
WIDTH OF THE TANK PROVIDED	**=**	**1.50**	**m**
VOLUME OF EACH TANK PROVIDED	=	11.70	m³

18.2 PLANT WATER PUMPS

DESIGN FLOW RATE	=	40.00	m³/h
NO. OF DUTY PUMPS	**=**	**1**	**No.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	40.00	m³/h
CAPACITY OF PUMP PROVIDED	**=**	**40.00**	**m³/h**
TYPE	**=**	**HORIZONTAL CENTRIFUGAL**	
OPERATION	=	INTERMITTENT	
FLUID HANDLED	=	TREATED SEWAGE	
VFD OPERATION	=	NO	

NOTES:

18.3 PLANT DRAIN SUMP

PLANT DRAIN SUMP IS PROVIDED TO COLLECT DRAINS AND OVERFLOW FROM VARIOUS PROCESS UNITS TO ARUPARA MAIN PUMPING STATION

DESIGN DRAIN FLOW RATE CONSIDERED	=	25.00	**m^3/h**
HYDRAULIC RETENTION TIME PROVIDED	=	20	min
OPERATING VOLUME REQUIRED	**=**	**8.33**	**m^3**
LIQUID DEPTH	**=**	**3.00**	**m**
DIAMTER OF THE TANK CONSIDERED	**=**	**2.00**	**m**
VOLUME OF EACH TANK PROVIDED	=	9.50	m^3

18.4 PLANT DRAIN PUMPS

DESIGN FLOW RATE	=	25.00	m^3/h
NO. OF DUTY PUMPS	**=**	**1**	**No.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	25.00	m^3/h
CAPACITY OF PUMP PROVIDED	**=**	**25.00**	**m^3/h**
TYPE	**=**	**HORIZONTAL CENTRIFUGAL**	
OPERATION	=	INTERMITTENT	
FLUID HANDLED	=	TREATED SEWAGE	
VFD OPERATION	=	NO	

NOTES:

19.0 ANNEXURES

ANNEXURE - 1 LITERATURE REFERENCES

NOTES:

APPENDIX C KMDA LAND DECLARATION LETTER

CMDA

Kolkata Metropolitan Development Authority

DECLARATION

This is to certify that all the STP facilities in Baranagar, Arupara and Bally under the Namami Gange Mission Project**(Pollution Abatement (Interception and Diversion with STP) Works for River Ganga at Howrah, Bally & Baranagar-Kamarahati Municipal Town in West Bengal Including 15 Years O&M Based on Hybrid Annuity Based PPP Mode)**, and as described in the below table are under the ownership of KMDA and that –

(i) During execution of the project, if it is necessary to acquire any land or ROW and if any re-settlement issues raised then KMDA will short out the said issue as per decision and direction of the Govt. of West Bengal.

(ii) There are no land issues or dispute, grievance or court case raised against these lands by a private individual or corporation in relation to the land area of the STP and its associated infrastructure such as pumping station, lifting station, I&D structures at Baranagar, Bally and Arupara project sites. (or if there are land claims, dispute or court cases, KMDA or Land Revenue Department may just state the status and how these are being addressed.)

STP Locations	Facilities	Ownership
Baranagar	STP is located in Matkol area	KMDA
	Main Pumping Station located at Rabindranath Tagore Road	KMDA
	I&D 1 (Goli Ghat Drain) and I&D 2 (Dhakshineswar Drain) are located in Kamarhati municipality whereas I&D 3 (Lock Gate Drain) and I&D 4 (Old PS drain)	KMDA
Arupara	STPand one MPS located at Dharsh area under HMC,	KMDA
	Ichapur MPSlocated at Ramrajatala on Kamardanga Road	KMDA
	(i) BESU lifting station is located near Shibpur BE College, (ii) Foreshore road lifting station is located in Shibpur, (iii) Roundtank lifting station located at Mullick Fatak on Roundtank lane	KMDA
Bally	Waste Stabilization Pond based STP is located under Bally-Jagacha Block	KMDA
	Lift Stations: (i) Hanuman Jute Mill (LS – 1) on Girish Ghosh Road, (ii) Belur Math (LS – 2), (iii) Bally Khal (LS - 3), (iv) Panchanantala (LS – 4), (v) Saltgola LS – 5, and (vi) Golabari LS – 6	KMDA
	Kona MPS under Bally-Jagacha block	KMDA

Superintending Engineer,
North Circle, GAP Wing,
W & S SECTOR, KMDA.

APPENDIX D DUTCH INTERVENTION VALUE

Soil Remediation Circular 2009

Table 1 Groundwater target values and soil and groundwater intervention values[9]

Concentrations in soil are shown for standard soil (10% organic matter and 25% clay)

Substance	Target value groundwater[7] shallow (< 10 m –gl) (µg/l)	National background concentration groundwater (BC) deep (> 10 m –gl) (µg/l)	Target value groundwater[7] (incl. BC) deep (> 10 m –gl) (µg/l)	Intervention values soil (mg/kg d.s.)	Intervention values groundwater (µg/l)
1 Metals					
Antimony	-	0.09	0.15	22	20
Arsenic	10	7	7.2	76	60
Barium	50	200	200	[8]	625
Cadmium	0.4	0.06	0.06	13	6
Chromium	1	2.4	2.5	-	30
Chromium III	-	-	-	180	-
Chromium VI	-	-	-	78	-
Cobalt	20	0.6	0.7	190	100
Copper	15	1.3	1.3	190	75
Mercury	0.05	-	0.01	-	0.3
Mercury (inorganic)	-	-	-	36	-
Mercury (organic)	-	-	-	4	-
Lead	15	1.6	1.7	530	75
Molybdenum	5	0.7	3.6	190	300
Nickel	15	2.1	2.1	100	75
Zinc	65	24	24	720	800

APPENDIX E ANBIENT AIR QUALITY MONITORING RESULT

Sl. No.	Date of Monitoring	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	CO (mg/m³)	NH3 (µg/m3)	HC as CH4(ppm)	H2S (µg/m3)
AAQ-1, Within the STP facility									
1	18.06.2019 to 19.06.2019	45.8	21.3	6.7	26.3	0.58	14.6	2.23	<10.0
2	22.06.2019 to 23.06.2019	70.2	41.8	7.8	38.5	0.82	22.5	1.5	<10.0
3	26.06.2019 to 27.06.2019	39.4	23.9	6.0	22.8	0.36	10	1.38	<10.0
AAQ-2, Hutpukur Para									
1	18.06.2019 to 19.06.2019	64.4	37.2	7.2	34.6	0.76	17.2	1.72	<10.0
2	22.06.2019 to 23.06.2019	51.4	30.9	6.5	28.8	0.67	13.8	1.59	<10.0
3	26.06.2019 to 27.06.2019	71.7	41.4	7.6	41.6	0.82	21.5	1.19	<10.0
AAQ-3, Police Training Ground									
1	18.06.2019 to 19.06.2019	52.6	30.1	6.8	30.7	0.63	16.3	1.73	<10.0
2	22.06.2019 to 23.06.2019	42.4	28.8	6.0	25.3	0.48	<10.0	2.94	<10.0
3	26.06.2019 to 27.06.2019	30.8	18.4	6.0	21.9	0.27	<10.0	2.05	<10.0

APPENDIX F AMBIENT NOISE QUALITY MONITORING RESULTS

Location code		N-1	N-2	N-3	N-4
Location Name		Within the STP Facility	At the gate of STP near Arupara Road	Police Training Facility	Hatpukur Para
Time (in Hrs.)	(06.00-07.00) hrs	48.2	53.9	52.7	50.8
	(07.00-08.00) hrs	49.7	50.7	51.9	52.4
	(08.00-09.00) hrs	49.8	55	53.5	55.2
	(09.00-10.00) hrs	50.2	56.7	62.7	60.1
	(10.00-11.00) hrs	52.5	60.6	58.8	58.9
	(11.00-12.00) hrs	52.3	63.5	62.9	61.2
	(12.00-13.00) hrs	52.1	63.8	64.9	60.7
	(13.00-14.00) hrs	52.6	70.7	66.8	59.1
	(14.00-15.00) hrs	45.3	64.9	66.2	56.3
	(15.00-16.00) hrs	47.2	63.5	67.4	57.2
	(16.00-17.00) hrs	46	64	66.3	57.3
	(17.00-18.00) hrs	49.2	62.6	57.5	54.1
	(18.00-19.00) hrs	48.7	61.2	55.4	51.8
	(19.00-20.00) hrs	48.8	56.6	53.5	52.4
	(20.00-21.00) hrs	49.1	53.7	53.4	49.3
	(21.00-22.00) hrs	49.9	51.7	56.4	53.3
	(22.00-23.00) hrs	52.4	50.3	48.5	47.2
	(23.00-00.00) hrs	48.8	49.1	48.8	45.3
	(00.00-01.00) hrs	45.7	46.3	44.1	42.6
	(01.00-02.00) hrs	45.8	46.5	37	41.3
	(02.00-03.00) hrs	46.5	47.3	38.5	39.6
	(03.00-04.00) hrs	46.7	48.6	37.2	40.3
	(04.00-05.00) hrs	46.2	49.7	40.5	40.2
	(05.00-06.00) hrs	48.3	52.6	44.1	42.6

APPENDIX G CPCB DESIGNATED BEST USE WATER QUALITY CRITERIA

Designated Best Use Water Quality Criteria

Designated-Best-Use	Class of water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	Total Coliforms Organism MPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6mg/l or more Biochemical Oxygen Demand 5 days 20C 2mg/l or less
Outdoor bathing (Organised)	B	Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more Biochemical Oxygen Demand 5 days 20C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more Biochemical Oxygen Demand 5 days 20C 3mg/l or less
Propagation of Wild life and Fisheries	D	pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH betwwn 6.0 to 8.5 Electrical Conductivity at 25C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/l

Traceability: https://cpcb.nic.in/wqstandards/

APPENDIX H TRAFFIC MONITORING DATA

LOCATION : Arupara Road -Up							PCU
SL. NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	Total	
		Heavy Motor Vehicles	Light Motor Vehicles	Two/Three Wheelers	VEHICLES		
	(Hours)	(Truck, Bus,Dumper, Tanker, Trailer)	(Car,Jeep,Van, Metador, Tractor,Tempo)	(Scooter,M.Cycle,Auto, Moped)	Bicycle, Tricycle	Numbers	
1	09.00-10.00	0	4	5	6	15	10.75
2	10.00-11.00	0	3	4	4	11	8
3	11.00-12.00	0	4	3	5	12	8.75
4	12.00-13.00	0	2	4	4	10	7
5	13.00-14.00	0	1	3	4	8	5.25
6	14.00-15.00	0	0	3	5	8	4.75
7	15.00-16.00	0	2	5	8	15	9.75
8	16.00-17.00	0	1	6	7	14	9
9	17.00-18.00	0	0	4	6	10	6
10	18.00-19.00	0	0	3	3	6	3.75
11	19.00-20.00	0	0	2	4	6	3.5
12	20.00-21.00	0	0	1	2	3	1.75
13	21.00-22.00	0	0	1	1	2	1.25
14	22.00-23.00	0	0	0	0	0	0
15	23.00-00.00	0	0	0	0	0	0
16	00.00-1.00	0	0	0	0	0	0
17	1.00-2.00	0	0	0	0	0	0
18	2.00-3.00	0	0	0	0	0	0
19	3.00-4.00	0	0	0	0	0	0
20	4.00-5.00	0	0	0	1	1	0.5
21	5.00-6.00	0	0	0	2	2	1
22	6.00-7.00	0	0	2	4	6	3.5
23	7.00-8.00	0	1	3	5	9	5.75
24	8.00-9.00	0	0	4	6	10	6
Total Numbers		**0**	**18**	**53**	**77**	**148**	**96.25**

LOCATION Arupara Road -Down								PCU
SL. NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	Total		
		Heavy Motor Vehicles	Light Motor Vehicles	Two/Three Wheelers	VEHICLES			
	(Hours)	(Truck, Bus,Dumper, Tanker, Trailer)	(Car,Jeep,Van, Metador, Tractor,Tempo)	(Scooter,M.Cycle,Auto, Moped)	Bicycle, Tricycle	Numbers		
1	09.00-10.00	0	2	5	3	10		7.25
2	10.00-11.00	0	3	4	2	9		7
3	11.00-12.00	0	2	5	3	10		7.25
4	12.00-13.00	0	2	4	2	8		6
5	13.00-14.00	0	2	3	4	9		6.25
6	14.00-15.00	0	0	4	4	8		5
7	15.00-16.00	0	1	2	3	6		4
8	16.00-17.00	0	1	3	3	7		4.75
9	17.00-18.00	0	0	4	4	8		5
10	18.00-19.00	0	3	3	3	9		6.75
11	19.00-20.00	0	2	4	1	7		5.5
12	20.00-21.00	0	1	3	2	6		4.25
13	21.00-22.00	0	0	2	1	3		2
14	22.00-23.00	0	0	0	0	0		0
15	23.00-00.00	0	0	0	0	0		0
16	00.00-1.00	0	0	0	0	0		0
17	1.00-2.00	0	0	0	0	0		0
18	2.00-3.00	0	0	0	0	0		0
19	3.00-4.00	0	0	0	0	0		0
20	4.00-5.00	0	0	0	0	0		0
21	5.00-6.00	0	0	2	4	6		3.5
22	6.00-7.00	0	1	3	3	7		4.75
23	7.00-8.00	0	1	3	5	9		5.75
24	8.00-9.00	0	3	4	3	10		7.5
Total Numbers		**0**	**24**	**58**	**50**	**132**		**92.5**

APPENDIX I HOUSEHOLD SOCIO-ECONOMIC SURVEY FORMAT

Household Socio-Economic Survey – ESIA, KMDA Sewerage Project

Questionnaire No.				STP Location:	Baranagar ☐ Bally ☐ Arupara ☐				
Date				Facility wise Component					
Name of Investigator				Name of Respondent					
Name of the Municipality /GP:				Relationship with HOH					
Municipal/ GP Ward No.:				HOH	Male ☐ Female ☐				
Name of Para/Hamlet:				Total No. of Family Members					
Caste:	General ☐	SC ☐	ST ☐	OBC ☐	Religion:	Hindu ☐	Muslim ☐	Christian ☐	Sikh ☐ Others ☐

Family Member Details (List Details of All Family Members)													
Relationship with Responde													**Codes: M**-Mother, **F**-Father, **W**- Wife, **HU –** Husband, **D**-Daughter, **S** Law, **DIL**-Daughter -in-Law, **GS**- Grandson, **GD**-Grand-daughter, **BIL** Niece, **NP**-Nephew, **O** – Other specify
Age													
Sex													**Code: M**-Male, **F**-Female
Marital Status													**Codes**: **M**-Married, **UM**- Unmarried, **D**-Divorced/Separated, **W**-Widow
Educational Qualification													**Codes: IL**-Illiterate, **FL**-Functionally Literate, **P**-Primary, **UP**-Upper Pr Secondary, **G**-Graduation, **PG**-Post Graduation
Continuing Education (Yes													**Y**-Yes, **N**-No
Does the member suffer fr													**Codes: ND**-No Disability, **M**-Mental, **V**-Visual, **S**-Speech, **L**-Locomoto
Primary Occupation of Working Members of the Family													
Primary Occupation													**Codes: F**-Farmer, **AL**- Agricultural Labour, **DL**- Daily Labour, **LO**- La Rural Artisan, **SG**-Service (Govt.), **SP –** Service (Private), **UE**-Unem Trading, **C –** Commercial business, shops etc. **CU –** Cultivator, **SC –** Husbandry, **HW –** Small-scale Household Industry**, UFW –** Unpaid Fa to work
Approximate Income (Per family member (in INR)													
Secondary Occupation of Working Members of the Family													
Secondary Occupation													**Codes: F**-Farmer, **AL**- Agricultural Labour, **DL**- Daily Labour, **LO**- La Rural Artisan, **SG**-Service (Govt.), **SP –** Service (Private), **UE**-Unem Trading, **C –** Commercial business, shops etc. **CU –** Cultivator, **SC –** Husbandry, **HW –** Small-scale Household Industry**, UFW –** Unpaid Fa
Approximate Income (Per family member (in INR)													

Approximate Family Income (Per Month/ Annum) (in INR)						
General Details						
Status of accommodation (house/ shop)		**Codes: O**-Owned, **R**-Rented, **S-** Squatter, **E -** Encroacher				
Quality of Life						
Electricity	Yes □	No □	Any other light source, specify: Solar □ Kerosene □ Bio-gas □ Others □			
Source of Drinking Water	Pond □ Well □	Tap Water □	Tube Well/Deep Tube	Khal (Canal) □	Other □ Specify-	
Drinking water source	Own □			Shared □		
Source of Water for Dome washing/ bathing)	Pond □ Well □	Tap Water □	Tube Well/ Deep Tube	Khal (Canal) □	Other Specify □	
Sanitation Arrangement	Open defecation □	Non-sanitary/ *Kutcha* □		Sanitary non-wate	Sanitary with water sealed □	
Soak pit □	Septic tank □	Public Toilet □	Open drain/nearby open are		Any other, specify……………………….	
Fuel for cooking/heating	Coal □	Gul □	Firewood □	LPG □	Kerosene □	Other Specify □
	Bio-gas □	Dried Cow dung with straw, leafs □				
Residence details						
Typology of Housing/Accomm	**Roof**	**Wall**		**Floor**	**Boundary**	
	RCC □	Brick/ Cement □	Tin (GI She	Mud/ cow dung □	Bricks/cement □	
	Straw/ bamb	Mud/ un--burnt Bricks □		Wood /bamboo □	Barbed Wire □ Mud wall □	
	Tin (GI Sheet	Straw/ bamboo/ polythene/pl		Brick /Cement □	Vegetation □	
	Tally □	Wood □		Floor Tiles □	Dry Wood □	
	Others, speci	Others, specify		Other, specify	No Boundary □	
House/ shop structure	Kutcha □	Semi-pucca □		Pucca □		
What are the movable assets	Refrigerator □	Television □	Cable TV/DTH con	Cycle □	Three-Wheeler □	
	Bike/Two-wh	Mobile/Telephone □	Computer □	Sewing Machine □	Ceiling Fan □	
	Water Pump	Mixer/Grinder □	Radio □	Others □ Specify-		
Access to Social Amenities						
Are there Primary Schools nearby (within 1 – 1.5 km)	Yes □	No □				
Are there Secondary Schools nearby	Yes □	No □				
Are there Colleges nearby	Yes □	No □				

Are there Hospitals nearby	Private Hospital □	Govt. Hospital □	Other specify....................	None □
When you experience a health problem, which he	Private Hospital □		Govt. H	Other specify..............
Do any household members have any permanent	Yes □ (if yes explain by giving the member co		Asthma □ Breathing problem □ Cancer □ Diabetes □ Diarrhoea □	
	No □		Any other, specify…………	
Did any of the household members suffer from any water borne diseases within the last 12 months?				
Yes □ (if yes explain by giving the member code)		No □		
Do the locality faces water-logging situation frequently in the last one year? …………………………………………………………………………. ………..				
Did any of the family members suffer from any vector borne diseases or water borne diseases in last three months? ………. ……….				
Did you get any foul smell due to STP operations? Yes □ No □				

Signature of the Respondent

APPENDIX J QUALITATIVE RISK ASSESSMENT FOR CHLORINE TONNER STORAGE

1. Risk Assessment – Chlorine Tonner Storage

This section on Risk Assessment (RA) aims to provide a systematic analysis of the major risks that may arise from storage of chlorine tonner as part of the expansion of the existing wastewater treatment plant at Arupara by GSPPL.
The RA process outlines rational evaluations of the identified risks based on their significance and provides the outline for appropriate preventive and risk mitigation measures. The output of the RA will contribute towards strengthening of the Emergency Response Plan (ERP) in order to prevent damage to personnel, infrastructure and receptors in the immediate vicinity of the plant. Additionally, the results of the RA can also provide valuable inputs for keeping risk at As Low As Reasonably Practicable (ALARP) and arriving at decisions for mitigation of high risk events.

1.1. RA - Methodology

The risk assessment process is primarily based on likelihood of occurrence of the risks identified and their possible hazard consequences particularly being evaluated through hypothetical accident scenarios. With respect to the proposed project, major risks viz. leaks from chlorine tonners is evaluated through a risk matrix generated to combine the risk severity and likelihood factor. Risk associated with the chemical storages have been determined semi-quantitatively as the product of likelihood/probability and severity/consequence by using order of magnitude data (*risk ranking = severity/consequence factor X likelihood/probability factor*). Significance of such project related risks was then established through their classification as high, medium, low, very low depending upon risk ranking.

1.2. Chlorine Storage Details & Associated Hazards

The details of chlorine tonner storage for the proposed expansion project is presented in the **Table 1.1** below.

Table 1.1: Chlorine Tonner Details

Sl. No.	Component	Value
1	Tank Type	Tonner
2	Diameter (m)	0.8
3	Height (m)	2.0
4	Storage (kg)	780
5	Pressure (kg/cm2)	Ambient
6	Temperature (degree C)	Ambient

For chlorine to be stored and handled for the proposed project, the following hazards have been identified and presented in **Table 1.2** below. For the hazard rating of the toxic chemicals to be used for the proposed project, the National Fire Protection Agency (NFPA) 704 rating system has been used. Chemical substances are rated for degree of HEALTH RISK, FLAMMABILITY and REACTIVITY, on a scale of 0 to 4 as described below
Health Risk

- Level 4 – Can affect health or cause serious injury, during periods of very short exposure, even though prompt medical treatment is given.

- Level 3 – Can affect health or cause serious injury, during periods of short exposure, even though prompt medical treatment is given.
- Level 2 – Can cause incapacitation or residual injury, during intense or continued exposure, unless prompt medical treatment is provided.
- Level 1 – Cause irritation upon exposure, but only minor injury is sustained even if no medical treatment is provided.
- Level 0 – Offer no unusual hazards upon exposure to fire conditions.

Flammability

- Level 4 – Completely vaporize at normal pressure and temperature and burn readily.
- Level 3 – Liquids and solids that can be ignited under the most ambient conditions.
- Level 2 – Must be moderately heated before ignition can occur.
- Level 1 – Must be strongly heated before ignition will occur.
- Level 0 – Will not burn.

Reactivity

- Level 4 – Capable of explosive decomposition at normal temperatures and pressure.
- Level 3 – Easily capable of explosive decomposition, but require an ignition source or will react explosively with water.
- Level 2 – Easily undergo a violent reaction, but do not explosively decompose.
- Level 1 – Normally stable, but become explosive at elevated temperatures and pressure.
- Level 0 – Stable even under exposure to fire.

Table 1.2: Hazards of Chlorine

Sl. No.	Component	Value
1	NFPA Hazard Rating - Health	4
2	NFPA Hazard Rating - Flammability	0
3	NFPA Hazard Rating - Reactivity	0
4	Toxicity	High toxic chemical with life threatening health effects likely to be experienced at a concentration of 20ppm and above for an hour of exposure (AEGL-3).

Source: https://cameochemicals.noaa.gov/ and **https://www.epa.gov/aegl/access-acute-exposure-guideline-levels-aegls-values#chemicals**

1.3. Chlorine Storage Failure – Frequency Analysis

The frequency analysis of the hazards identified with respect to the proposed project was undertaken to estimate the likelihood of their occurrences during the project life cycle. Hazard frequencies in relation to the proposed project were estimated based on the analysis of historical accident frequency data and professional judgment. Based on the range of probabilities arrived at for different potential hazards that may be encountered with respect to the storage and handling of flammable and toxic chemicals including fuel with respect to the expansion project, the following frequency categories and criteria have been defined (Refer **Table 1.3**)

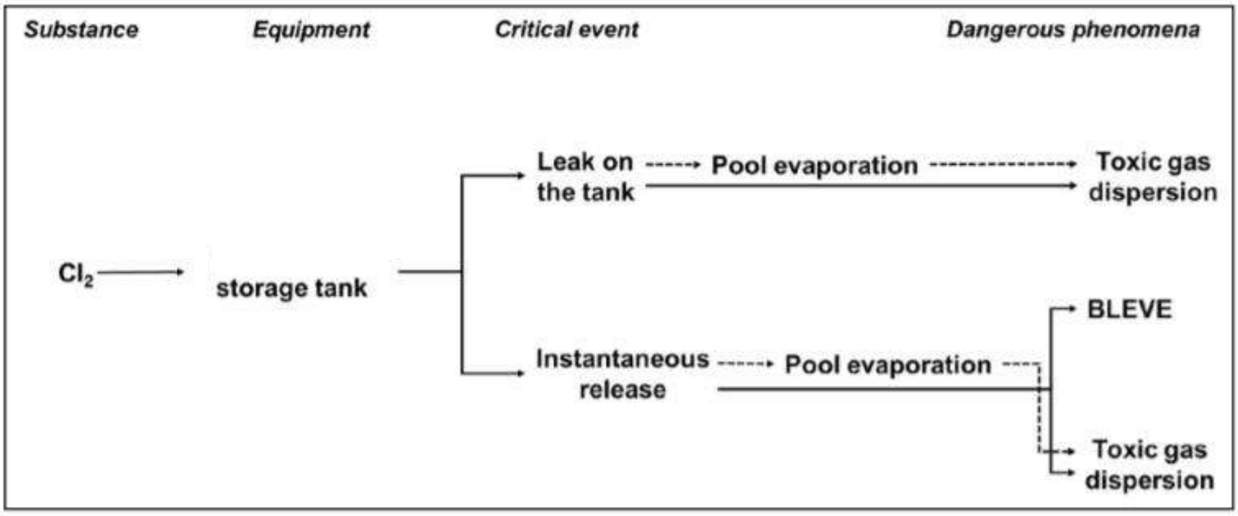
Table 1.3: Frequency Categories and Criteria

Likelihood Ranking	Criteria Ranking (cases/year)	Frequency Class
5	Likely to occur often in the life of the project, with a probability greater than 10^{-1}	Frequent
4	Will occur several times in the life of project, with a probability of occurrence less than 10^{-1}, but greater than 10^{-2}	Probable
3	Likely to occur sometime in the life of a project, with a probability of occurrence less than 10^{-2}, but greater than 10^{-3}	Occasional/Rare
2	Unlikely but possible to occur in the life of a project, with a probability of occurrence less than 10^{-3}, but greater than 10^{-6}	Remote
1	So unlikely it can be assumed that occurrence may not be experienced, with a probability of occurrence less than 10^{-6}	Improbable

Source: Guidelines for Developing Quantitative Safety Risk Criteria – Centre for Chemical Process and Safety

The most credible scenario of chlorine tonner will be toxic vapour cloud dispersion. Event tree analysis (ETA) for chlorine release (both from leak and instantaneously) indicates formation of chlorine pool, followed by evaporation and toxic gas dispersion (Refer **Figure 1.1**).

Figure 1.1: Event Tree Analysis – Chlorine Tank Failure



In order to determine the probability of a toxic vapour cloud occurring, the failure rate needs to be modified by the probability of the material finding an ignition source. The probability of any of the aforesaid incident occurring in the event of a release is therefore equal to the product of the failure rate and the probability of ignition. The frequency of the possible release scenarios has been presented in Table 1.4 below.

Table 1.4: Chlorine Storage – Failure Rate

Sl. No.	Release Type	Failure Rate (per vessel year)	Frequency Rating
1	Catastrophic	2×10^{-6}	Remote
2	50mm diameter hole	5×10^{-6}	Remote
3	25mm diameter hole	5×10^{-6}	Remote
4	13mm diameter hole	1×10^{-5}	Remote
5	6mm diameter hole	4×10^{-5}	Remote

Source: http://www.hse.gov.uk/landuseplanning/failure-rates.pdf

1.4. Chlorine Storage Failure – Consequence Analysis

In parallel with the frequency analysis, hazard prediction / consequence analysis exercises were undertaken to assess the likely impact of project related risks on onsite personnel, infrastructure and environment. In relation to the proposed project as well as the existing activities have been considered, the estimation of the consequences for each possible event has been based on either accident frequency, consequence modeling or professional judgment, as appropriate. Overall, the consequence analysis takes into account the following aspects:

- Nature of impact on environment and community;
- Occupational health and safety;
- Asset and property damage;
- Corporate image; and
- Timeline for restoration of property damage.

The following criteria for consequence rankings (Refer **Table 1.5**) have been drawn up in context of the possible consequences of the risk events that may occur during the proposed project operations:

Table 1.5 Severity Categories and Criteria

Consequence	Ranking	Criteria Definition
Catastrophic	5	• Multiple fatalities/permanent total disability to more than 50 persons. • Net negative financial impact of >10 crores • International media coverage • Loss of corporate image and reputation
Major	4	• Single fatality/permanent total disability to one or more persons • Net negative financial impact of 5 -10 crores

Consequence	Ranking	Criteria Definition
		• National stakeholder concern and media coverage.
Moderate	3	• Short term hospitalization & rehabilitation leading to recovery • Net negative financial impact of 1-5 crores • State wide media coverage
Minor	2	• Medical treatment injuries • Net negative financial impact of 0.5 – 1 crore • Local stakeholder concern and public attention
Insignificant	1	• First Aid treatment • Net negative financial impact of <0.5 crores. • No media coverage

Risk Evaluation

Based on ranking of likelihood and frequencies, each identified hazard has been evaluated based on the likelihood of occurrence and the magnitude of consequences. The significance of the risk is expressed as the product of likelihood and the consequence of the risk event, expressed as follows:

Significance = Likelihood X Consequence

The **Table 1.6** below illustrates all possible product results for the five likelihood and consequence categories while the **Table 1.7** assigns risk significance criteria in three regions that identify the limit of risk acceptability. Depending on the position of the intersection of a column with a row in the risk matrix, hazard prone activities have been classified as low, medium and high thereby qualifying for a set of risk reduction / mitigation strategies.

Table 1.6 Risk Matrix

			Likelihood →				
			Frequent	**Probable**	**Unlikely**	**Remote**	**Improbable**
			5	**4**	**3**	**2**	**1**
Consequence →	**Catastrophic**	**5**	25	20	15	10	5
	Major	**4**	20	16	12	8	4
	Moderate	**3**	15	12	9	6	3
	Minor	**2**	10	8	6	4	2
	Insignificant	**1**	5	4	3	2	1

Table 1.7 Risk Criteria and Action Requirements

S.N.	Risk Significance	Criteria Definition & Action Requirements
1	High (16 – 25)	**"Risk requires attention"** – Project HSE Management need to ensure that necessary mitigation are adopted to ensure that possible risk remains within acceptable limits

S.N.	Risk Significance	Criteria Definition & Action Requirements
2	**Medium (10 – 15)**	**"Risk is tolerable"** – Project HSE Management needs to adopt necessary measures to prevent any change/modification of existing risk controls and ensure implementation of all practicable controls.
3	**Low (5 – 9)**	**"Risk is acceptable"** – Project related risks are managed by well-established controls and routine processes/procedures. Implementation of additional controls can be considered.
4	**Very Low (1 – 4)**	**"Risk is acceptable"** – All risks are managed by well-established controls and routine processes/procedures. Additional risk controls need not to be considered

1.4.1. Consequence Analysis – Chlorine Tonner

The main hazards associated with the storage and handlings of chlorine with respect to the proposed project are toxic vapour cloud resulting from the leak/failure of tonners. The hazards may be realised following tank overfilling and leaks/failures in the storage tank and ancillary equipment such as transfer pumps, metering equipment, etc. all of which can release significant quantities of toxic material on failure.

Risk Modelling Scenarios

In addition to overfill, the scenarios considered for chlorine tonner were leaks and catastrophic failures. Factors that have been identified as having an effect on the integrity of tanks are related to design, inspection, maintenance, and corrosion[1]. The following representative scenarios for the tanks were considered (Refer **Table 1.8**).

Table 1.8 Chlorine Tonner – Risk Modelling Scenarios

S.No	Chemical Name	Total Storage (kg)	Event	Scenario
1	Chlorine	780	Toxic gas release	2.5mm leak
2			Toxic gas release	5mm leak
3			Toxic gas release	10mm leak (worst case scenario)

The chemical storage tank and container failure scenarios have been modeled using ALOHA and interpreted in terms of Toxic Level of Concern (LOC) encompassing the following threshold values (measured in kilowatts per square meter) and ppm respectively to create the default threat zone.

Toxic Level of Concern

Toxic Level of Concern has been interpreted in the form of Acute Exposure Level Guidelines (AEGLs) and Emergency Response Planning Guidelines (ERPGs) calculated for– 60 minutes. AEGL "levels" are dictated by the severity of the toxic effects caused by the exposure, with Level 1 being the least and Level 3 being the most severe. All levels are expressed as parts per million or milligrams per cubic meter (ppm or mg/m^3) of a substance above which it is predicted that the general population could experience, including susceptible individuals:

AEGL-1 (Yellow): *Notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure;*

[1] AEA Technology, HSE Guidance Document

AEGL-2 (Orange): *Irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape; and*

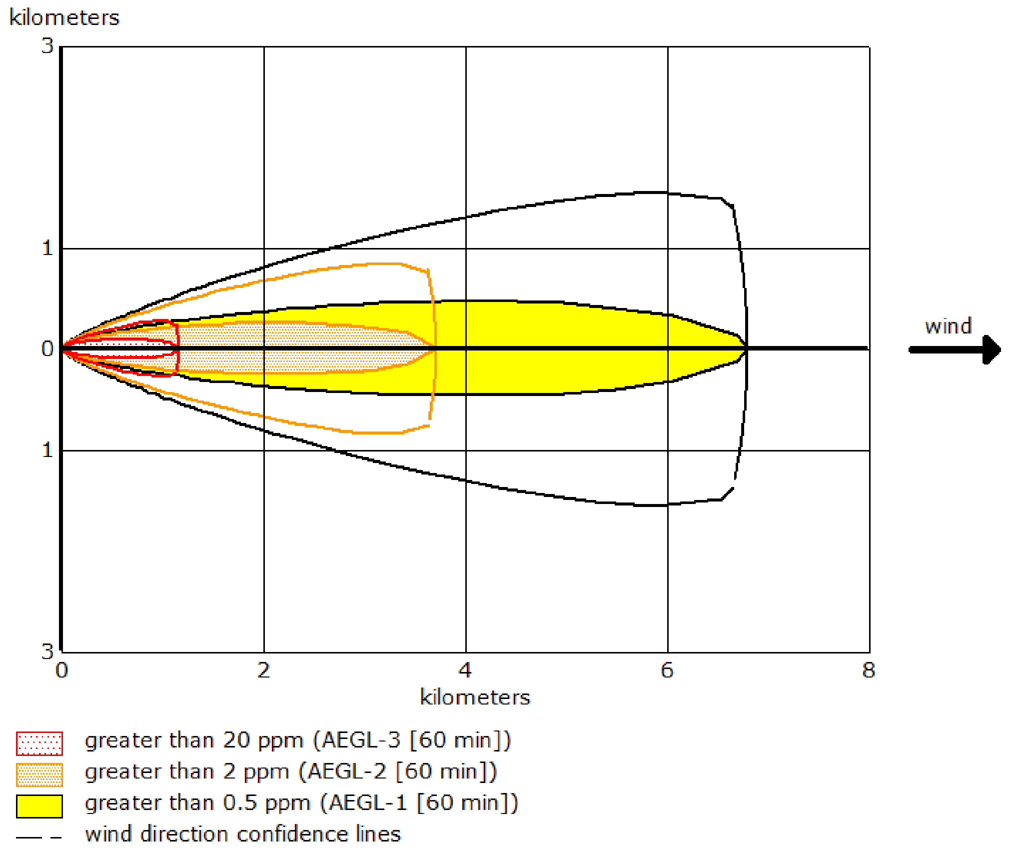
AEGL-3 (Red): *Life-threatening health effects or death.*

The risk contours for hypothetical risk scenarios considered for chlorine storage have been have been presented in **Figure 1.2** to **Figure 1.4** below.

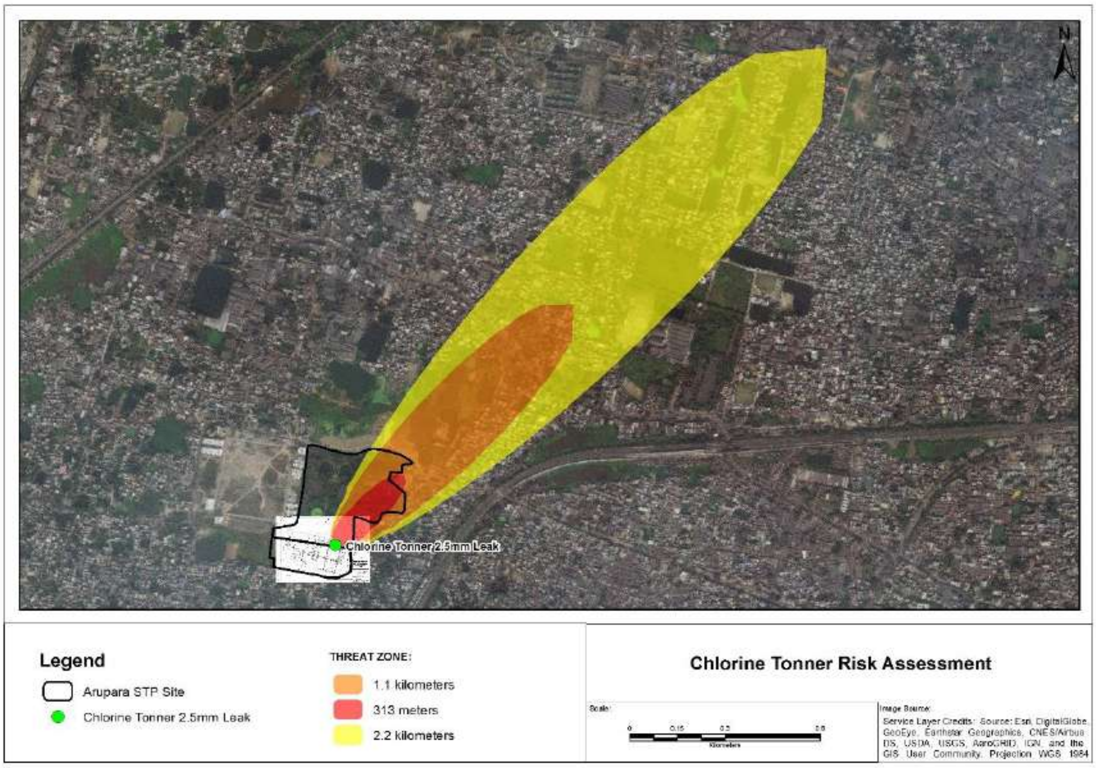
Scenario 1: Chlorine Tonner – 2.5 mm leak

The toxic vapour threat zone plot for chlorine tonner leak of 2.5mm is represented in **Figure 1.2** below.

Figure 1.2: Threat Zone Plot – Chlorine Tonner (2.5mm leak)



Source: ALOHA



THREAT ZONE:

Threat Modeled: Toxic Level of Concern

Model Run: Gaussian

Red : 1200 meters --- (20 ppm = AEGL-3 [60 min])

Orange: 3700 meters --- (2 ppm = AEGL-2 [60 min])

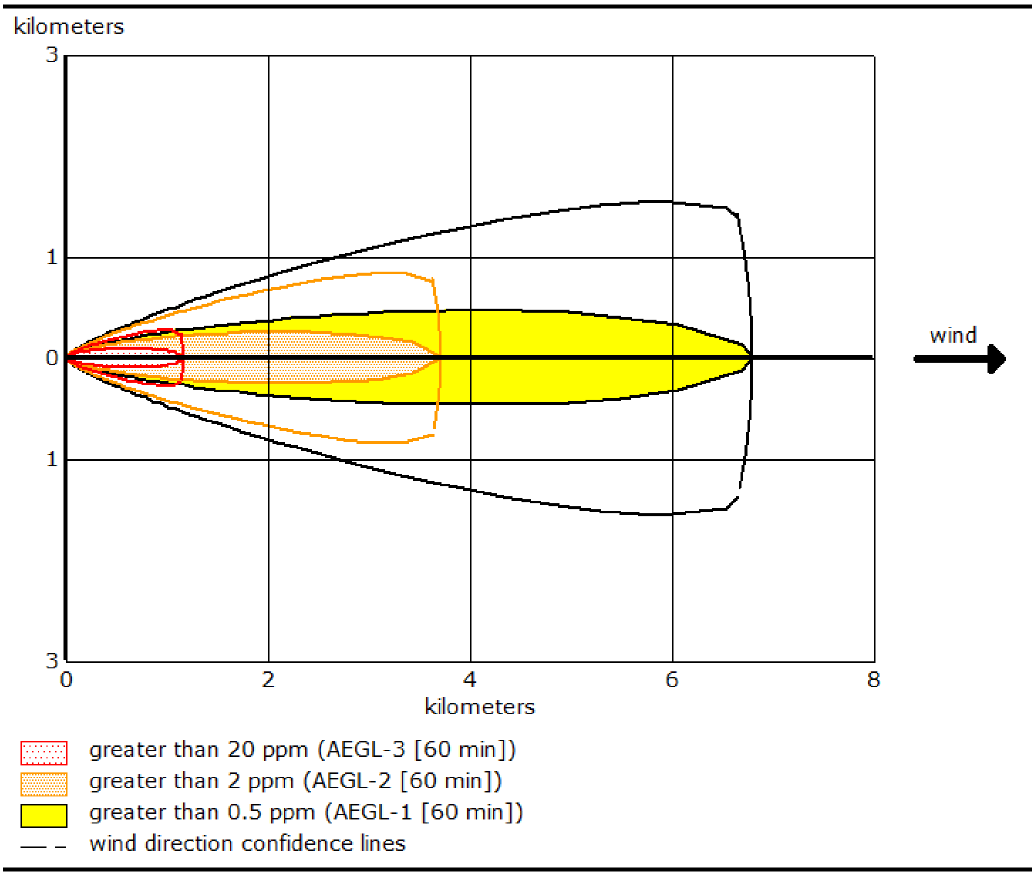
Yellow: 6800 meters --- (0.5 ppm = AEGL-1 [60 min])

The maximum effect resulting from failure of chlorine tonner (2.5mm leak) will be experienced within a maximum radial distance of 1200m from the source with potential lethal effects within 1 hour.

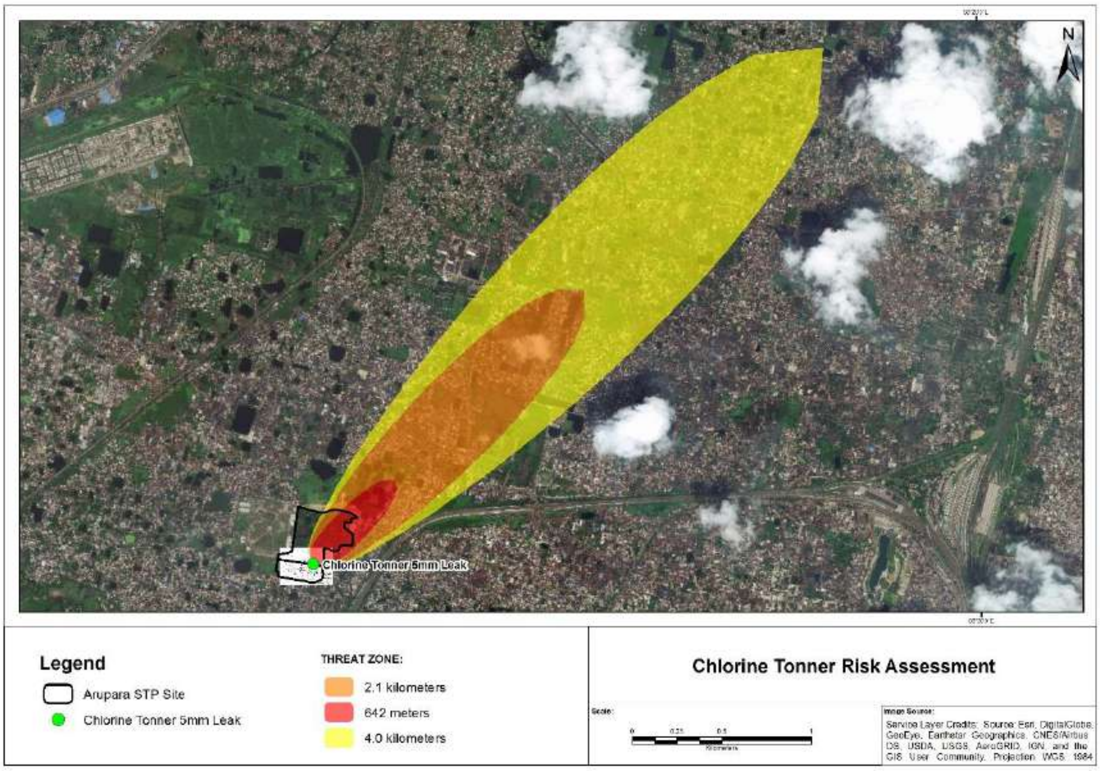
Scenario 2: Chlorine Tonner – 5 mm leak

The toxic vapour threat zone plot for chlorine tonner leak of 5mm is represented in **Figure 1.3** below.

Figure 1.3: Threat Zone Plot – Chlorine Tonner (5mm leak)



Source: ALOHA



THREAT ZONE:

Threat Modeled: Toxic Level of Concern

Model Run: Gaussian

Red : 1200 meters --- (20 ppm = AEGL-3 [60 min])

Orange: 3700 meters --- (2 ppm = AEGL-2 [60 min])

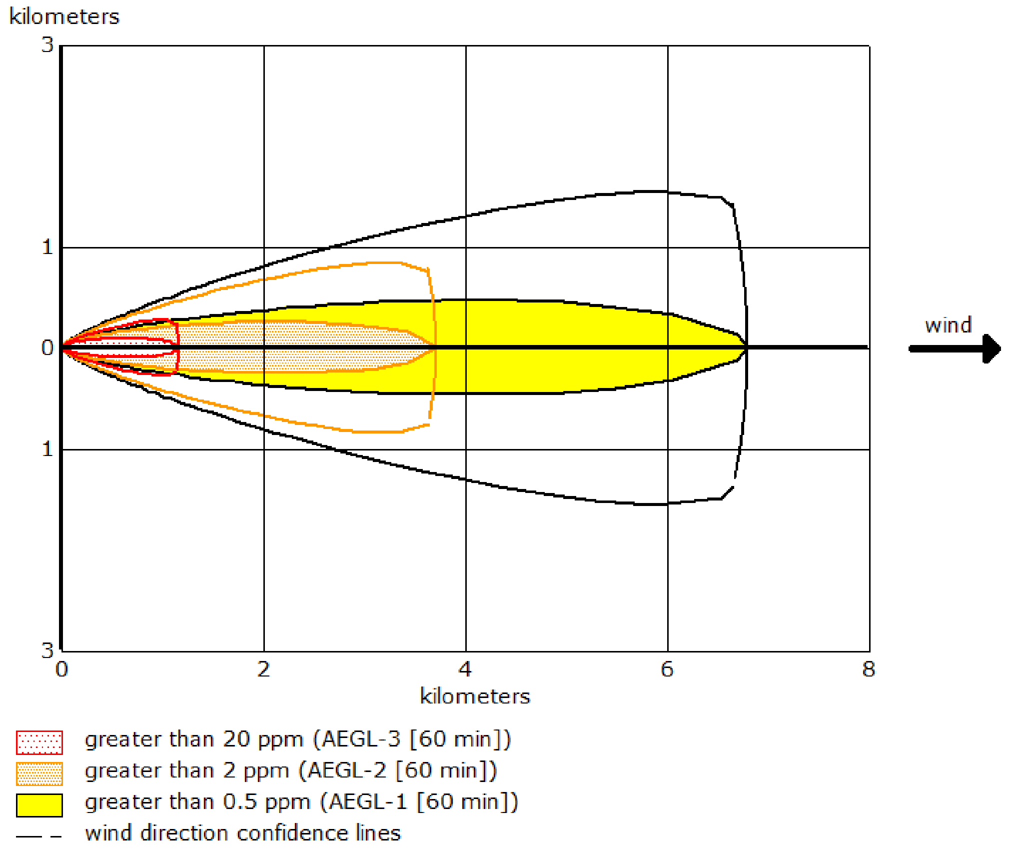
Yellow: 6800 meters --- (0.5 ppm = AEGL-1 [60 min])

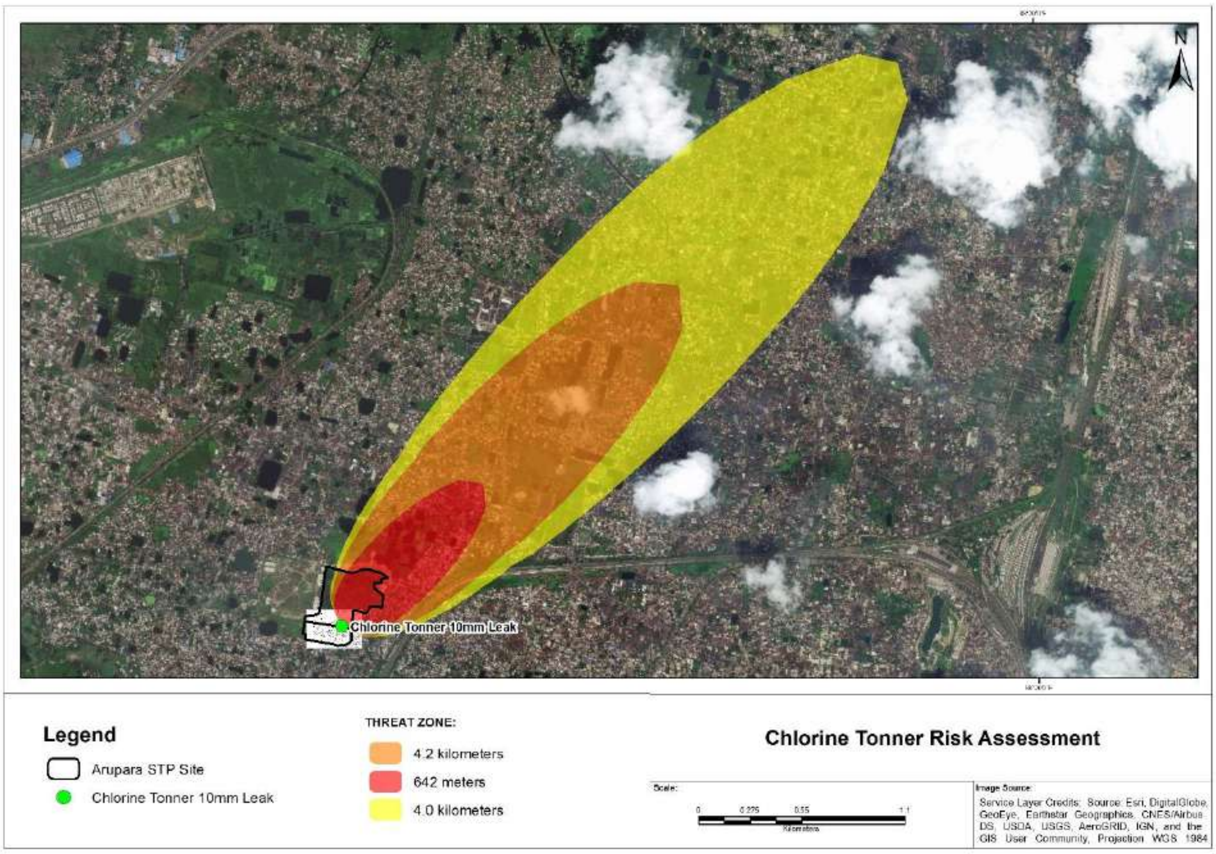
The maximum effect resulting from failure of chlorine tonner (5mm leak) will be experienced within a maximum radial distance of 1200m from the source with potential lethal effects within 1 hour.

Scenario 2: Chlorine Tonner – 10 mm leak (Worst Case)

The toxic vapour threat zone plot for chlorine tonner leak of 10mm (worst case) is represented in **Figure 1.4** below.

Figure 1.4: Threat Zone Plot – Chlorine Tonner (10mm leak – Worst Case)





Source: ALOHA

THREAT ZONE:

Threat Modeled: Toxic Level of Concern

Model Run: Gaussian

Red : 1200 meters --- (20 ppm = AEGL-3 [60 min])

Orange: 3700 meters --- (2 ppm = AEGL-2 [60 min])

Yellow: 6800 meters --- (0.5 ppm = AEGL-1 [60 min])

The maximum effect resulting from catastrophic failure of chlorine tonner (10mm leak) will be experienced within a maximum radial distance of 1200m from the source with potential lethal effects within 1 hour.

1.5. Quantitative Risk Assessment (QRA)

A QRA has been undertaken using a standard procedure in order to estimate a numerical value for risk to people, by combining the frequency of accident occurence with the consequence of damage, leading to loss of life. For quantitative estimation of risk, 3 potential release scenario's – Catastrophic, 13 mm Hole and 6 mm Hole was considered with corresponding failure rates being 4×10^{-6}, 1×10^{-5} and 4×10^{-5} respectively, as per UK HSE database (refer Table 1.4 above). To account for event probability, the assumption was made that wind direction in any given quadrant of 45º is equal with 12.5% chance of the plume to fall in any given quadrant.

The severity of accident scenarious have been re-estimated in terms of fatalities that may be caused by exposure to toxic Chlorine gas, with the reference damage assuming the deat of a normal non-protected person. The following Probit equation has been used to estimate the likelihood of fatality due to exposure to Chlorine: **$Pr = -6.35 + 0.5 \ln (C^{2.75} t)$**, where t = 30 mins. Using this probit relationship, the concentration thresholds for Chlorine has been calculated for 3 different probability of fatality – Lethal Dose 50, Lethal Dose 20 and Lethal Dose 05 in **Table 1.5**, as follows:

Table 1.5 – Probit Values for Chlorine

Hazardous Chemical	Probability of Fatality (Probit)	Concentration (mg/m3)
Chlorine	0.5 (LD50)	870
	0.2 (LD20)	470
	0.05 (LD05)	260

As a next step, using toxic as dispersion model (in heavy gas mode) in ALOHA consequence modelling tool, the endpoint distances to respective probit values have been estimated for the 3 release scenarious, as is presented in Table 1.6.

Table 1.6 – Chlorine Toxic Effect Relationship & Endpoint Distances

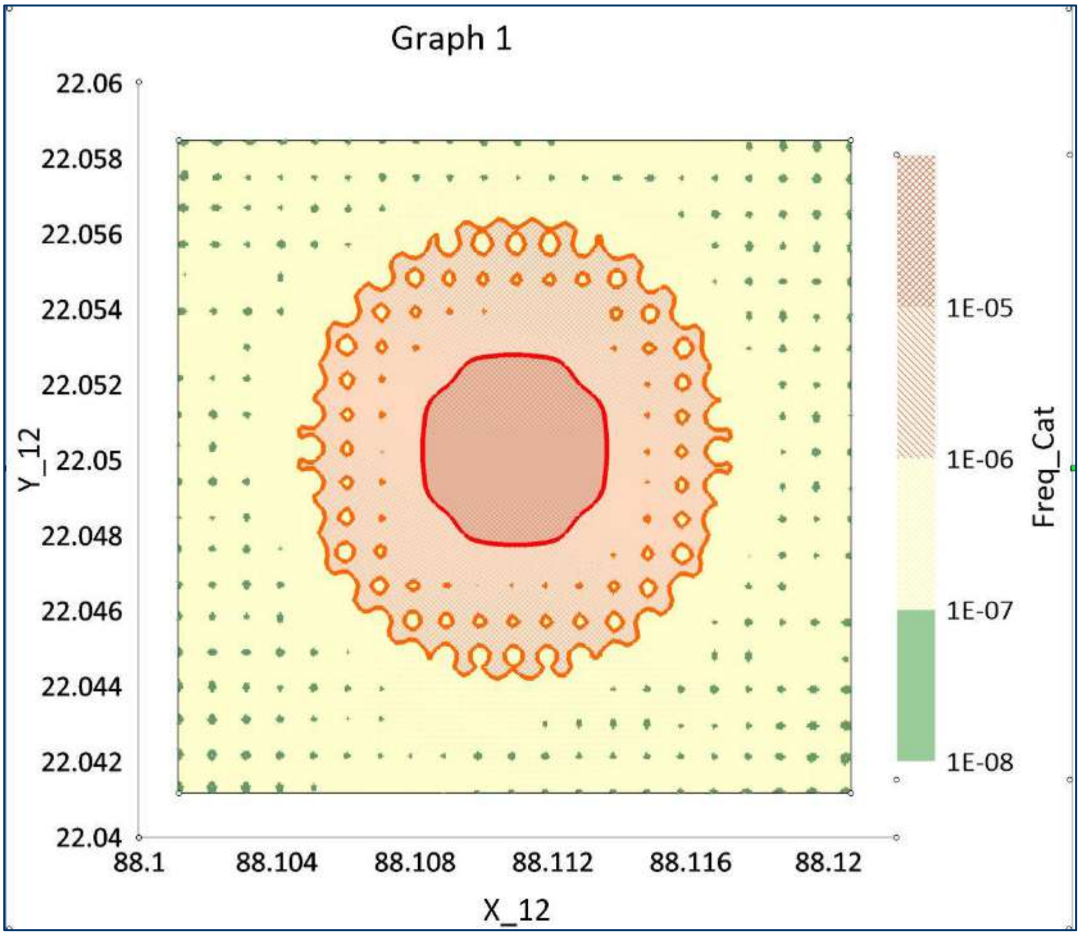
Release Scenario	Probability of Fatality (Probit)	Endpoint Distance (m)
Catastrophic (Cas)	0.5	543
	0.2	684

Release Scenario	Probability of Fatality (Probit)	Endpoint Distance (m)
	0.05	858
Leak 13mm Hole (L13)	0.5	300
	0.2	408
	0.05	545
Leak 6 mm Hole (L6)	0.5	150
	0.2	222
	0.05	328

Individual Risk is estimated as as the probability at which an individual may be expected to sustain a level of harm from specified hazards by combining the level of consequences with their frequency of occurrence. Graphically the IR is represented by a spatial risk summation of all the 3 scenarious across the 3 probit endpoint distance of damage to calculate the resulting Individual Risk at a particular x,y location from the source (the location of the Tonner).

The result of the summation show IR contours as in **Figure 1.5** with the Iso-risk contour of 1X 10^{-5} (per year), an IR level higher to which is considered unacceptable as per Dutch VROM Directives, at within 300 m from the source of where the Chlorine tonner is located with the STP site and would mostly be lying within the boundary of the STP premises. The iso-pleth level of 1X 10^{-6} (per year) is at around 600 m radial distance beyond which the risk is to be considered acceptable. In the zone between 300 m – 600 m, the risk level can be considered as As Low As Reasonably Achievable (ALARA) which would mean that reasonable mitigation and adaptive measures need to be taken to try and bring down the risk to acceptale level at below 1X 10^{-6} (per year).

Figure 1.5: IR Contours after Risk Summation



A second metric for risk estimation, as a part of QRA, is Societal Risk (SR) and provides the relationship between frequency and the number of people that may suffer from a specified level of harm in a given population from the relaization of specific hazards (here, a Chlorine relase). This metric will be dependant on the population present in the vicinity of the Arupara STP.

Out of the several measures to estimate SR, the Potential Loss of Life (PLL) measure has been chosen because it allows for a spatial display of the risk to the society by combining the damage potential with population desnity estimates and therefor can be used as a basis for discussion with the administration for drawing up risk resduction measures for the area. It is important to take note that SR is a conservative risk metric as it always considers all people to be unsheltered and always present at their residences. The PLL has been estimated using the following expression:

$$\mathbf{PLL}_{(x,\,y)} = \left[\, \mathbf{IR}_{(x,\,y)} \times \mathbf{NP}_{(x,\,y)} \,\right]$$

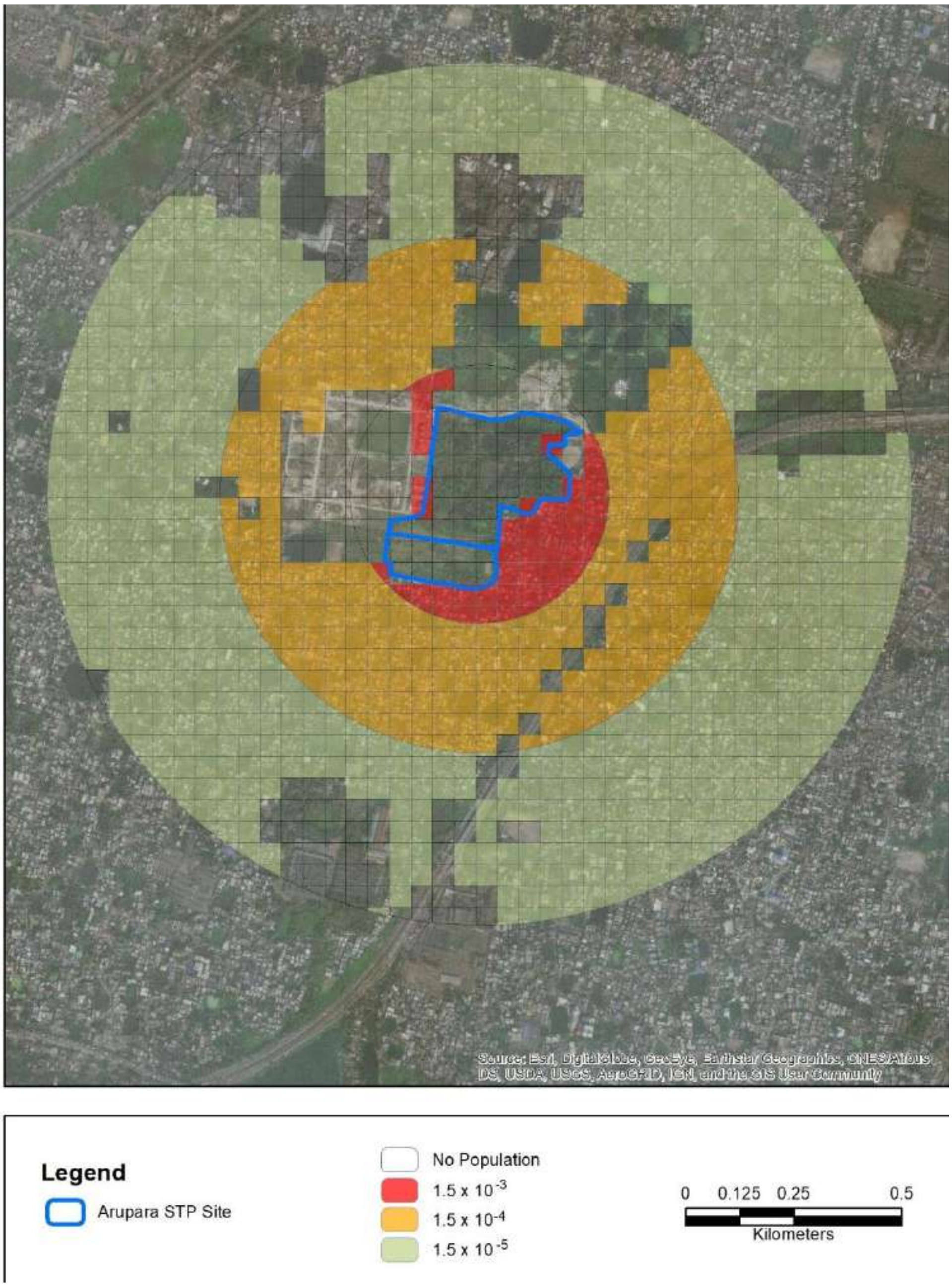
- $PLL_{(x,\,y)}$ is the Potential Loss of Life at a geographical location (x, y);
- $IR_{(x,\,y)}$ is the individual risk at location (x, y); and
- $NP_{(x,\,y)}$ is the number of people at a geographical location (x, y).

To allow for PLL to be spatially calculated across a spatial grid, an interpolated population database taking into account an area of 1 kms radius around the facility has been developed on a 50 m X 50 m grid, accounting for residential areas and with average population calculated based on Ward level population as per 2011 Census. The spatial PLL map shown in **Figure 1.6** shows the number of people in the grid affected by risk levels 1.5 X 10^{-3} (red), 1.5 X 10^{-4} (amber), 1.5 X

10^{-5} (green) / year respectively. The total estimated population who would be exposed to the specific SR levels are presented in **Table 1.6**.

Societal Risk Level	Population at Risk
1.5 X 10^{-3} (red)	8370
1.5 X 10^{-4} (amber)	47120
1.5 X 10^{-5} (green)	120435

Figure 1.6: Societal Risk as Potential Loss of Life (PLL)

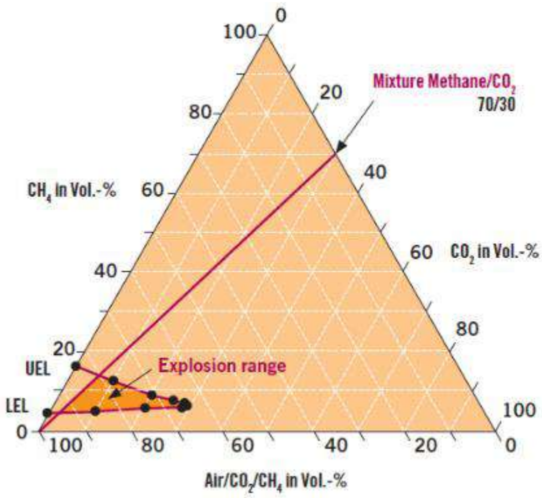


1.6. RA Discussion - Biogas

Biogas produced by an anaerobic digestion plant is composed of combustible gases methane (50-75%), carbon dioxide (25-50%), water (H2O), nitrogen (N2), oxygen (O2), hydrogen sulfide (H2S), ammonia (NH3), and trace elements (organo-halogenated, siloxanes, etc.), with the composition varying depending on the nature of the substrates being used and the operating conditions.

The hazards arising out of biogas production, storage and transportation system (using pipelines) potentially include fire and explosion, risk of gas poisoning or asphyxiations through creation of oxygen deficient atmosphere, hazards associated with pathogens and due to confined space entry. For the purposes of this risk assessment, the fire and explosion risk that may be caused by the leakage of Bio-gas has been considered.

The fire and explosion risk for biogas, often in combination with air, depends on several factors like presence of sufficient amount of combustible gas (methane), presence of oxygen from air and that of an ignition source, and will be particularly high close to the digesters and the gas storage. The explosion regions of the methane – air mixtures are represented by triangular explosion diagrams as one below drawn up by the German Biogas Association.



In the case of a leakage resulting in an accidental release of biogas into the surrounding mixture, an explosive mixture can be formed if concentration for the Lower Explosive Limit (LEL) of methane is exceeded and the level is below the Upper Explosive Limit (UEL). Given that the plant building and associated infrastructure are well spread out, it is very unlikely that any leaked out gas would find a enclosed space in which such explosive gas mixture can develop. Also, because the gas would not be stored under pressure, the possibility of a jet fire would also be very remote. However, on modelling for probable jet fire or vapour cloud explosion scenario for biogas using ALOHA consequence assessment model, the tool did not result in any hazard footprints to recognised end-points or levels of concern (both for fire radiation and explosion overpressure).

1.7. Risk Mitigation & Emergency Management Plan

In order that the risk posed by the hazardous substances stored within the STP site (Chlorine & Biogas), a risk management framework which comprising of risk mitigation measures and an emergency prevention and response plan has been formulated and is presented in the following sections.

Risk Mitigation Measures – Chlorine

The STP site would conform to the following safeguards/risk mitigations as per Indian Standard IS 10553, Part I – General Guidelines for Chlorination Plants including handling, storage and safety of Chlorine drums:

- ***Chlorine Leak Absorption System:*** An air extraction system connected to a Leak Absorption System will be provided for the tonner room and chlorinator room to remove chlorine in contaminated air, in case of Chlorine leak in these rooms***.*** The extraction system will consist of extractor fans 2 Nos***.*** (1W**+**1S) withdrawing air from these areas separately by a system of low level ducts through a chlorine absorber and discharging chlorine free air to the atmosphere***.*** The ductwork will be arranged to extract from the rooms and provided at floor level connected to the absorber*.* The scrubber exhaust rate will be designed to maintain negative pressure in the tonner room and Chlorinator building during a leak*.* In the chlorine scrubber tower, the chlorine gas will be neutralized with absorbent (Caustic) solution*.* The pH of the spent absorbent (caustic) will be checked at the outlet of the scrubber. If the pH is found to be high, then absorbent will be neutralised with water in a neutralisation pit. This activity would be triggered only in case of an accidental release of Chlorine which has a probability of less than 1 event in less than 100 years. If such an instance occurs, the neutralised water from the pit would be recycled back to the Clarifier and will be treated through the STP system, before being discharged along with treated sewage water.~~Spent absorbent is stored in the caustic storage tank and subsequently drained~~

- ***Absorbent Tank:*** The absorbent to be used for Chlorine would be Caustic (NaOH) solution. The concentration of caustic used in the absorber will be selected such that it can limit the temperature rise during the absorption process to 10ºC. One (1) no, Caustic solution cum recirculation tank adequate to neutralize the content of One (1) Chlorine drum will be provided for this purpose. The tank will also be provided with dilution water supply.
- ***Caustic Solution Recirculation Pump:*** Two (2) Nos. Horizontal Centrifugal Type Caustic Solution Pumps (1W+1S) will be provided to transfer the NaOH solution required for neutralizing the contents of one chlorine drum (1000 kg), from the storage tank to the scrubber. These pumps will also be used for loading the Absorbent Holding / Recirculation tank with fresh caustic solution.
- ***Chlorine Leak Blower***: Extraction fans will be mounted on the downstream side of the absorber to induce an upward draft of contaminated air through the absorber. Two Centrifugal Blowers (1W+1S) each of capacity adequate to provide the required number of air changes per hour will be provided.
- ***Chlorine Leak Response:*** If an extensive Chlorine leak is identified, an effort should be made by the Chlorination Plant operator should warn all persons in the path of the gas, notify the STP plant manager and consider intimating the chemical emergency coordinator, fore brigade or the police. Water shall not be sprayed on the Chlorine leak as it tends to make the leak worse because of corrosive effect. If the leak occurs in an equipment where Chlorine gas is being used, the controlling valves at the Chlorination Toners should be immediately closed. Leaks around valve stems would be stopped immediately after detection by tightening the packing nut or the gland.
- ***Storage Area Restrictions:*** It should be ensured that no other compressed gas containers, inflammable materials, turpentine, ether, anhydrous ammonia or finely divided metal should be stored in the Chlorination Plant. The storage

Emergency Management Plan

Emergency Management is a process or strategy that is implemented when any type of catastrophic event takes place. The Emergency Management Plan envisages the need for providing appropriate action so as to minimize loss of life/property and for restoration of normalcy within the minimum time in event of any emergency. Adequate manpower, training and infrastructure are required to achieve this.

The objectives of the site's Emergency Management Plan will be as follows:

- Rapid control and containment of the hazardous situation;
- Minimising the risk and impact of occurrence and its catastrophic effects;
- Effective rehabilitation of affected persons and prevention of damage to Property and environment;
- To render assistance to outside the factory.

The following important elements in the Emergency Management Plan (EMP) are recommended to effectively achieve the objectives of emergency planning:

Command, Co-ordination and Response Team

One of the most important objectives of emergency planning is to create a response organisation structure capable of being developed in the shortest time possible during an emergency.

Command and control of an emergency condition, will cover the key management functions necessary to ensure the least impact on environment, health and safety of employees, as well as the public living in the vicinity. These primary functions to be commanded are as follows:

- Detection of the emergency conditions;
- Assessment of the conditions;
- Classification of emergency;
- Mitigation of the emergency conditions;
- Notification to management personnel;
- Notification to local, state, and government agencies;
- Activation and response of the necessary on-site and off-site support personnel;
- Continuous assessment and reclassifications, as necessary;
- Initiation of proactive actions;
- Aid to affected personnel;
- Recovery and re-entry.

Training Program

Training is one of the basic components of disaster management. In principle, anyone who occupies a position within the disaster management plant organisation undergoes some kind of training, followed by refresher courses at periodical intervals.

The main goal of training for emergencies is to enable the participants to understand their roles in the response organisation, the tasks associated with each position, and the procedures for maintaining effective communications with the other response functions and individuals. An in-house team will be appointed for the development of such training programme. This team is composed of the same people in-charge of developing and reviewing the response plan.

Mock Drill

In spite of detailed training, it may be necessary to try out whether, the emergency plan works out and will there be any difficulties in execution of such plan. In order to evaluate the plan and see whether the plan meets the objectives of the emergency plan, periodical mock drills are contemplated. Before undertaking the drill, it would be very much necessary to give adequate training to all staff members and also information about possible mock drill. After few pre-informed mock drills, few un-informed mock drills would be taken. All this is to familiarize the employees with the concept and procedures and to see their response. These scheduled and unscheduled mock drills would be conducted during shift change, public holidays, in night shift etc. To improve preparedness once in 6 months, ateleast one mock drill will be conducted.

PPEs

In certain circumstances, personal protection of the staff maybe required as a supplement to other preventive action. It should not be regarded as a substitute for other control measures and must only be used in conjunction with substitution and elimination measures. PPEs must be appropriately selected individually fitted and workers trained in their correct use and maintenance. PPEs must be regularly checked and maintained to ensure that the worker is being protected.

Internal Emergency Communication

The plant will install a Local Audio Alarm System, PA system, & Emergency siren with siren code to make the emergency known both inside and outside of the facility, and co-ordinating among the various groups involved in response operations. A protocol for operating the siren should be worked out and to be informed to all employees of teh STP.

Personal Protective Equipment

This equipment is used mainly for three reasons:

- To protect personnel from a hazard while performing rescue/accident control operations,
- To do maintenance and repair work under hazardous conditions, and
- For escape purposes.

Security and Access Control Equipment

In case of an emergency the incoming response teams and resources will be directed to assembly place. Admission to contaminated area / effected area will be restricted. The response team and resources coming from outside will reach to event place after permission from STP Manager. Assembly point will be a predesignated location, where, persons not-connected with emergency operations would proceed at assembly point and await for rescue operation.

APPENDIX K STAKEHOLDER CONSULTATION & PARTICIPANT LIST

STAKEHOLDER CONSULTATION

A	*Project Title:*	Updating /Revalidation and Preparation of Safeguard documents for Sewerage Projects Implemented by KMDA under one of the Namami Gange Program at 24th Paraganas (North) and Howrah Districts.
B	*Stakeholder Title:*	Consultation with Arupara STP Staff Members .

Note: This document provides a working summary of the main facts captured during the consultation/key informant interview held and should not be treated as formal minutes. It is therefore deliberately not exhaustive or chronological. Its purpose is to record significant information/feedback and not intended for official review or approval.

C	*Basic details:*	
	Location: Arupara	Village/Urban: Arupara, Howrah Corporation
	Date: 05/07/2019	Ward no: Union:

D *Attended By*

Sr.	Name	Designation
1.	Mr.Subit Roy	Pump OP Incharge
2.	Mr. Sanjay Bhattacharjee	Plant OP Incharge
3.	Mr. Sibangshu Ranjan Mukherjee	Supervisor for pump & plant
4.	Number of six	Pump Operator
5.	Number of twenty one	Plant Operator
6.	Number of one	Pump sweeper

E *Purpose of Consultation* Focus group Discussion,

To learn about the affected community's opinion on the project, advantages/ disadvantages of the project, their opinion on minimizing the adverse situations.

F *Key Points Discussed:*

Brief History of the STP : Water comes from MPS Ichapur to Arupara STP. The STP receives sewage water from MPS that raw water have been treated and bypass to Hashkhali pole to river Ganga. This STP is maintained and operated by Associated Cooperative Society. The STP is operating last 20 years.

- The pump operators staff members are aware of this proposed project of KMDA but they don't have any clear idea about the work to be done . They are waiting for the repair and replacement of the pipelines and STP Plant to improve the services .
- According to them if the proposed work to be implemented the peoples of the area to be benefitted but one thing should remember the area of Arupara near Railway Gate to Arupara Plant are very congested.
- According to the pump operators there is water logging point of the Housing quarter to Arupara STP plant and if the pipe lines or machines repaired/replace there will be no problem.
- Condition of the pump building is poor and the capacity of machine also.
- The total no of Staff is 32 and they are doing duties in 4 shifts. Morning, day night and in General Shift.
- This STP is also operated and maintained by Associated Cooperative Society.

Photo Evidence:

STAKEHOLDER CONSULTATION

<table>
<tr><td>A</td><td>Project Title:</td><td colspan="2">Updating /Revalidation and Preparation of Safeguard documents for Sewerage Projects Implemented by KMDA under one of the Namami Gange Program at 24th Paraganas (North) and Howrah Districts.</td></tr>
<tr><td>B</td><td>Stakeholder Title:</td><td colspan="2">Discussion with Contractual Worker at BESU Lifting Station,Howrah Municipal Corporation (HMC)</td></tr>
<tr><td colspan="4">Note: This document provides a working summary of the main facts captured during the consultation/key informant interview held and should not be treated as formal minutes. It is therefore deliberately not exhaustive or chronological. Its purpose is to record significant information/feedback and not intended for official review or approval.</td></tr>
<tr><td rowspan="3">C</td><td colspan="3">Basic details:</td></tr>
<tr><td>Location: BESU Lifting Station, Howrah Municipal Corporation (HMC)</td><td colspan="2">Village:</td></tr>
<tr><td>Date: 18/07/2019</td><td colspan="2">Ward no: Union:</td></tr>
<tr><td rowspan="3">D</td><td colspan="3">Attended By</td></tr>
<tr><td>Sr.</td><td>Name</td><td>Designation</td></tr>
<tr><td>1.</td><td>Mr. Shubojeet Chanda</td><td>Operator</td></tr>
<tr><td rowspan="2">E</td><td colspan="3">Purpose of Consultation: Focus group Discussion,</td></tr>
<tr><td colspan="3">To learn about the affected community's opinion on the project, advantages/ disadvantages of the project, their opinion on minimizing the adverse situations.</td></tr>
<tr><td rowspan="3">F</td><td colspan="3">Key Points Discussed:</td></tr>
<tr><td colspan="3">.</td></tr>
<tr><td colspan="3">Consulted with pump operator of BESU Lifting Station and it was informed that there are five workers presently working.
All of the five machines in the Lifting Station are out of order therefore the Lifting Station in non-functioning.
The water intake for this facility is from Botanical Garden and Swarnamoyee area and it was informed that waterlogging used to take place at Narayana Hospital area.
The discussion revealed that the workers have been working at the Lifting Station for the last 20 years, and they are presently engaged under the contractor, Cigma Cooperative.</td></tr>
</table>

STAKEHOLDER CONSULTATION

A	*Project Title:*	Updating /Revalidation and Preparation of Safeguard documents for Sewerage Projects Implemented by KMDA under one of the Namami Gange Program at 24th Paraganas (North) and Howrah Districts.
B	*Stakeholder Title:*	Discussion with Contractual Worker at Fore Shore Lifting Station, Foreshore Road, Howrah Municipal Corporation (HMC)

Note: This document provides a working summary of the main facts captured during the consultation/key informant interview held and should not be treated as formal minutes. It is therefore deliberately not exhaustive or chronological. Its purpose is to record significant information/feedback and not intended for official review or approval.

C	*Basic details:*	
	Location: Foreshore Road, Howrah Municipal Corporation (HMC)	Village:
	Date: 18/07/2019	Ward no: Union:

D *Attended By*

Sr.	Name	Designation
1.	Mr. Ajoy Das	Operator

E *Purpose of Consultation:* Focus group Discussion,

To learn about the affected community's opinion on the project, advantages/ disadvantages of the project, their opinion on minimizing the adverse situations.

F *Key Points Discussed:*

- According to the Operators of this lifting station, water comes from the Chouri Basti and B E College area.
- This Lifting Station has three shifts i.e. 6 to 2 pm, 2 to 10 pm and 10-6 am.
- Many of the present workers joined the Lifting Station approximately 20 years ago and are working under the contractor, Associated Cooperative Society. There are earning an average income of Rs. 10,000.
- The Lifting Station has a total of five machines out of which only three are operational. No waterlogging was observed in the area.

Photo Evidence

STAKEHOLDER CONSULTATION

A	*Project Title:*	Updating /Revalidation and Preparation of Safeguard documents for Sewerage Projects Implemented by KMDA under one of the Namami Gange Program at 24th Paraganas (North) and Howrah Districts.	
B	*Stakeholder Title:*	Contractual Workers at Itchapur MPS	
Note: This document provides a working summary of the main facts captured during the consultation/key informant interview hd and should not be treated as formal minutes. It is therefore deliberately not exhaustive or chronological. Its purpose is to record significant information/feedback and not intended for official review or approval.			
C	*Basic details:*		
	Location: Itchapur, Kadamtala	Village/Urban: Kodam Tala, Howrah	
	Date: 05/07/2019	Ward no: NA	
D	*Attended By*		
	Sr.	Name	Designation
	1.	Mr. Samar Chatterjee	Supervisor
	2.	Mr. Joydev Konar	Operator
	3.	Mr. Srimangol Sumandra	Operator
	4.	Mr.Jayanta Boler	Operator
	5.	Mr. Sudhir Roy	Operator
	6.	Mr. Bhola Nath Gupta	Operator
	7.	Mr. Sudhir Bhodak	Helper
	8.	Mr. Deep Adhikary	Helper
E	*Purpose of Consultation*Focus group Discussion,		
	To learn about the affected community's opinion on the project, advantages/ disadvantages of the project, their opinion on minimizing the adverse situations.		
F	*Key Points Discussed:*		
	Brief History of the MPS : Water comes from RoundTank Road, Forser Road and Ballias Road area and as the Pipelines the Pump operators Bye pass the .water at Arupara Pumping.This MPS is Well maintained and operated by Associated Cooperative Society .		
	• The pump operators heard about the proposed work but they don't have any clear idea about the work to be done. They are waiting for the repair/replacement of the pipelines to improve the services . • According to them if the proposed work to be implemented the peoples of the area to be benefitted but one thing should remember the area of Arupara near Railway Gate are very congested. • According to the pump operators there is water logging point of the Housing quarter to Arupara STP plant and if the pipe lines or machines repaired/replace there will be no problem. • Condition of the pump building is poor and the capacity of machine also. • The total no of Staff is 8 and they are doing duties in 4 shifts: morning, day night and in General Shift. • This MPS is also operated and maintained by Associated Cooperative Society.		
Photo Evidence			

STAKEHOLDER CONSULTATION

A	*Project Title:*	Updating /Revalidation and Preparation of Safeguard documents for Sewerage Projects Implemented by KMDA under one of the Namami Gange Program at 24^{th} Paraganas (North) and Howrah Districts.
B	*Stakeholder Title:*	Discussion with Worker at Round Tank Road LS

Note: This document provides a working summary of the main facts captured during the consultation/key informant interview held and should not be treated as formal minutes. It is therefore deliberately not exhaustive or chronological. Its purpose is to record significant information/feedback and not intended for official review or approval.

C	*Basic details:*	
	Location: Roundtank Lifting station, Arupara	Village: NA
	Date: 18/07/2019	Ward no: NA

D *Attended By*

Sr.	Name	Designation
1.	Sri. Mrinal Kanti Dey	Operator

E *Purpose of Consultation:* Consultation with Pump Operators are Roundtank LS

To learn about the stakeholder’s opinion on the project, advantages/ disadvantages of the project, their opinion on minimizing the adverse situations.

F *Key Points Discussed:*

- A consultation was conducted with the contractual worker at Roundtank Lifting station.
- There working hours at the LS are divided into three shifts, as well as a general shift from 10am to 6pm.
- The workers are working under the contractor, Associated Cooperative Society and their approximate salary is Rs. 12,000. They have been working at the pumping station for over 20 years.
- Currently, there are five machines at the pumping station but only two are operational.
- The worker indicated that water intake is from the Sri Ram krishnapur area and covers approximately 6-7 wards of Howrah Municipal Corporation (HMC).
- The worker indicated that there is no waterlogging that takes place in this area.

Photo Evidence:

STAKEHOLDER CONSULTATION

A	*Project Title:*	Updating /Revalidation and Preparation of Safeguard documents for Sewerage Projects Implemented by KMDA under one of the Namami Gange Program at 24th Paraganas (North) and Howrah Districts.	
B	*Stakeholder Title:*	Consultation with Workers at Arupara and Bally STP and Associated Facilities	
Note: This document provides a working summary of the main facts captured during the consultation/key informant interview held and should not be treated as formal minutes. It is therefore deliberately not exhaustive or chronological. Its purpose is to record significant information/feedback and not intended for official review or approval.			
C	*Basic details:*		
	Location:	Chittaranjan Bayam Samiti, 16 Naskapara Byelane, Howrah	
		Howrah Municipal Corporation, West Bengal	
	Date	17th of September 2019	
D	*Attended By (List attached)*		
	Sr.	Name *(Key attendees)*	Organization/ Individual
	1	Parthapratim Bandyapadhyay	Executive Engineer (E/M) KMDA
	2	Debashish Ganguly	Executive Engineer (GAP), KMDA
	3	Anjan Kumar Bhuniya	Executive Engineer (Civil), KMDA
	4	Sushanta Kumar Banerjee	Assistant Engineer (Civil), KMDA
	5	Sibu Chandra Dey	Assistant Engineer (E/M), KMDA
	6	There was no representation from NMCG	
	7	Amar Saha	Chairman, Associated Cooperative Labour Contractor and Construction Society Ltd & Operator at LS 1 Ghusri
	8	Jibon Majumdar	Secretary, Associated Cooperative Labour Contractor and Construction Society Ltd
	9	Amalesh Ch. Jana	Director, Ganga Action Plan Contract Workers Co-operative Society Ltd
	10	Pradip K. Chandra	Chairman, Ganga Action Plan Contract Workers Co-operative Society Ltd
	11	Ananta Sinha	VA Tech Wabag
	12	Sunil Kumar Ganguly	VA Tech Wabag
	13	Shantanu Roy	VA Tech Wabag
	14	Arindam Talukdar	VA Tech Wabag
	15	Workers from Arupara and Bally STP and Associated Facilities	Individuals
	16	Durjoy Mallick, Mayanka Singh	ERM
E	*Purpose of Consultation:*		
	▪ To obtain understanding on the existing contract arrangement between KMDA the Contracting (O&M) Agency engaged at the Arupara and Bally STP and their associated facilities. ▪ To physically verify to the extent possible the deployed manpower at the project facilities at Arupara and Bally, in presence of the workers themselves or by their nominated representatives. ▪ To understand from KMDA, the modalities and thought process for re-engagement of the existing workers.		
	Points discussed:		

- The programme began with a briefing on the purpose of the consultation along with a round of introduction by all the members present i.e. KMDA, VA Tech Wabag, ERM and the workers and/or representatives from the O&M agencies engaged at the Arupara and Bally STP sites and associated facilities.
- The discussion revealed that the contractors at these facilities are engaged by three different agencies i.e. Associated Cooperative Labour Contractor and Construction Society Ltd; M.C.E Construction, and Ganga Action Plan Contract Workers Co-operative Society Ltd since 2009, 2008 and 2006 respectively.
- The list of workers shared by KMDA (hereinafter stated as "KMDA list) mentions Ganga Action Plan Contract Workers Co-operative Society Ltd. as the only O&M agency engaged at these facilities. The table below thus highlights the names of the agencies and the time period of engagement. Futher details on the manpower engagement at each site are mentioned in the subsequent tables.

O&M Agency	Time Period
Associated Cooperative Labour Contractor and Construction Society Ltd	2009 to present
M.C.E Construction	2008 to present
Ganga Action Plan Contract Workers Co-operative Society Ltd.	2006 to present

- The workers of Associated Cooperative Labour Contractor and Construction Society Ltd and Ganga Action Plan Contract Workers Co-operative Society Ltd. present during the consultation indicated that they have been receiving their salary, ESI, PF, Bonuses as well as some increase in their salary proportionate to Dearness Allowance (DA) increase, during the government pay scale change. However, the workers at M.C.E Construction do not avail this D.A benefit.
- The Arupara STP was commissioned in 1970, after which it was handed over to K.M.W & SA in 1983 in a non-functional state. Reportedly, the STP has not been functioning since March 2019.
- It was also reported during previous consultations that the Kona MPS in Bally has not been functioning for the last 7 months.
- Furthermore, the names mentioned in the KMDA list were verified against the names of the workers present during the consultation. Those who could not attend the consultation, were verified by the representatives of their respective agencies as well as their co-workers at their respective locations. This exercise thus revealed the following facts:
    - The name of Mr. Achinta Roy who was recently engaged at Arupara MPS, (as confirmed by his co-workers) was not included in the KMDA list. Therefore there are a total of nine (9) workers at the Arupara MPS, not eight (8) workers, as reported in the KMDA list.
    - Mr. Dip Adhikari has been engaged at the Itchapur MPS in place of his recently demised father Mr. Samir Adhikary. This engagement has been confirmed by the KMDA as per their letter to the Secretary of Associated Cooperative Labour Contractor and Construction Society Ltd, dated 26th of June, 2019. Therefore, there are a total of eight (8) workers at the Itchapur MPS, not seven (7) workers, as reported in the KMDA list.
    - The name Mr. Pratap Karmakar, who is engaged as an operator at Arupara MPS is incorrect as per the KMDA list. His actual name is Mr. Pratip Karmakar.
    - As stated earlier, the KMDA list only mentions the name of one O&M agency i.e. Ganga Action Plan Contract Workers Co-operative Society, for both Bally and Arupara sites. The verification however revealed that Associated Cooperative Labour Contractor and Construction Society Ltd and M.C.E Construction are also engaged as O&M agencies at these two sites.

- Therefore as per the verification, there are a total of sixty-three (63) workers at the Arupara STP and associated facilties and a total of thirty-two (32) workers at the Bally site and associated facilities.
- Reportedly, the security guards working at the Arupara facilities are engaged directly by KMDA, and KMDA has its own plan to relocate the guards, as per their requirement.
- The tables below highlights the updated names of the agencies including the updated numbers of workers at each facility, in the respective sites:

Arupara STP & Associated Facilities

STP & Facilities	Project Components	Location	Contractor	Manpower Involvement
Arupara	STP-Arupara	Arupara Sewage Treatment Plant, South Howrah Zone	Associated Cooperative Labour Contractor and Construction Society Ltd	24
	MPS-Arupara	Arupara Main Pumping Station		9
	MPS- Itchapur	Itchapur Main Pumping Station		8
	LS-3	Round Tank Road		6
	LS-2	CPT Land, Foreshore Road		5
	LS-1	BESU, B.E College	M.C.E Construction	5
	Security Personnel		Reportedly, they are directly engaged by KMDA	6
	Total			**63**

Bally STP & Associated Facilities

STP & Facilties	Project Components	Location	Contractor	Manpower Involvement
Bally	LS-1	Ghusuri, Hanuman Jute Mill	Associated Cooperative Labour Contractor and Construction Society Ltd	6
	LS-3	Bally Khal		4
	LS-4	Liluah, Panchanantala		4
	LS-5	Salt Gola		4
	LS-6	Golabari		4
	MPS-Kona	Kona		7
	LS-2	Belur Math	Ganga Action Plan Contract Workers Co-operative Society Ltd.	3
	Total			**32**

- It is understood from the consultation that O&M agency Associated Cooperative Labour Contractor and Construction Society Ltd is formed as a consortium of existing workers, out of which some workers are holding designated posts. For instance, Mr. Amar Saha who is working as an operator at LS 1-Ghusri (Hanuman Jute Mill) also holds the post of Chairman, Associated Cooperative Labour Contractor and Construction Society Ltd.
- Representative from KMDA indicated that the correct list of workers' names should be shared by the respective O&M agencies along with their personal details, duration of service and documentary evidence in support of their work, under the specified contractor at the site, to the Executive Engineer at KMDA Head Office.

	▪ The workers shared the following opinions on the project: ○ They strongly expressed their apprehension of losing their jobs due to the onset of this project. ○ They also requested the authorities for their reasonable consideration to protect their livelihood and current earnings.

Photo Evidence:


ROJECT NAME: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY FOR UPGRADATION OF SEWAGE TREATMENT PLANT (STP) AT ARUPARA AND BALLY, HOWRAH MUNICIPAL CORPORATION, HOWRAH, WEST BENGAL

PROGRAMME: CONSULTATION WITH WORKERS AT SEWAGE TREATMENT PLANT AND ASSOCIATED FACILITIES AT ARUPARA AND BALLY

VENUE: CHITTARANJAN BAYAM SAMITI, HOWRAH, WEST BENGAL

DATE: TUESDAY, 17th OF SEPTEMBER 2019

Sl No	Name	Occupation/Designation	Address and Contact No.	Signature
1.	Satyajit Chanda	Operator M.C.E Contractor	Uttar Podrah, Howrah - 9,801770883	[signature]
2	Kartick Mondal	Do	B.E. College Pump House; Howrah - 3	K Mondal. 9433808507
3,	Partha Pramanik	J.E., KMDA	DIV. O&M-II/GAP-II Dasnagar, Howrah	[signature]
4.	Tapas Kr. Sarkar	A.E. KMDA	- Do -	[signature]
5	Partha Pratim Bandyopadhyay	EE (E/M) KMDA	GAP-II (E/M)	[signature]
6	Debashis Ganguly	EE/GAP/WB-1	GAP (WB-1), KMDA	[signature]
7	Anjan Kumar Bhowmik	A.E (Civil) KMDA	Div. - O&M - II/GAP - II Dasnagar Howrah.	[signature]
8.	Sushanta Kumar Banerjee	AE(C) KMDA	GAP (WB-1) KMDA	[signature]
9.	Sibu Chandra Dey	A.E (E/M) KMDA	GAP(E/M)-I, KMDA	[signature]
10	Sanjoy Bhattacharya	Arupara Pump House (Incharge)	Account contractor 8296528278	[signature]

Sl No	Name	Occupation Designation	Address & Contact No	Signature
11.	Sibangshu RN. Mukherji	Incharge/Operator	Arupara Associated Co.op. 9831064521	[signature]
12.	Sukit Roy.	Incharge/Operator	Arupara Associated Co.op. 6290746068	S. Roy.
13.	Sailen Das	Incharge/operator	Arupara Associated Co. O. 8013975709	[signature]
14.	Jibon Mojumdar	Secretary Associated Co.op.	9903332445	[signature] 17.09.19
15	Samar Nath Chaurasia	operator -	Ichapur pump house 9830363665	[signature] 17.09.19
16	Amar Saha	Chairman Associated Co-op.	Ehesuri Pump Ho. 9896576829	Amar Saha
17	Amalesh Ch. Jana -	Director Gangaaction plan Co-op	7478751976	[signature]
18	Banwari Lal Das	Vice chairman Ganga Action Plan contract workers Co-op Socty	~~968~~ 8777590633	[signature]
19	Prodip Kr. Chandra.	Chairman Ganga Action Plan Contract workers Co-operative Socty LTD	9681274101	[signature]
20	ANANTA SINHA	VA TECH WABAG Chief Manager (O&M)	9330481521	[signature]
21	S. K. Ganguly	VA TECH WABAG Chief Mgr - Project	8260741804	[signature]
22	SANTANU ROY	VATECH WABAG Chief Manager	9333504323	[signature] 17.09.19

Sl No	Name	Occupation/Designation	Address & Contact NO	Signature.
23	Arindam Talukdar	Va Tech Wabag Ltd	8100833340	Arindam Talukdar
24	Mayanka Singh Nongpiur	ERM India Pvt Ltd	8451088225	Mayanka Singh.
25	Dr. Dmjoy Mallick	ERM India Pvt Ltd.	9830029865	[illegible]

STAKEHOLDER CONSULTATION

A	*Project Title:*	Updating /Revalidation and Preparation of Safeguard documents for Sewerage Projects Implemented by KMDA under one of the Namami Gange Program at 24th Paraganas (North) and Howrah Districts.	
B	*Stakeholder Title:*	Consultation with local community at GIP Colony, Arupara	
Note: This document provides a working summary of the main facts captured during the consultation/key informant interview held and should not be treated as formal minutes. It is therefore deliberately not exhaustive or chronological. Its purpose is to record significant information/feedback and not intended for official review or approval.			
C	*Basic details:*		
	Location: Arupara	Village: GIP Colony	
	Date: 11/02/2020	Ward no: NA	
D	*Attended By*		
	Sr.	Name	Designation
E	*Purpose of Consultation:* Consultation with local community at GIP Colony, Arupara		
	To learn about the stakeholder's opinion on the project, advantages/ disadvantages of the project, their opinion on minimizing the adverse situations.		
F	*Key Points Discussed:*		
	A consultation was conducted with the local community residing at the GIP colony situated near the Arupara Sewage Treatment Plant (STP). There are approximately 150-200 HHs and 80-100 commercial shops. The purpose of the consultation is to provide awareness to the community at the GIP Colony about the proposed upgradation works of the brick sewer line. The team further explained that the replacement work will not cause any damage to their residential structures as machinery will be used to replace the pipelines. Reportedly, majority of the residents are engaged in daily wage labour whereby they earn an approximate income of Rs. 5000 per month. The women are mainly engaged in domestic work. The residents indicated that during the rainy season, the area gets waterlogged as a result of the clogged pipelines, particularly from a manhole near one of the dwellings, which often causes the houses in the area to flood. The team also shared with the community, the toll free number for the project, in case they would like to convey any grievances during the construction phase. There were approximately 15 participants present at the meeting but the participants were not willing to share their personal details for the participant's list.		
	Photo Evidence:		

APPENDIX L INFORMATION DISCLOSURE

INFORMATION DISCLOSURE WITH ULB

A	Project Title:	Updating /Revalidation and Preparation of Safeguard documents for Sewerage Projects Implemented by KMDA under one of the Namami Gange Program at 24th Paraganas (North) and Howrah Districts.	
B	Stakeholder Title:	Howrah Municipal Corporation- Urban Local Body (ULB)	
Note: This document provides a working summary of the main facts captured during the consultation/ key informant interview held and should not be treated as formal minutes. It is therefore deliberately not exhaustive or chronological. Its purpose is to record significant information/ feedback and not intended for official review or approval.			
C	Basic details:		
	Location:	Ward 39, Howrah Municipal Corporation (HMC)	
	Date	12/11/2019	
D	Attended By (List attached)		
	Sr.	Name (Key attendees)	Organization/ Individual
	1	Sri. Mr. Pijush Bhanja	Executive Engineer
	2	Mr. Arup Roy	Executive Engineer (PWD)
	3	Smt. Sabita Santra	Councillor Ward No. 39
E	Purpose of Consultation:		
	Disclose about the Bally & Arupara STP Project implemented by KMDA under Howrah District		
	Points discussed: A meeting was conducted with the officials of Howrah Municipal Corporation to disclose about the KMDA project on the upgradation of the STP and sewerage system at Bally and Arupara STP project, both of which fall within the Howrah Municipal Corporation (HMC). Present during the meeting were the Executive Engineer, HMC; Executive Engineer, PWD and Councillor of Ward 39. The ERM team apprised the HMC members about the purpose of the meeting including the potential environmental and social impacts, which include impacts on air quality, noise as well as community health and safety during the construction phase. Other potential social impacts include temporary livelihood loss and access disruption, during the laying or replacement of the sewer pipelines in the project area. The ERM team also informed about the potential short-term disturbance in the neighbourhoods near the Arupara and Bally STP, during the construction phase. However, it was highlighted that these impacts are temporary and will be addressed through proper mitigation measures. It was also informed to the HMC members present that the survey would be conducted to identify the potentially affected persons at both the Arupara and Bally STP project locations. The information on the affected persons will be further updated on finalisation of the design and detailed measurement survey. If any person/s is/are assessed to be impacted, he/she will be compensated for the loss as per the Livelihood Restoration Framework (LRP) document. The members present have requested for the final project design including the timeline of the project implementation. The HMC members thus indicated that they understand the purpose and value of the project and mentioned that since the project is in the public interest of the community, they have agreed to offer their full cooperation during the project implementation phase. After the discussion, the Executive Engineer, HMC; Executive Engineer, PWD and Councillor of Ward 39, conducted a joint visit to the project area, to understand the potential areas for disruption		

INFORMATION DISCLOSURE WITH COMMUNITY

<table>
<tr><td>A</td><td colspan="2">Project Title:</td><td>Updating /Revalidation and Preparation of Safeguard documents for Sewerage Projects Implemented by KMDA under one of the Namami Gange Program at 24th Paraganas (North) and Howrah Districts.</td></tr>
<tr><td>B</td><td colspan="2">Stakeholder Title:</td><td>Community at Howrah Municipal Corporation</td></tr>
<tr><td colspan="4">Note: This document provides a working summary of the main facts captured during the consultation/key informant interview held and should not be treated as formal minutes. It is therefore deliberately not exhaustive or chronological. Its purpose is to record significant information/feedback and not intended for official review or approval.</td></tr>
<tr><td rowspan="3">C</td><td colspan="2">Basic details:</td><td>Disclosure Meeting with Community on Arupara STP Project</td></tr>
<tr><td colspan="2">Location:</td><td>Ward 39, Howrah Municipal Corporation (HMC)</td></tr>
<tr><td colspan="2">Date</td><td>23.11.2019</td></tr>
<tr><td rowspan="2">D</td><td colspan="3">Attended By (List attached)</td></tr>
<tr><td>Sr.</td><td>Name (Key attendees)</td><td>Organization/ Individual</td></tr>
<tr><td></td><td>1</td><td>Ranjit Das</td><td rowspan="8">Affected Person</td></tr>
<tr><td></td><td>2</td><td>Md. Jhumna</td></tr>
<tr><td></td><td>3</td><td>SanjuBhagat</td></tr>
<tr><td></td><td>4</td><td>JharnaDey</td></tr>
<tr><td></td><td>5</td><td>PradipPraral</td></tr>
<tr><td></td><td>6</td><td>Dipak Thakur</td></tr>
<tr><td></td><td>7</td><td>MunnaBhagat</td></tr>
<tr><td></td><td>8</td><td>Ranjit Das</td></tr>
<tr><td></td><td>9</td><td>Jyoti Das</td><td>ERM</td></tr>
<tr><td></td><td>10</td><td>Subhasis Chakrabarti</td><td>ERM</td></tr>
<tr><td rowspan="3">E</td><td colspan="3">Purpose of Consultation:</td></tr>
<tr><td colspan="3">Disclose about the Arupara STP Project implemented by KMDA under one of the Namami Gange Program at 24th Parganas (North).</td></tr>
<tr><td colspan="3">Points discussed:
A meeting was conducted with the community at Swarnamoyee Road, situated near the BESU Lifting Station 1. The purpose of the meeting was to disclose about the KMDA project on the upgradation of the STP and sewerage system at the Howrah Municipal Corporation. The individuals present include the shop owners who will be potentially impacted by the project implementation works, mainly in the form of temporary livelihood loss.
The ERM team explained to the member's community about the purpose of the disclosure meeting and explained about the proposed upgradation works.
The team further highlighted that there will be potential temporary impacts particularly related to access disruption and temporary livelihood loss during the laying or replacement of the sewer pipelines.
The community members present at the meeting indicated that they were not previously aware of the proposed works but they indicated that they will cooperate with the project activities as as they view it as beneficial to the area.
They however requested that they be informed about the implementation works in advance, and requested that the work be completed in a manned where there is minimum access disruption.</td></tr>
<tr><td colspan="4">Photo Evidence:</td></tr>
</table>

INFORMATION DISCLOSURE WITH COMMUNITY

A	*Project Title:*	Updating /Revalidation and Preparation of Safeguard documents for Sewerage Projects Implemented by KMDA under one of the Namami Gange Program at 24th Parganas (North) and Howrah Districts.
B	*Stakeholder Title:*	Community at Howrah Municipal Corporation
Note: This document provides a working summary of the main facts captured during the consultation/key informant interview held and should not be treated as formal minutes. It is therefore deliberately not exhaustive or chronological. Its purpose is to record significant information/feedback and not intended for official review or approval.		
C	*Basic details:* Disclosure Meeting with Community on Arupara STP Project	
	Location: Howrah Municipal Corporation	Village: GIP colony
	Date: 04.12.2019	Ward no: 48 HMC
D	*Attended By*	

Sr.	Name	Designation
1.	Smt. Bijoli Das	Local Community
2.	Smt. Archana Mondal	
3.	Smt. Pratima Jana	
4.	Smt. Kalpana Mondal	
5.	Sri Madan Karar	
6.	Sri Jayanta Das	
7.	Sri Pabir Karar	
8.	Sri Bapan Roy	
10.	Jyoti Das	ERM
11.	Subhasis Chakrabarti	ERM

E	*Purpose of Meeting*
	Disclose about the Arupara STP Project implemented by KMDA under one of the Namami Gange Program at 24th Parganas (North).
F	Key Points Discussed:

A meeting was conducted with the community situated in GIP colony , along the left side of the Ichapur- Arupara Road, near the railway gate. The purpose of the meeting was to disclose about the KMDA project on the upgradation of the STP and sewerage system at the Howrah Municipal Corporation. It was also highlighted that the upgradation works would improve the water flow the Itchapur MPS to the Arupara STP.

The team further highlighted that there will be potential temporary disturbances during the construction period of the project, such as access disruption, particularly during the pipeline upgradation works.

The community members present at the meeting indicated that they will cooperate with the project activities as they view it as a public good.

They however requested that they be given prior information before starting of the proposed works and also requested that the road be repaired after completion of the works.

Photo Evidence:

ROJECT NAME: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY FOR UPGRADATION OF SEWAGE TREATMENT PLANT (STP) AT ARUPARA AND BALLY. HOWRAH MUNICIPAL CORPORATION, HOWRAH, WEST BENGAL
PROGRAMME: CONSULTATION WITH WORKERS AT SEWAGE TREATMENT PLANT AND ASSOCIATED FACILITIES AT ARUPARA AND BALLY
VENUE: CHITTARANJAN BAYAM SAMITI, HOWRAH, WEST BENGAL
DATE: TUESDAY, 17th OF SEPTEMBER 2019

Sl No	Name	Occupation/Designation	Address and Contact No.	Signature
1.	Satyajit Chanda	Operator M.C.E Contactor	Uttar Podrah, Howrah - 9, 8017708831	[signature]
2	Kartick Mondal	Do	B.E. College Pump House; Howrah - 3	K Mondal. 9433808507
3.	Partha Pramanik	J.E., KMDA	DIV. D&M-I/GAP-I Dasnagar, Howrah	[signature]
4.	Tapas Kr. Sarkar	A.E. KMDA	- Do -	[signature]
5	Partha Pratim Bandyopadhyay	EE (E/M) KMDA	GAP-II (E/M)	[signature]
6	Debashis Ganguly	EE/GAP/WB-I	GAP (WB-I), KMDA	[signature]
7	Anjan Kumar Bhunya	A.E (Civil) KMDA	Div. - O&M - I/GAP - I Dasnagar Howrah.	ABhunya.
8.	Sushanta Kumar Banerjee	AE(C) KMDA	GAP (WB-I) KMDA	[signature]
9.	Sibu Chandra Dey	A.E (E/M) KMDA	GAP(E/M) - I, KMDA	[signature]
10	Sanjoy Bhattacharya	Arupara Pump House - (Incharge)	Account cum ... 8296528273	[signature]

Sl No	Name	Occupation Designation	Address & Contact No	Signature
11.	Sibangshu Kr. Mukherjee	Incharge/Operator	Arupara Associated Co.op. 9831064521	[signature]
12.	Sukit Roy.	Incharge/Operator	Arupara Associated Co.op. 6290746068	S. Roy.
13.	Sailen Das	Incharge/operator	Arupara Associated Co. 8013975709	[signature]
14.	Jiban Mojumdar	Secretary Associated Co.op.	9903332445	[signature] 17.09.19
15	Samar Nath Chakraborty	operator -	Ichapur pump house 9830363665	[signature] 17.09.19
16	Amar Saha	Chairman Associated Co-op	Ghusuri Pump Ho. 9896576829	Amar Saha
17	Amalesh Ch. Jana	Director Ganga Action Plan Co-op	7478751976	[signature]
18	Banwari Lal Das	Vice Chairman Ganga Action Plan Contract Workers Co-op Society	9688977590633	[signature]
19	Pradip Kr. Chandra	Chairman Ganga Action Plan Contract Workers Co-op Society LTD	9681274101	[signature]
20	ANANTA SINHA	VA TECH WABAG Chief Manager (O&M)	9330681521	[signature]
21	S. K. Ganguly	VA TECH WABAG Chief Mgr - Project	8260741804	[signature]
22	SANTANU ROY	VATECH WABAG Chief Manager	9383524323	[signature] 17.09.19

Sl No	Name.	Occupation/Designation	Address & Contact NO	Signature.
23	Arindam Taluleda	Va Tech Wabag Ltd	8100833348	Arindam Taluleda
24	Mayanka Singh Nagpiar	ERM India Pvt Ltd	8451038225	[illegible]
25	Dr. Dmjoy Mallick	ERM India Pvt Ltd	9830029865	[illegible]

APPENDIX M KMDA LETTER TO CEO NMCG MINUTES ON 2ND REVIEW MEETING DATED 22ND OCT, 2019

Pr-12013/15/2018/PPP/NMCG

National Mission for Clean Ganga

Ministry of Jal Shakti

1st Floor, Major Dhyan Chand National Stadium,
India Gate, New Delhi-110 002.
Dated: November 7, 2019

Subject: Minutes of 2nd Review Meeting of progress of achievement of conditions Precedent by the stakeholders of Howrah, Bally and Baranagar & Kamarhati STP Projects under HAM held on 22nd October 2019 under the chairmanship of Director General, NMCG

Please find the attached MoM of 2nd Review Meeting of progress of achievement of conditions Precedent by the stakeholders of Howrah, Bally and Baranagar & Kamarhati STP Projects under HAM, held on 22nd October 2019 at NMCG, for your perusal and necessary action.

Madhava Kumar R
Sr. Economic Financial Analysis expert
National Mission for Clean Ganga

Enclosures: As above

To,
1. Chief Executive Officer, KMDA
2. Mr. Swadhin Samantaray, VA Tech Wabag

Copy to:
1. Office of the DG, NMCG
2. Office of the ED(Projects), NMCG
3. Director (T-III), NMCG

Minutes of 2nd Review Meeting of progress of achievement of conditions Precedent by the stakeholders of Howrah, Bally and Baranagar & Kamarhati STP Projects under HAM held on 22nd October 2019 under the chairmanship of Director General, NMCG

List of participants is enclosed in Annexure-I.

Ganga Amantran – River Rafting Expedition

1. The meeting was started with discussion on '*Ganga Amantran-River Rafting Expedition*'. It was informed that the rafting team will reach West Bengal on 6th November 2019 at '*Farakka*' and ends with '*Bakkhali Sea Beach*' on 12th November 2019. DG, NMCG instructed the SPMG/KMDA to provide support on logistics, boarding within the budget of Rs.2,00,000/- and IEC activities in the tentative budget ofRs.50,000/-. Further, SPMG/EA was asked to depute Nodal Officer for coordination in this regard.

Howrah, Bally and Baranagar

1. The Concession Agreement for the project was signed on 5th June 2019and 120 days for achievement of conditions precedent lapsed on 3rd October 2019.The Basic Engineering Package (BEP) submitted by the concessionaire has been submitted to IIT, Kharagpur by KMDA the approval is still awaited. It was directed to expedite the approval process.

2. In connection to the employability of people deployed by KMDA for operating existing facilities, it was decided in the last meeting that KMDA and concessionaire shall conduct a consultative meeting with the existing employees within 2 weeks and submit the necessary action plan to the lender (IFC, ADB). However, till date it is not been concluded. Further, concessionaire stated that in order to prepare and finalise the Resettlement Action Plan (RAP), inputs from KMDA is pending. It was instructed to complete the assessment and submit the necessary EISA report to IFC within two (2) weeks.

3. Representative from ADB informed that the concessionaire shall be indemnified from the existing STP site contaminations and shall be insulated from any Liquidated Damages (LDs) due to that. It was informed that the existing site conditions/contaminations shall not be a constraint on assessing the non-performance of the STPs. In any ways concessionaire was requested to prepare a report on site contaminations and submit the same to KMDA for scrutiny.

4. KMDA and Concessionaire informed that application for Consent to Establish (CTE) for new STPs at Howrah, Baranagar & Kamarhati have been submitted to WBPCB and the approval is expected on 8th November 2019.

5. Concessionaire has requested to extend timeline for achievement of conditions precedent till 1st February 2020 stating the delay in approval on basic engineering packages and finalization of ESIA. DG, NMCG expressed his concerns about lack of coordination between KMDA and the concessionaire in obtaining approval on Basic Engineering Package (BEP) and instructed that achievement of conditions precedent is the joint responsibility of all parties. However, it was decided that based on the progress by the concessionaire in coming days, extension of time 2to3 months beyond the initial 4 months' period will be decided for achievement of conditions precedent in due course.

6. The meeting ended with vote of thanks to the chair.

Minutes of 2nd Review Meeting of progress of achievement of conditions Precedent by the stakeholders of Howrah, Bally and Baranagar & Kamarhati STP Projects under HAM held on 22nd October 2019 under the chairmanship of Director General, NMCG

List of participants is enclosed in Annexure-I.

Ganga Amantran – River Rafting Expedition

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Howrah, Bally and Baranagar

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6. The meeting ended with vote of thanks to the chair.

Annexure I: List of participants

1. Director General -NMCG
2. Executive Director (Finance)- NMCG
3. Dr. Pravin Kumar, Director (T-III) –NMCG
4. Sh. Madhava Kumar, SEFAE – NMCG
5. Sh. B. Sengupta, CE/GAP –KMDA
6. Sh. S. Mukherjee, KMDA
7. Sh. Udayan Mandal – KMDA
8. Sh. Swadhin Samantaray, VA Tech Wabag
9. Sh. S. Varadarajan, VA TECH Wabag
10. Sh. Manjay Verma, VA TECH Wabag
11. Sh. K. N. Apasal, ADB
12. Sh. Senthil Kumar , NMCG
13. Sh. Sherya Sharda, PwC

APPENDIX N CONCESSIONAIRE'S LETTER TO KMDA DATED 27TH NOVEMBER, 2019

An ISO 9001 Company

KMDA-NMCG/Proj/016/19-20

27th Nov 2019

The Chief Executive Officer,
Kolkata Metropolitan Development Authority,
3rd Floor, Unnayan Bhavan,
Salt Lake City, Kolkata – 700 091

Kind Attn: Smt. Antara Acharya, IAS

Subject : Regarding pending CP Issues of KMDA Baranagar, Aurupara and Bali STP Project on HAM model under Namami Gange Program.

Reference : LoA Ref. no: 165/SE(N)/GAP/W&S/KMDA/W-29 Dated: 06th March 2019 Concession Agreement signed on 5th June 2019

Dear Madam,

We thank you so much for your valuable time in meeting us on the subject matter during our visit to your office on 27th November 2019. Wabag is equally keen to achieve the financial closure of the KMDA STP Project sooner and we are grateful to you and the senior officers of KMDA for the support assured to us in this regard.

We discussed on the following pending obligations/issues which are related to achievement of "Financial Closure" of project which are more in nature of CPs of KMDA :

1) **Article 3.8 *Handover of existing facilities free of all encumbrances as CP :***
   a. **Sub-clause (a)** : In line with discussion in NMCG review meeting held on 22.10.2019 in New Delhi, we shall facilitate re-engagement of around 25 nos of existing workers. KMDA to identify alternate sites for rest of them from the list of workers provided by KMDA. KMDA may kindly advice concerned person to provide age/identity proof for the ones chosen.
   b. **Sub Clause (b)(ii)** : *The Concessionaire to complete survey of the existing facilities and notify structures that it would want the KMDA to remove from the relevant Site (Baranagar) prior to the respective Effective Date :*
   Wabag would like to mention:
      - KMDA may retain few identified structures based on survey and discussion viz Admin Building, Centrifuge Shed and Sludge Storage Shed because these 3 building are neither to be used in our system nor these are obstructing our STP layout in Baranagar. This can save cost of demolition & transportation.
      - Wabag would explore possibility of retaining part of base raft of "Secondary Clarifier" & "Digester" so that saving on demolition & transportation to that extent is feasible. This will be discussed in detail with KMDA team to come to a conclusion.
      - All other existing structures and buildings can be demolished including disposal of debris and hazardous waste generated during demolition.

Sustainable solutions, for a better life

VA TECH WABAG LIMITED
CIN : L45205TN1995PLC030231
"WABAG HOUSE"
No.17, 200 Feet Thoraipakkam - Pallavaram Main Road,
Sunnambu Kolathur, Chennai - 600 117, India.

Board : +91-44-6123 2323
: +91-44-4223 2323
Fax : +91-44-6123 2324
Email : wabag@wabag.in
Web : www.wabag.com

An ISO 9001 Company

KMDA's support with copy of drawings of existing structure or more specific narration of structure to be removed / retained would be greatly appreciated.

*Please refer to **Annexure-II** for extract of relevant portion of Article 3.8*

c. Permits / Approvals from WBPCB, Railway, NHAI & Local Municipality Authority at appropriate time and ROW, free of encumbrances during construction is requested.
*Please refer to **Annexure-III** for extract of relevant portion of Article 3.3*

2) **Article 11.1 Sub-clause (d) *Indemnity and Limitation of Liability:* *Indemnity is provided for any environmental pollution or health hazard caused by the quality of raw sewage in Article 11.1.*** Inclusion of spillage of potential contamination of soil and underground water in Baranagar STP site due to surficial intrusion of MSW leachate, requested. This was also discussed in NMCG's meeting on 22.10.2019 in the presence of lender. Copy of MOM extract is enclosed. Please find attached report on contamination of water as discussed.
*Please refer to **Annexure I** for extract of relevant portion of **Article 11.1***

3) MSW site adjacent to Baranagar STP premises - construction of high boundary wall requested. This was agreed in meeting held on 4th June 2019 in KMDA and during our yesterday's meeting.
4) Approach Road for "Bally STP" - Some broadening & strengthening of existing road requested. This was agreed in meeting held on 4th June 2019 in KMDA and during our yesterday's meeting.
5) **Vetting/approval of Design & Drawings by IIT Kharagpur :** Wabag submitted the drawings to KMDA on 5th of July as per CA. KMDA approved the same on 10th August. These drawings were to be approved by IIT in 30 days. Considering the delay, we request support in facilitating the approval by IIT. Wabag has deployed its design engineers in Kolkata for this purpose and they shall meet the Professor concerned in Kharagpur or Kolkata as required.
6) **Appointment of Project Engineer by NMCG for Project :** This would be required soon on achieving Financial closure.

As advised by you, we would seek your appointment for review of progress in the above matters after two weeks time.

Yours truly
For **VA TECH WABAG LTD.**

VA TECH WABAG LIMITED

(SWADHIN SAMANTARAY)
Head-Capital Projects

Copy to:-

1. **Executive Director – Projects**
   National Mission for Clean Ganga
   1st floor, Major Dhyanchand National Stadium, India Gate, New Delhi – 110002
2. Sh. Bhaskar Sengupta CE/ GAP -KMDA
3. Sh. Udayan Mandal SE / GAP - KMDA

Encls: 1) Annexure 1-3
2) Baranagar Soil & Ground Water Contamination Test Report
3) MOM dtd. 22nd Oct'2019 with NMCG

Sustainable Solutions, for a better life

WABAG
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Fax : +91-44-6123 2324
Email : wabag@wabag.in
Web : www.wabag.com

APPENDIX O IBAT SCREENING

Proximity Report

BALLY 2

Country: India

Location: [22.6, 88.3]

Date of analysis: 25 February 2020

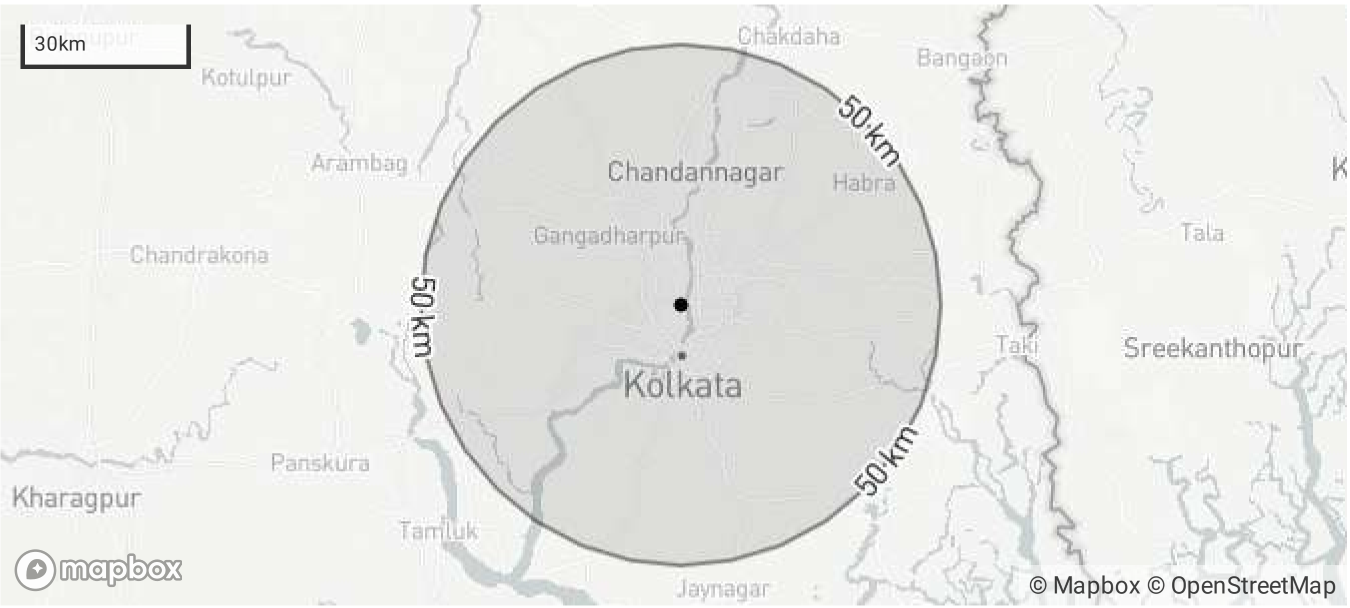
Buffers applied: 50.0 km

Generated by: Abhishek Roy Goswani

Company/Subscriber: Environmental Resources Management

Overlaps with:

Protected Areas	2
Key Biodiversity Areas	0
IUCN Red List	111



Displaying project location and buffers: 50.0 km

About this report

This report presents the results of [3296-7207] proximity analysis to identify the biodiversity features and species which are located within the following buffers: 50.0 km.

This report is one part of a package generated by IBAT on 25 February 2020 that includes full list of all species, protected areas, Key Biodiversity Areas in CSV format, maps showing the area of interest in relation to these features, and a 'How to read IBAT reports' document.

Data used to generate this report

- UNEP-WCMC and IUCN, 2020. Protected Planet: The World Database on Protected Areas (WDPA)[On-line], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net - February 2020.
- BirdLife International (on behalf of the KBA Partnership), 2019. Key Biodiversity Areas - October 2019.
- IUCN, 2020. IUCN Red List of Threatened Species - January 2020.

Protected Areas

The following protected areas are found within 50.0 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

Area name	Within buffer of
East Calcutta Wetlands	50.0 km
Narendrapur	50.0 km

Key Biodiversity Areas

The following key biodiversity areas are found within 50.0 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

No KBAs within buffer distance

IUCN Red List of Threatened Species

The following threatened species are potentially found within 50km of the area of interest.

For the full IUCN Red List please refer to the associated csv in the report folder.

Species name	Common name	IUCN Category	Taxonomic Class
Acropora rudis		EN	Anthozoa
Aetobatus flagellum	Longhead eagle ray	EN	Chondrichthyes
Aetobatus ocellatus	Spotted eagle ray	VU	Chondrichthyes
Aetomylaeus maculatus	Mottled eagle ray	EN	Chondrichthyes
Aetomylaeus nichofii	Banded eagle ray	VU	Chondrichthyes
Alopias pelagicus	Pelagic thresher	EN	Chondrichthyes

Species name	Common name	IUCN Category	Taxonomic Class
Alopias superciliosus	Bigeye thresher	VU	Chondrichthyes
Alopias vulpinus	Common thresher	VU	Chondrichthyes
Anacyclus pyrethrum	Atlas daisy	VU	Magnoliopsida
Anoxypristis cuspidata	Narrow sawfish	EN	Chondrichthyes
Aquila heliaca	Eastern imperial eagle	VU	Aves
Aquila nipalensis	Steppe eagle	EN	Aves
Aythya baeri	Baer's pochard	CR	Aves
Aythya ferina	Common pochard	VU	Aves
Balaenoptera musculus	Blue whale	EN	Mammalia
Batagur baska	Northern river terrapin	CR	Reptilia
Batagur dhongoka	Three-striped roofed turtle	CR	Reptilia
Batagur kachuga	Red-crowned roofed turtle	CR	Reptilia
Calidris pygmaea	Spoon-billed sandpiper	CR	Aves
Calidris tenuirostris	Great knot	EN	Aves
Carcharhinus albimarginatus	Silvertip shark	VU	Chondrichthyes
Carcharhinus falciformis	Silky shark	VU	Chondrichthyes
Carcharhinus hemiodon	Pondicherry shark	CR	Chondrichthyes

Species name	Common name	IUCN Category	Taxonomic Class
Carcharhinus longimanus	Oceanic whitetip shark	CR	Chondrichthyes
Carcharias taurus	Sand tiger shark	VU	Chondrichthyes
Carcharodon carcharias	White shark	VU	Chondrichthyes
Chaenogaleus macrostoma	Hooktooth shark	VU	Chondrichthyes
Chaetornis striata	Bristled grassbird	VU	Aves
Clanga clanga	Greater spotted eagle	VU	Aves
Clanga hastata	Indian spotted eagle	VU	Aves
Crocodylus palustris	Mugger	VU	Reptilia
Dermochelys coriacea	Leatherback	VU	Reptilia
Eretmochelys imbricata	Hawksbill turtle	CR	Reptilia
Eusphyra blochii	Winghead shark	EN	Chondrichthyes
Francolinus gularis	Swamp francolin	VU	Aves
Geoclemys hamiltonii	Spotted pond turtle	EN	Reptilia
Glaucostegus typus	Giant guitarfish	CR	Chondrichthyes
Glyphis gangeticus	Ganges shark	CR	Chondrichthyes
Gymnura zonura		VU	Chondrichthyes
Gyps bengalensis	White-rumped vulture	CR	Aves

Species name	Common name	IUCN Category	Taxonomic Class
Gyps indicus	Indian vulture	CR	Aves
Gyps tenuirostris	Slender-billed vulture	CR	Aves
Haliaeetus leucoryphus	Pallas's fish-eagle	EN	Aves
Halophila beccarii	Ocean turf grass	VU	Liliopsida
Heliopora coerulea		VU	Anthozoa
Hemipristis elongata	Snaggletooth shark	VU	Chondrichthyes
Heritiera fomes		EN	Magnoliopsida
Himantura uarnak	Reticulate whipray	VU	Chondrichthyes
Hippocampus histrix	Thorny seahorse	VU	Actinopterygii
Hippocampus kelloggi	Great seahorse	VU	Actinopterygii
Hippocampus spinosissimus	Hedgehog seahorse	VU	Actinopterygii
Hippocampus trimaculatus	Three-spot seahorse	VU	Actinopterygii
Holothuria fuscogilva		VU	Holothuroidea
Holothuria lessoni		EN	Holothuroidea
Holothuria scabra		EN	Holothuroidea
Isurus oxyrinchus	Shortfin mako	EN	Chondrichthyes
Isurus paucus	Longfin mako	EN	Chondrichthyes

Species name	Common name	IUCN Category	Taxonomic Class
Lamiopsis temminckii	Broadfin shark	EN	Chondrichthyes
Lepidochelys olivacea	Olive ridley	VU	Reptilia
Leptoptilos dubius	Greater adjutant	EN	Aves
Leptoptilos javanicus	Lesser adjutant	VU	Aves
Lonchura oryzivora	Java sparrow	EN	Aves
Lutrogale perspicillata	Smooth-coated otter	VU	Mammalia
Maculabatis gerrardi	Whitespotted whipray	VU	Chondrichthyes
Manis crassicaudata	Indian pangolin	EN	Mammalia
Melursus ursinus	Sloth bear	VU	Mammalia
Mobula alfredi	Reef manta ray	VU	Chondrichthyes
Mobula birostris	Giant manta ray	VU	Chondrichthyes
Mobula mobular	Giant devilray	EN	Chondrichthyes
Mobula tarapacana	Sicklefin devilray	EN	Chondrichthyes
Mobula thurstoni	Bentfin devilray	EN	Chondrichthyes
Mola mola	Ocean sunfish	VU	Actinopterygii
Nebrius ferrugineus	Tawny nurse shark	VU	Chondrichthyes
Negaprion acutidens	Sharptooth lemon shark	VU	Chondrichthyes

Species name	Common name	IUCN Category	Taxonomic Class
Neophocaena phocaenoides	Indo-pacific finless porpoise	VU	Mammalia
Neophron percnopterus	Egyptian vulture	EN	Aves
Omobranchus smithi		VU	Actinopterygii
Ophiophagus hannah	King cobra	VU	Reptilia
Orcaella brevirostris	Irrawaddy dolphin	EN	Mammalia
Oryza malampuzhaensis		VU	Liliopsida
Panthera pardus	Leopard	VU	Mammalia
Panthera tigris	Tiger	EN	Mammalia
Pateobatis jenkinsii	Jenkins' whipray	VU	Chondrichthyes
Pateobatis uarnacoides	Bleeker's whipray	VU	Chondrichthyes
Physeter macrocephalus	Sperm whale	VU	Mammalia
Platanista gangetica	South asian river dolphin	EN	Mammalia
Prionailurus viverrinus	Fishing cat	VU	Mammalia
Pristis clavata	Dwarf sawfish	EN	Chondrichthyes
Pristis pristis	Largetooth sawfish	CR	Chondrichthyes
Pristis zijsron	Green sawfish	CR	Chondrichthyes
Python bivittatus	Burmese python	VU	Reptilia

Species name	Common name	IUCN Category	Taxonomic Class
Rhina ancylostoma	Bowmouth guitarfish	CR	Chondrichthyes
Rhincodon typus	Whale shark	EN	Chondrichthyes
Rhinoceros unicornis	Greater one-horned rhino	VU	Mammalia
Rhynchobatus australiae	Bottlenose wedgefish	CR	Chondrichthyes
Rhynchobatus laevis	Smoothnose wedgefish	CR	Chondrichthyes
Rusa unicolor	Sambar	VU	Mammalia
Sarcogyps calvus	Red-headed vulture	CR	Aves
Sonneratia griffithii		CR	Magnoliopsida
Sousa chinensis	Indo-pacific humpback dolphin	VU	Mammalia
Sphyrna lewini	Scalloped hammerhead	CR	Chondrichthyes
Sphyrna mokarran	Great hammerhead	CR	Chondrichthyes
Stegostoma tigrinum	Zebra shark	EN	Chondrichthyes
Sterna acuticauda	Black-bellied tern	EN	Aves
Stichopus herrmanni		VU	Holothuroidea
Taeniurops meyeni	Blotched fantail ray	VU	Chondrichthyes
Thelenota ananas		EN	Holothuroidea
Tringa guttifer	Spotted greenshank	EN	Aves

Species name	Common name	IUCN Category	Taxonomic Class
Urogymnus asperrimus	Porcupine ray	VU	Chondrichthyes
Urogymnus polylepis		EN	Chondrichthyes
Wallago attu		VU	Actinopterygii

Recommended citation

IBAT Proximity Report, 2018. Generated under licence 3296-7207 from the Integrated Biodiversity Assessment Tool on 25/02/2020. http://www.ibat-alliance.org

How to use this report

This report provides an indication of the potential biodiversity-related features - protected areas, key biodiversity areas and species - close to the specified location. It provides an early indication of potential biodiversity concerns, and can provide valuable guidance in making decisions. For example, this information can be helpful when assessing the potential environmental risk and impact of a site, categorising investments/projects, preparing the terms of reference for an impact assessment, focusing attention on key species of conservation concern and sites of known conservation value, and reviewing the results of an impact assessment.

The report does not provide details of potential indirect, downstream or cumulative impacts. Furthermore, the report should be regarded as a “first-step”, providing a set of conservation values sourced from global data sets, and is not a substitute for further investigation and due diligence, especially concerning national and/or local conservation priorities.

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