Environmental and Social Impact Assessment for Sewage Treatment Plant in Baranagar

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-Litre 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 Baranagar STP. The existing Baranagar STP is located in Matkal, under Baranagar Municipality (Ward Number 18) and is one of the sub-projects under the project titled “Development of Sewerage Treatment Plants – Kolkata City Area” of KMDA. This project would involve the decommissioning and dismantling including demolition of decommissioning of the existing 40 MLD STP followed by construction of a new STP of 60 MLD capacity. The existing STP and its linked sewerage infrastructure fall under Baranagar and Kamarhati Municipalities respectively. These fall under the administrative jurisdiction of the North 24 Parganas 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. Baranagar, Arupara and Bally, and this ESIA is only focused on Baranagar and separate ESIAs have been completed for Arupara 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 guidelines and requirements of the International Finance Corporation (IFC).

B) Policy, Legal & Administrative Framework

Environment

6. The proposed project activity involves decommissioning of existing STP infrastructure, construction of new Baranagar STP, renovation 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 institution 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 will apply. 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 40 MLD Baranagar STP was constructed in South Dumdum Municipality initially under the Ganga Action Plan (GAP) scheme to reduce the pollution of the Ganga River in the year of 1996. Additionally, as part of the scheme's second phase (2004-06), KMDA created a structure for interception and diversion of the sewage carrying drains located in Baranagar and Kamarhati

Municipalities to divert the sewage water towards the MPS. The old Baranagar sewage treatment plant and linked sewage infrastructure comprises of underground Gravity sewer line network, four Interception & Diversion (I&D) structures, one Main Pumping Station (MPS), Rising main from MPS to STP, defunct STP and the outlet pipe. The old STP was functional until 2011 and after 2011; the STP gradually loses its efficiency and completely stop functioning from June 2018 due to end of operational life cycle.

13. The project area for Baranagar Sewage Treatment Facility comprises of South Dumdum municipality, Baranagar Municipality and Kamarhati Municipality located in North 24 Parganas District of West Bengal State. The existing STP is located in Matkol area, on the far eastern edge of Ward number 18 of the Baranagar municipality and at the tri-junction point of Baranagar, South Dum and North Dum Dum municipalities. The existing main pumping station is located at Rabindranath Tagore Road, under Kamarhati municipality. The total length of existing inlet gravity sewer line is 8.3km of which 4.7 km of gravity sewer line is within Baranagar municipality and the rest of 3.6 km gravity sewer line is within Kamarhati municipality.

14. A new 60 MLD STP will be constructed in place of existing 40 MLD, new pipelines will laid in place of existing pipelines and I&D structures will be replaced. The proposed new STP project will utilize the existing land and infrastructure of the sewage treatment facility and linked sewerage infrastructure of the old Baranagar STP. The total area of the proposed STP facility will be 18,681.3 m^2.

15. Old structures which cannot be utilized will be dismantled and demolished for installation of new structures as per the project design. As part of the proposed project activity, old pipelines and old I&D structures will be replaced and existing main pumping station and the linked equipment will be renovated. Reportedly, the new route of rising main from MPS to STP will be finalized and will subject to minor alterations during construction phase. 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. Reportedly, in the first year of the construction, when majorly civil work will be undertaken, on an average, 300-350 workers will be required and in the second year, when majorly technical work will be undertaken, the manpower 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.

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 m3/day. Another 0.1 m3/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 and infrastructure of the old STP and will not involve any additional ROW/ land acquisition. The total requirement for the proposed STP facility will be 18,681.3 m^2 and the same land area will be fulfilled within the old Baranagar STP premises. The renovation work at the MPS will be done within the existing MPS facility, so no additional land will be required. As part of the project activity old de-functional I&D structures will be replaced and installation of these new I&D structures will require approximately 1 m^2 of area each. Regarding 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.

19. As per declaration submitted, it has been confirmed that the land for the old STP and STP linked facilities belongs to KMDA and that KMDA declaration further points out that there are no land ownership issue, disputes, grievances or court case raised against the land area of the STP and its linked facilities. Moreover, during execution of the project, if there is a requirement for any additional land acquisition, this will be carried out as per the direction of the Government of West Bengal following prevailing regulatory framework.

20. **Power:** During decommissioning and construction phase of the proposed project, portable Diesel Generator (DG) sets will be used as a common practice in India. During operational phase, existing grid connection will be used as the primary electricity source. Whereas, a backup DG set of 800 KVA capacity will be installed for emergency purpose during the operational phase of the project. A 800kW rated capacity biogas plant will be installed as part of the proposed project for generation of electricity by utilizing the biogas generated from the waste water treatment process. The power from bio-gas generation plant will also proposed to be utilized within the STP facility by wheeling through the local grid system. The estimated power requirement for construction phase will be estimated by the Concessionaire during finalization of the orders for project equipment (following vendor specifications of the respective equipment) during construction phase. The total power requirement for both construction and operation phases 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:** Decommissioning of existing STP, including demolition activities and construction of new facility involving 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 will lead to emission of fugitive dust. DG sets will be used during construction period, which will generate exhaust gas. During operational phase DG set will be operated as backup electricity source and biogas will be generated during the operation phase, which may be required to be flared under certain circumstances resulting in flare combustion products comprising of Carbon Monoxide, Total Volatile Organic Carbon (VOC) and Oxides of Nitrogen).

    a) **Liquid Discharges:** During construction phase, due to demolition of the old STP structure the source of liquid discharge will be the wastewater stored within the existing STP structures (two clarifiers). As the STP is non-functional over two years, the stored wastewater has more or less similar characteristics of rainwater that is collected in these open structures over the period. Hence, this liquid discharge was not considered as a potential source of pollution. During operational phase of the proposed project activity, treated water due to operation of the proposed 60 MLD STP will be discharged into adjacent canal. 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.

Hence, the discharge of the treated water from the proposed STP operation was not considered as a potential source of pollution.

b) **Solid Waste:** During demolition of existing structures at the old STP site, construction and demolition waste will be generated. The demolition waste from the existing electrical station and motorized instruments will generated electrical wastes. Dismantling of the mechanical instruments present at the site will generate metal scraps. Sludge will be generated during dewatering of clarifiers, desilting of gravity sewer line. Portion of the construction and demolition waste generated will be reused for backfilling activities, to the extent required. During operational phase sludge will be generated due to treatment of sewage water. Grit chambers and screens will be used to separate floating materials and grits. Sludge generated from the sewage water treatment will be used for the bio-gas generation and composting (end-use). The discarded solid wastes such as grit, screenings and silt during construction and operational phase will be disposed at the relevant waste disposal site to be identified by the KMDA within a radius of 10 km from the relevant Site, in accordance with the regulatory requirements.

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 and decommissioning 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 of North 24 Parganas has flat topography with average elevation from MSL (mean sea level) of about 5-6 m and having a gentle slope. In the early days of the urbanization of Kolkata, the area within the boundaries of the city had an abundance of depressions, low-lying waterlogged areas, ponds, ditches and tidal creeks with some of them housing mangrove swamps. Thereafter, rapid urbanisation has led to filling of the depressions through continues dumping with river side levee being the highest feature in the city and overall slope being towards the east

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 Ganga-Bhagirathi River system. The alluvium deposit can be divided into Recent Alluvium deposit and Older Alluvium deposit. Maximum clay

thickness of 25 mbgl (meter below ground level) was observed in south-eastern part of the district.

25. **Landuse:** The study area is located in predominantly urban settings. The broad landuse classes identified in the study area are water bodies, infrastructure corridors, drainage channels, settlements, vacant land and green cover. The green cover is 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 study area is part of Kolkata Metropolitan Area (KMA). Most areas of KMA have a century old drainage and sewerage system. The drainage system is divided into 25 drainage basins (Catchment Area) with 18 basins on the east bank and 7 on the west bank of the river Hooghly. Similarly, the entire metropolitan area of KMA is divided into 20 sewerage zones, 14 on the east bank and 6 on the west bank. These drainage used to drain both the storm water and sewage water. These drainage system is located in east-west direction to carry the wastewater and storm runoff from the western part of the city to the eastern part through different pumping stations for disposal into the Kulti River which is located at an aerial distance of 36 km from the city.
    The important canals are Bagjola Khal flowing from the eastern side of the STP facility area, Circular Canal flowing from the western side of the study area and Udaypur Canal flowing from west and southern side of the study area. Udaypur Canal meets the Bagjola khal on southern side of the study area. Bagjola khal meets the circular canal on the western part of the district. The Bagjola khal is a major drainage artery catering discharges from a large part of areas comprised of 5 to 6 municipalities in northern part of the city of Kolkata.

27. **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 water bodies within the study area that could potentially be impacted due to the operation of STP, including the upstream and downstream of the Udaypur canal and water bodies (ponds) at the surrounding localities. Surface water quality analysed was found to be in compliance with the surface water use criteria and classification in India as defined by Central Pollution Control Board.

28. **Groundwater Quality:** Groundwater samples were collected in two sets. The first set comprising of two samples, one tube well drawing from the deeper aquifer at around 60 – 65 m and 2nd tube well drawing from the shallow aquifer at a depth of 8 – 10 m located to the south of the site boundary from the study area for analysis of the water quality. The analysed parameter values were compared with IS 10500 (2012): Drinking Water Specification as applied in India and WHO drinking water limits to evaluate the suitability with respect to each parameter. The groundwater analysis has revealed that almost all the parameters were within the permissible limit of the IS 10500:2012 specification and WHO drinking water limits, except inter sample variations for the parameters Calcium, Iron, Magnesium, Nitrate and Total Hardness. The variation identified is considered to be due to the samples drawn from different the samples were taken from different aquifers. The exceedances of iron and chloride concentrations as well total hardness value in groundwater is more likely to be because of the inherent quality of groundwater of the study area as reported by Central Ground Water Board (CGWB), Government of India.

29. Additionally four groundwater samples were drawn from the test bore wells which were dug to 12 m depth and representing the perched water zone, shallow groundwater sample analytical results for the brownfield suite screened against the Dutch, USEPA and Indian drinking water standards indicated an exceedance of Manganese in all the four (4) wells w.r.t. the USEPA RSL and Indian Drinking Water Standard limits. Elevated Manganese in groundwater have found to be associated with shallow, anoxic water tables and soils enriched in organic carbon, suggesting soil-derived dissolved organic carbon that supports manganese reduction and mobilization in shallow groundwater, in other geographies. There is also a possibility that such higher Manganese

concentrations are contributed from industrial sources or anthropogenic induced activities, though it is difficult to arrive at such attribution based on the limited set of ground water analysis undertaken. A detailed Phase II, Environmental Site Assessment adopting ASTM 1903-11 standard, is proposed to explore probable sources and causes of elevated levels of contaminants in the groundwater.

30. **Soil Quality**: Soil samples were collected from four locations within existing Baranagar STP site for analysis of soil quality. Soil sample analytical results for the brownfield suite screened against the Dutch and USEPA standards indicated exceedance of Arsenic in all the four-soil boreholes w.r.t. the USEPA RSL limit and exceedance of Copper only in one soil boring location w.r.t. the Dutch standard. Per the CGWB 'Bhu-Jal News' journal (volume no. 24, no. 2 and 3, Apr-Sep 2009) the groundwater in the upper aquifer of the North 24 Parganas district, where the site is located, is naturally affected by arsenic beyond the 'permissible limit in absence of alternate source (0.05 mg/L)' per the Indian drinking water standard. Also per the CGWB – North 24 Parganas District Report, the groundwater upper aquifer of the North 24 Parganas district has been designated to be naturally affected by arsenic. A detailed Phase II, Environmental Site Assessment adopting ASTM 1903-11 standard, is proposed to explore probable sources and causes of elevated levels of contaminants in the soil.

31. **Climate and Meteorology:** The climate of North 24 Paraganas district, West Bengal 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 a summer from March to May. Winter season is characterized by dry weather. Rainfall occurs primarily during the south-west monsoon months i.e. June to September and constitutes about 74% of the total annual rainfall. Mean temperature for most period of the year besides winter season remains around 24.1 to 30.4 ºC. The relative humidity of South 24 Paraganas district is reported to be high (71% to 85%) throughout the year. The period between June to September is the monsoon season with the average annual rainfall of the district being about 1579 mm.

32. **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 and found in compliance except PM_{10}. The predominant PM_{10} levels around Kolkata metropolitan city area remains high.

33. **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 at all the four monitoring locations was found exceeding the daytime and night time standard for residential areas. The proximity of the study area with the Belghoria Expressway and other infrastructural corridors, adjacent railway lines as well as heavy equipment functioning at the Baranagar dumping ground was considered the reason for the variance.

34. **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. A major part of the North 24 Parganas district is characterized by low-lying areas with respect to the flood levels of the rivers in the respective basins. However, extensive man-made alterations of natural drainages in the Kolkata Metropolitan Area 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 area around the STP facility has not recently experienced any flooding or water-logging situation. Based on the report prepared by Climate Central on 29th October 2019 referring to the peer-reviewed paper published by Nature Communications, West Bengal and coastal Odisha are projected to be particularly vulnerable, as is the eastern city of Kolkata. Based on the referred scientific study details, 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

35. **Terrestrial ecosystem:** The predominant tree species recorded during site assessment inlvolves local floral species including Swietenia macrophylla, Dalbergia sissoo, Phyllanthus emblica, Azadirachta indica, Albizia lebbeck, Moringa oleifera, Terminalia cattapa, Bombax ceiba, Polyalthia longifolia. 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, etc. No protected floral species were recorded.

36. 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 6 species of terrestrial mammals, 26 species of avi-fauna, 2 amphibian species and 4 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.

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

38. A basic risk screening on biodiversity related sensitivity was undertaken utilizing the Integrated Biodiversity Assessment Tool (IBAT). The proximity analysis iidentified 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.

Socioeconomic Environment

39. Project area for the Sewage Treatment Plant (STP) and its linked facilities are situated in Baranagar Municipality as well as Kamarhati Municipality, both of which fall under the North 24 Parganas District of West Bengal. The old STP facility of Baranagar is located under South Dumdum Municipality under the North 24 Parganas District. A socio- economic baseline assessment has been conducted on the settlements situated within one-kilometre radius of the old Baranagar STP site as well as 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.

40. There are five main settlements within the vicinity of the STP namely Nowapara, Pramod Nagar, Satin Sen Nagar, West Rabindra Nagar and Adharsh Nagar. The settlements within the one kilometre radius of the STP site are located in various wards across Baranagar, Kamarhati, North Dum Dum and South Dum Dum Municipalities. As per the 2011 Census of India, the total population of North 24 Parganas district is 10,009,781 comprising of 2,348,683 households. Baranagar Municipality has a total population of 245,213 individuals residing in 63,387 households and constitutes approximately 2.4 percent of the total population of North 24 Parganas district. Whereas Kamarhati Municipality has a total population of 330,211 individuals residing in 70,107 households and constitutes approximately 2.4 percent of the total population of North 24 Parganas district.

41. Analysis on the demographic profile of the municipal wards and settlements within the one kilometre radius of the STP site indicates that there are approximately 15,547 HHs and a population of 60,944 persons, collectively, within the defined radius of one km from the Barangar STP. Out of 60,944 persons, 51% (31,146) are male, and 49% (29,797) are female and the average HH size is 3.9. It is observed that ward number 3 of South Dum Dum Municipality, where Pramod Nagar, Bedia Para and West Radindra Nagar settlements are located have the highest population density, followed by ward number 18 in Baranagar Municipality.

42. Analysis on the demographic profile of the municipal wards and settlements within the 500 metre buffer of the sewer line alignment indicated that there are approximately 71,145 HHs and a population of 312,982 persons, collectively, within the defined buffer zone. Out of 312,982 persons, 51.3% (160,628.9) are male, and 48.7% (152,353) are female and the average HH size is 4.4.

43. Based on the analysis on the occupational profile of the surveyed local population, out of 91 surveyed population, 28 individuals are presently working. Over 50% (14 numbers) of the surveyed population are shop owners out of which 13 are male and 1 is female. The shops include clothing shops, a cosmetics shop and a meat shop. 18% (5 numbers) are engaged in daily labour, out of which one is female and 4 are male. 14% (4 numbers) are running tea stalls and all are male. 11% (3 number) is engaged in private service, out of which 1 is female and 2 are male. 7% (2 numbers) are engaged in other activities which include working as driver who is a male, and as a female domestic worker. In addition, two tea stall owners are also engaged in daily labour as their secondary occupation. Out of the 28 surveyed population, approximately 2 shops will be potentially impacted on account of the project implementation activity (due to trunk sewer pipeline and I&D structure installation).

E) Potential Impacts and Mitigation Measures

44. 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 broadly 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

45. 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 dismantling of the OLD STP structure; storage of construction materials; physical presence of labour camps; movement

of transportation construction and demolition waste through trucks, tippers and dumpers, earth work along the pipeline route etc. The above mentioned activities are expected to create major long standing changes of the environmental setting. The aesthetics and visual impact is assessed to be minor.

46. During the period of the construction, the Project will ensure that the all the construction and demolition 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.

Potential Impact on Air Quality

47. During construction phase, the sources of emission are fugitive emission from demolition of concrete structures, construction material handling, earth work, and emission from machinery and vehicles. The pollutant especially particulate matter will be settled in areas surrounding proposed project site, 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. Construction activities such as transportation of materials, operation of heavy equipment and construction machinery are likely to cause increase in the ambient noise levels in and around the project site. 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. 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.

53. 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 and other pumps and equipments is estimated to be 90.14 dB.

Potential Impact due to odour

54. 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.

55. The dispersion of odour concentrations based on emissions from source of origin shows that the highest concentrations 28.31 OU/m^3 at a point located within 50 m from the source. At the point where the nearest receptors (~250 m) are present as also the infrastructure corridors (railway line and highway), the odour concentrations fall to values in the range of 1.00 OU/m^3 or lesser. In addition, the sensitivity of the site and its immediate vicinity can be considered to be relatively low because of prevailing high odour levels caused by the Baranagar waste dump and the Udaypur canal as also low population density in the immediate surroundings with no residential area within 500 m of the site.

56. 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. It is also anticipated that the odour from the STP will be masked sufficiently by the existing larger odour sources (garbage dump and Udaypur canal) and no incremental adverse odour impacts will be caused by the operation of the STP.

Potential Impact on Drainage

57. During project life-cycle potential scenarios impacting the surrounding drainage system are, firstly, dewatering of existing structures through electrically operated pumps and pipes discharging, secondly, storm water from dumpyard entering into STP complex through gaps along the shared boundary along, thirdly, 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 adjacent Udaypur canal due to natural slope. During study period, the carrying capacity of Udaypur canal estimated to be 652.61 MLD. Hence it has been inferred that excess load of 60 MLD from STP operation will not have any impact on the drainage of the surrounding or will affect the load bearing capacities of the Bagjola canal system. The potential impact scenarios as discussed above will also have negligible impact on the drainage due to buffer carrying capacity of ~590 MLD. Therefore the impact significance is assessed to be negligible.

Potential Impact on Surface Water Quality

59. During construction phase, no adverse impact on surface water quality is envisaged. Although due to dismantling of the old STP structures, the wastewater stored within the existing clarifier structures will be discharged to the adjacent Udaipur canal, but since the old STP is reported to be non-functional over two years, the stored wastewater has more or less similar characteristics of rainwater that is collected in the these open structures over the period.

60. During operational phase of the proposed project activity, treated water due to operation of the proposed 60 MLD STP will be discharged into adjacent canal. 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. The

Udaypur canal, 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 Bagjola canal system has also been observed to be having similar conditions with the average observed BOD concentration in the range of 20 – 26 mg/l. Therefore 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, reportedly all water requirement during construction and demolition phase 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. Potential sources of impact for ground water contamination are minor oil and grease spillage, during maintenance of construction machinery, de-watering of existing STP structures, repair of pumps and compressors during operational phase. Depth of shallow aquifer in the study area varies from 60-80 m; the top of the shallow aquifer is characterized by aquitard formation composed of sandy/ slity clay with limited permeability. The aquitard formation is overlain by alluvial soil with very limited permiablity (vertical and horizontal). The aquitard is underlain by alluvial clay deposit.

62. The proposed STP structural design will not permit any percolation to the soil. Any accidental discharge from the STP if occurred will be restricted to the upper soil as the geology of the area doesn't allow any percolation into soil. Hence there is no potential risk related to contamination of groundwater due to STP operation is envisaged and potential impact on groundwater quality due to operation of the proposed STP is assessed to be negligible.

63. Any potentiality of ground water contamination due to presence of adjacent Baranagar dumpyard will be confined to limited within or around the dumpyard site due low permeability of the aquitard. However a detailed phase II Environmental Site Assessment (ESA) study is proposed for the project site area to understand any exiting level of soil and groundwater contamination status and there potential sources.

Potential Impact on Soil Quality

64. During construction phase, existing structures of the old STP will be dewatered before the dismantling the concrete structures. Retained water in the existing STP structures will be pumped and discharged into adjacent Udaypur canal through dewatering pumps. Any major Leakage from this dewatering arrangement in not envisaged as the operational integrity will be maintained. Any potential contamination of the soil due to the exposure during dewatering process is not considered to be creating soil contamination, since the old STP is reported to be non-functional over two years, the stored wastewater has more or less similar characteristics of rainwater that is collected in the these open structures over the period.

65. 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

66. Major heavy vehicle movement around the project site is envisaged only during construction phase. Major movement of the trucks, tippers, and other heavy machinery that will be mobilized

for carrying construction and demolition waste, other solid wastes, construction materials and plant machineries. Those heavy vehicles will be using the Belghoria expressway and arterial site access road. Based on the baseline traffic survey conducted, average peak hourly traffic on this route was 3.93 PCU/Hr (up) and 8.19PCU/hr (down) number of vehicles per hour and maximum traffic load was 19 PCU per hour. The arterial site access road has the carrying capacity of 35 tons vehicles. Therefore movement of heavy vehicles along the Belghoria expressway and arterial site access road will not cause perceptible changes in the existing scenario as the arterial site access road is mostly used by the trucks accessing to the adjacent Baranagar dump yard or heavy vehicles carrying materials/ equipment for the nearby metro railway site. That arterial road is not used by the local resident for day to day activities. Therefore the envisaged additional load of 10-15 PCU/day of traffic load for the site access road will not cause major changes. Therefore potential impact on road traffic is assessed to be **minor**.

Potential Impact on Community Health & Safety

67. Construction materials and heavy equipment used during the construction phase will be brought into the site by heavy vehicles. Though it will not cause any traffic congestions on Belghoria expressway along with the arterial site access road and possible disruption to the community usage of roads – it will increase the inconvenience to community in terms of air and noise pollution caused by loading and unloading of materials and construction. 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.

68. Since 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 the 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 is assessed to be minor. Adequate mitigation measures as outlined in the ESMP will be implemented to prevent and minimize impacts on community health and safety.

Potential Impact on Occupational Health & Safety

69. During construction phase, the site activity will involve, demolition activities for existing STP structures; waste handling and storage; material handling and storage; welding and gas cutting activities; use of heavy earth moving equipment; installation of electrical equipment etc. These identified impact sources are considered to be hazard prone and may involve a significant amount of risk for the workers present at the construction site. 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 and demolition workers and people residing within the construction site.

70. During decommissioning and construction phase, different embedded occupational health and safety control measures will be implemented including use of Personal Protective Equipment (PPE), Health and Safety policy and procedures, Project specific Health and Safety committee to ensure worker safeguarding. Therefore, overall impact on the occupational health and safety with considering the embedded control systems is assessed to be Minor.

Potential Social Impact due to Access Disruption

71. During construction phase, the proposed project will entail temporary access disruption during renovation and replacement of the sewer lines involving laying of new gravity sewer lines, rising main and replacement of sewer line. These will involve, excavation work, removal of debris and piling up of mud earth along the roadside for replacement of 8.5 km gravity sewer line and replacement of new rising mains of 2.7 km from Baranagar-Kamarhati MPS to STP. Movement of large construction machinery and vehicular movement for transportation of construction materials will also likely to cause access disruption.

72. Based on the site assessment, the alignment of the existing sewer line will traverse through congested market and residential areas. Since the roads along with the sewer lines involve congested areas, the proposed laying of the sewer pipelines may temporarily impact business of these vendors.

73. Construction work along the sewer line 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.

74. Replacement of sewer lines in stretches will be undertaken in stretches. In one each day, the maximum stretch at one location for the construction work which include trench excavation and replacement will be covering 25 Meters. Therefore, the total duration of all stages (Excavation, Laying & Back filling) of sewer line replacement work in one day will be 10-12 working Hours. The construction work will be carried out during off-business hours from 1:00pm to next day morning 6:00am. Along with these, a Traffic Safety Management Plan will be put in place for contractor to comply during construction carry out work on the road in a manner creating least interference to the flow traffic while consistent with the satisfactory execution. 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 Social Impact due to temporary Loss of Income

75. Road side vendors and shops who are operating their businesses as squatters within the RoW of existing government roads and the trunk sewer pipelines will be laid within the RoW of existing roads. 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 (sewer line) will face temporary disruption to on-going commercial and vending activities leading. That will lead to temporary income loss for the commercial establishments and roadside vendors during the construction period estimated to be around 3 days for a road stretch of 25 meters.

76. 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

77. Based on analysis of the secondary data on employment ability showed that 34.7 percent of the total population under Baranagar Municipality are main workforce, 2.7 percent are marginal workforce, out of which only 16.2 percent are female main workers, and 43.4 percent are female

marginal workers. Also, based on the primary socio-economic survey undertaken in Baranagar project location indicate at 18 percent female work participation, 0.85 percent women are involved into household industries in Baranagar Municipality area. This indicates that the overall women participation as work force is less in the study area. Furthermore, women's participation into civil construction work is limited to unskilled workers for carrying construction materials.

78. Hence, it is assessed that in the first year of the construction work when maximum number of unskilled workforce will majorly be required for civil construction work, there will be less women workforce participation. Therefore, during project construction phase participation of women in the construction workforce should be ensured to reduce gender disparity and enhance gender mainstreaming. GSPPL will implement the documented Prevention of Sexual Harassment (POSH) Policy for the project construction sites.

79. Apart from an improved sewerage system for the local inhabitants, the project can potentially bring about more economic opportunities for women, especially those residing in the project affected area. 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

80. At present there are 31 contractual workers employed at the Baranagar STP as well as the MPS, under the manpower supply contractors M/s Kakinara Engineer's Workers Co-operative Society and M/s Sunny Enterprise, respectively. 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.

81. 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

82. The proposed project involves de-commissioning of old 40 MLD STP facility at Baranagar and building a new 60 MLD sewage treatment plant along with renovation of the linked pumping station and sewer lines. 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

83. 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

84. Implementation of the proposed project activity will involve replacement of old/ existing sewer lines and laying of new rising main. The proposed sewer line renovation work will be carried out in the existing RoW connecting to the existing STP site and hence, no new alignment route will be required. Therefore as per the scope of the bounding Concession Agreement to GSPPL, opportunity on analyzing alternative sewer pipeline alignment route will be very limited.

85. Reportedly, during construction phase GSPPL will consider the alternatives. Alternative A: In case the pipeline stretches for carrying out the proposed work is found to have any sort of social 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, to avoid physical displacement. Alternative B: In case the pipeline stretches involving any severe impact such as social displacement (physical or economical), the proposed work will be revisited to avoid major impacts. Moreover, for impacts that are unavoidable, including temporary impacts, consultations will be undertake and mitigation measures will be adopted meeting the safeguard requirements of IFC Performance Standard.

G) Information Disclosure, Consultation and Participation

86. 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

87. 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

88. 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

89. 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

90. 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

91. 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.

92. 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.)
93. 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 Baranagar STP, linked sewerage infrastructures and land. KMDA is also the designated agency for executing renovation and upgradation of the Baranagar STP under the NMCG Programme[1] and the principal project titled "Development of Sewage Treatment Plants – Kolkata City Area".

The existing STP is located at Matkal, under Baranagar Municipality (Ward Number 18) and is one of the sub-projects under the project titled "Development of Sewerage Treatment Plants – Kolkata City Area" of KMDA. This project would involve the decommissioning and dismantling, including demoliton of the existing 40 MLD STP followed by construction of a new STP of 60 MLD capacity. The linked sewerage infrastructure under the project fall under the Baranagar and Kamarhati Municipalities in District North 24 Parganas, West Bengal.

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 includes 3 components i.e. STP and associated pipeline networks in Baranagar, Arupara and Bally. This ESIA focusses on the Baranagar project while separate ESIA have been undertaken for the Arupara and Bally projects.

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 from the towns and cities situated along the banks flow into the river, significant part of it without receiving any treatment. Previous plans to clean the river had been carried out through the Ganga Action Plan (GAP). Lauched in 1985, the GAP focused on developing sewerage infrastructure assets, which were operated and maintained by state governments or urban local bodies (ULBs). However, the plan met with limited success and did not result in any significant improvement in the water quality of river Ganges[2].

In recent years, 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 planned 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 in 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 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 ensure continued performance of the assets created. Based on 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 STPs for treatment and allow only treated sewage to be discharged into the 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 KMDA, has conceived to implement the project titled "Development of Sewage Treatment Plants – Kolkata City Area", under sub-project pertaining to Baranagar STP. Baranagar STP sub-project specifically comprises of the following components:

i. Decommissioning and dismantling including demolition of existing structures;

ii. Construct, operate and maintain one STP at Baranagar with a proposed capacity of 60 MLD;

iii. Renovate, operate and maintain Baranagar linked Infrastructure (Main Pumping Station, Inlet Gravity Sewer line, I&D structures, Rising Main and Outlet Pipe).

Reportedly, the previous STP of capacity 40 MLD at Baranagar, 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. 60 MLD and provision of power generation from 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 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 i.e. fifteen (15) years. The NMCG will operate as the governing authority and will be governing the overall escrow mechanism and payments to Concessionaire.

[3] As per discussion with the workers at the STP.

Previously KMDA has commissioned one (1) ESAMP study for the STP project through external agency IPE Global 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.

Baranagar STP with 40 MLD capacity was built to treat the sewage water generated in Kamarhati and Baranagar municipality but the STP stopped functioning since 2018. The old STP has completed its operational life-cycle and feasibility studies show that cannot be made be 100% functional 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 60 MLD (as per the project documents) of sewage generated from the catchment area, which is presently discharged directly without any treatment into the Udaipur Canal and River Hooghly through the exiting I&D structures. The new STP will treat the sewage wastewater coming from Baranagar and Kamarhati municipalities and discharge the treated water into Udaipur Canal which in turn will prevent the direct discharge of sewage wastewater into River Hooghly through the I&D structures.

The proposed STP will treat the sewage water coming from Baranagar and Kamarhati municipalities. The treated water from the STP will improve the water quality of the Hoogly 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 is increasing with the increase in population. The enhanced capacity of the new STP has considered to accomodate 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 goverened 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 STP and linked infrastructures 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 GSPPL:

a) Conduct an environmental and social gap assessment of the existing infrastructures under the proposed 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) Formulation of E&S management plans (ESMP), 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 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), Social Impact Assessment, Livelihood Restoration Framework and Labour Management Framework
5.	Undertake limited soil and groundwater quality monitoring and hydrological investigation due to the presence of unlined MSW dump site located adjacent to Baranagar STP
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 environmental and social baseline of the project's study area and assessing impacts associated with the proposed project activities, covering the following points:

- Review of existing EIA/ESMP report for Baranagar STP;
- Conducting environmental 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 Baranagar 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 demolition and 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.

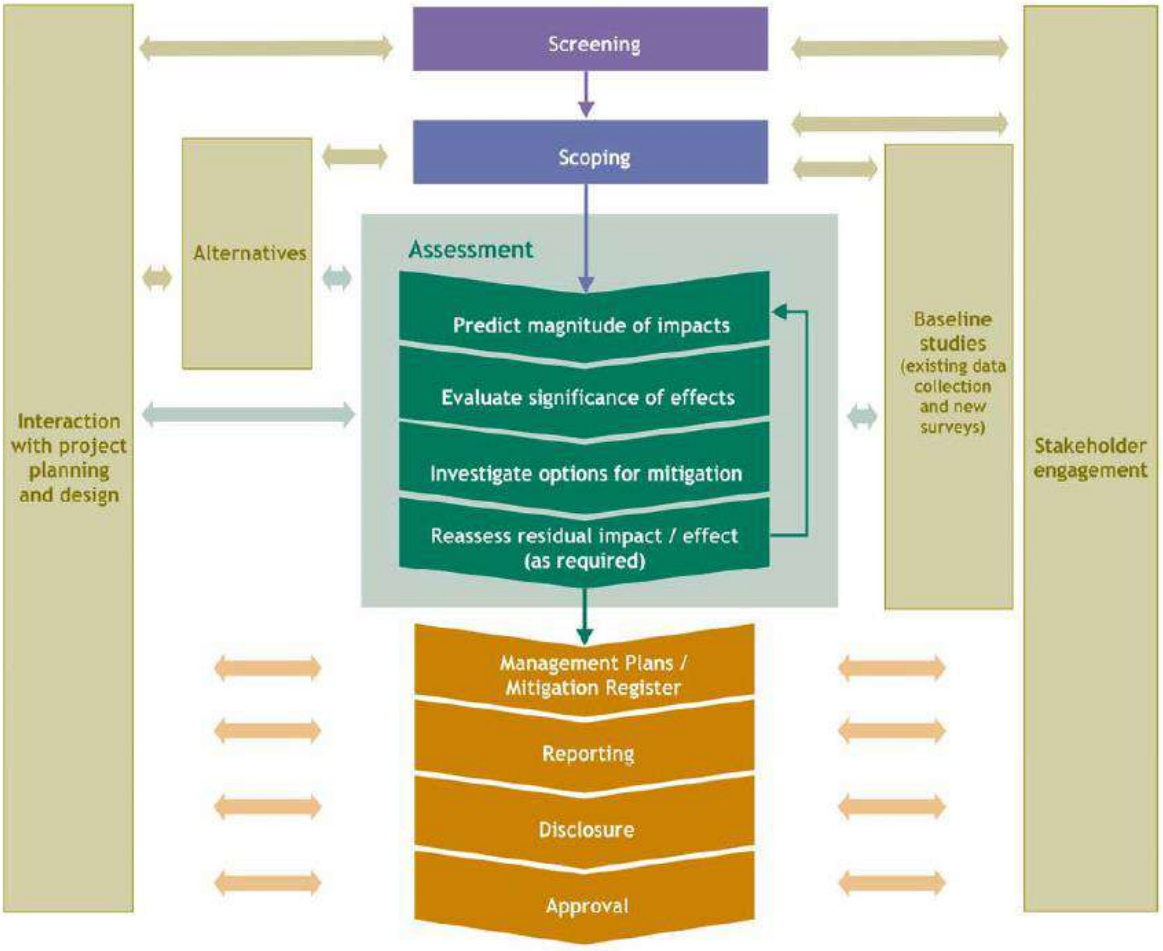
- Formulate mitigation measures and actions, where impacts and risks cannot be avoided or prevented and prepare an Environmental and Social Management Plan (ESMP) for the project. The ESMP shall also include a Stakeholder Engagement Plan (SEP), Gender Action Plan (GAP), Livelihood Restoration Framework and Labour Management Framework.
- The ESMP has charted out 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 at the 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 o preliminary information provided to ERM for determining applicability of relevant GoI legal regulations, IFC performance standard requirements to the project. This step was conducted desktop review of dicumentation and an on-site assessment of the project area as well as linked infrastructures and 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 decommissioning of existing STP infrastructure, construction of new Baranagar STP, renovation and installation linked sewerage infrastructure. The proposed project does not qualify for Environmental Clearance under the listed project as per EIA Notification, 2006.

1.5.1.2 Project 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 environment and social impacts, they are mostly site specific and 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 shall be covered during 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 exercise 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 Baranagar 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 proposed STP area is collected from June, 2019 to August, 2019. Primary socio-economic data was collected during July, 2019 to September, 2019. A second phase of surface water quality monitoring was undertaken in first week of November, 2019.

Apart from primary data, secondary data was also collected from different government department websites, local bodies, literature surveys etc. All data's were compiled and compared with applicable relevant standards, and the same has been represented 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 Impact Assessment Process. Impact Assessment Methodology has been detailed in ***Section 5***. The section covers the identification, prediction and quantification through modelling (where appropriate) of potential impacts from the proposed project activities.

The impact assessment involved the prediction and evaluation of impacts from the proposed project in different phases i.e. decommissioning phase, construction phase 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 1**) 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. 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 the applicable reference framework being used for the ESIA study in addition to the national regulatory requirements for project financing.

Chapter No.	Chapter Title	Description
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.
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;

Chapter No.	Chapter Title	Description
		■ 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. This is to be noted that the final project design is yet to be completed by the Concessionaire. 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.

ERM is not engaged in social and environmental, health & safety consulting and reporting for the purposes of advertising, sales promotion, or endorsement of any client's interests, or other publicity purposes. The client acknowledges that the report prepared by ERM are for exclusive use of the client and agrees that ERM's reports or correspondence will not be used or reproduced in full or in part for such promotional purposes, and may not be used or relied upon in any prospectus or offering circular. The client also agrees that none of its advertising, sales promotion, or other publicity matter containing any information obtained from these assessments or reports, either in parts or entirety, will make reference to ERM's trade name.

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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Nothing contained in this report shall be construed as a warranty or affirmation by ERM that the site and property described in the report are suitable collateral for any loan or that acquisition of such property by any lender through foreclosure proceedings or otherwise will not expose the lender to potential environmental or social liability.

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 diversion pipeline in order to divert the sewage water from I&D structures to the gravity sewer lines, though specific detail in this regard is yet to be finalised.

2. PROJECT DESCRIPTION

2.1 Project Background

The existing 40 MLD Baranagar STP was constructed in South Dumdum Municipality initially under the Ganga Action Plan (GAP) scheme to reduce the pollution of the Ganga River in the year of 1996. Additionally, as part of the scheme's second phase (2004-06), KMDA created a structure for interception and diversion of the sewage carrying drains located in Baranagar and Kamarhati Municipalities to divert the sewage water towards the MPS. The STP linked sewage infrastructure comprises of underground gravity sewer line network, four Interception & Diversion (I&D) structures, one Main Pumping Station (MPS), Rising main from MPS to STP, Defunct STP and the Outlet Pipe. The STP was functional till 2011. After 2011, the STP gradually loses its efficiency and completely stop functioning from June, 2018[4] due to end of operationl life-cycle. Reportedly, the interception and diversion structures are currently non-functioning due to siltation and lack of maintenance, therefore causing blockages and reduction in the flow of effluent to the Main Pumping Station (MPS) and the STP. A part of the sewage water from these areas are presently being discharged into the Hooghly River to the west after being channelled through existing old sewerage networks near the proposed I&D structure areas. The other part (near the proposed STP and MPS area) of the sewerage generated in the catchment area of these munipalities get discharged into the Udaypur canal and Bagjola Canal.

The proposed project includes the following components:

- The proposed scenario of Baranagar STP involves development of a new 60 MLD capacity STP within the existing STP complex after complete demolishing the existing STP structures,
- Rehabilitation of existing 4 number of Interception and Diversion (I&D) structures,
- Laying of 1.5 km (approx.) of new sewer line in place of existing sewer pipeline,
- Laying of 2.7 km of raising main,
- Replacement of 900 meter existing sewer line,
- Rehabilitation of linked sewerage infrastructure (including desilting of existing trunk sewer lines, interception and diversion (I&D) structures, rising main, main pumping station).

2.2 Existing and Proposed Project Facility Location

The project area for Baranagar Sewage Treatment Facility comprises of South Dumdum municipality, Baranagar Municipality and Kamarhati Municipality located in North 24 Parganas District of West Bengal State. The existing STP, which is presently not in operation, is located in Matkol area, on the eastern edge of Ward number 18 of the Baranagar municipality and at the trijunction point of Baranagar, South Dum and North Dum Dum municipalities.The existing main pumping station is located at Rabindranath Tagore Road, under Kamarhati municipality. The total length of existing inlet gravity sewer line is 8.3 km of which 4.7 km of gravity sewer line is within Baranagar municipality and the rest of 3.6 km lies within Kamarhati municipality.

Existing trunk sewer lines run along the main urban roads namely Mill Approach Road, Mahadeb Ghosal Road, Sashtitala Road, K.N Singh Road, Jay Krishna Ghosal Road, Kalinath Ghosal Road, Kumud Ghosal Road, R.N Tagore Road and A.C Sarkar Road at Kamarhati municipality area and Gopal Nath Tagore Road and at Baranagar municipality area. 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) are located within Baranagar municipality. The rising main from MPS passes

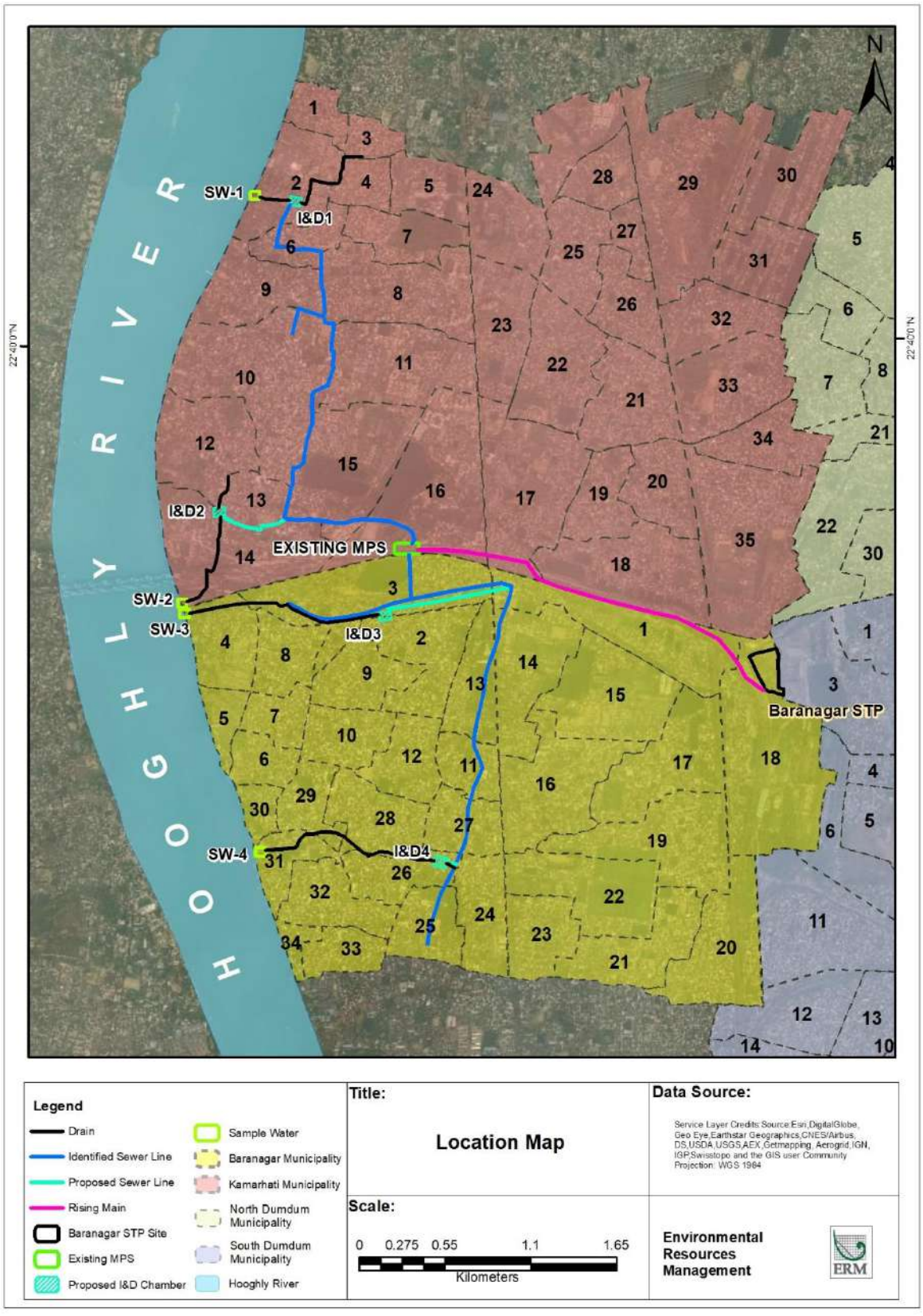
4

through RN Tagore Road, Barackpore Trunk Road, Bhonmizn St. and Belghoria Express way. The location of the existing STP is shown in the **Figure 2.1.**

The proposed STP project will utilise the existing land and infrastructure of the sewage treatment facility and linked sewerage infrastructure. The area occupied by the proposed STP in Baranagar is 1.87 ha.The new route for rising main from MPS to STP is yet to be finalized and may be subjected to minor alterations during construction phase based on stakeholder inputs. The existing 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 will be involved for the proposed project and development of associated infrastructure.

KMDA had constructed a separate septage building for night-soil treatment within the STP facility area in 2019. This septage treatment facility is not part of the proposed STP project although it is located within the existing STP area. Reportedly, the septage facility will be separated by a physical boundary and would operate as an independent facility under KMDA's perview with no interaction with STP operation or in any way affect GSSPL's scope of work. As a part of the re-development project, a new 60 MLD STP will be constructed in place of existing 40 MLD, new pipelines will laid in place of existing pipelines and I&D structures will be replaced.

Figure 2.1 Project Location Map



2.3 Accessibility

The STP site can be accessed through the Belghoria Express way (NH 34) which is approximately about 100m away from the site and connected through an unpaved road. An alternate connectivity to the site is provided by the paved A K Mukherjee Road, which connects to the BT Road (Barackpore Trunk Road) on the western side. Following are other alternative modes of access to the STP site:

- Nearest bus stop from STP is Matkol Bus Stand which is approximately 0.75 km
- Nearest railway station is Belghoria Railway Station, which is approximately 2 km away from the site.
- Nearest metro station is Noapara metro station which is roughly 1 km away
- Nearest airport is the Netaji Subhash Chandra Bose International Airport, Kolkata located at approximately 12 km away from the site can be reached via Belghoria Express-way as shown in **Figure 2.2** Accessibility Map of the Project Site

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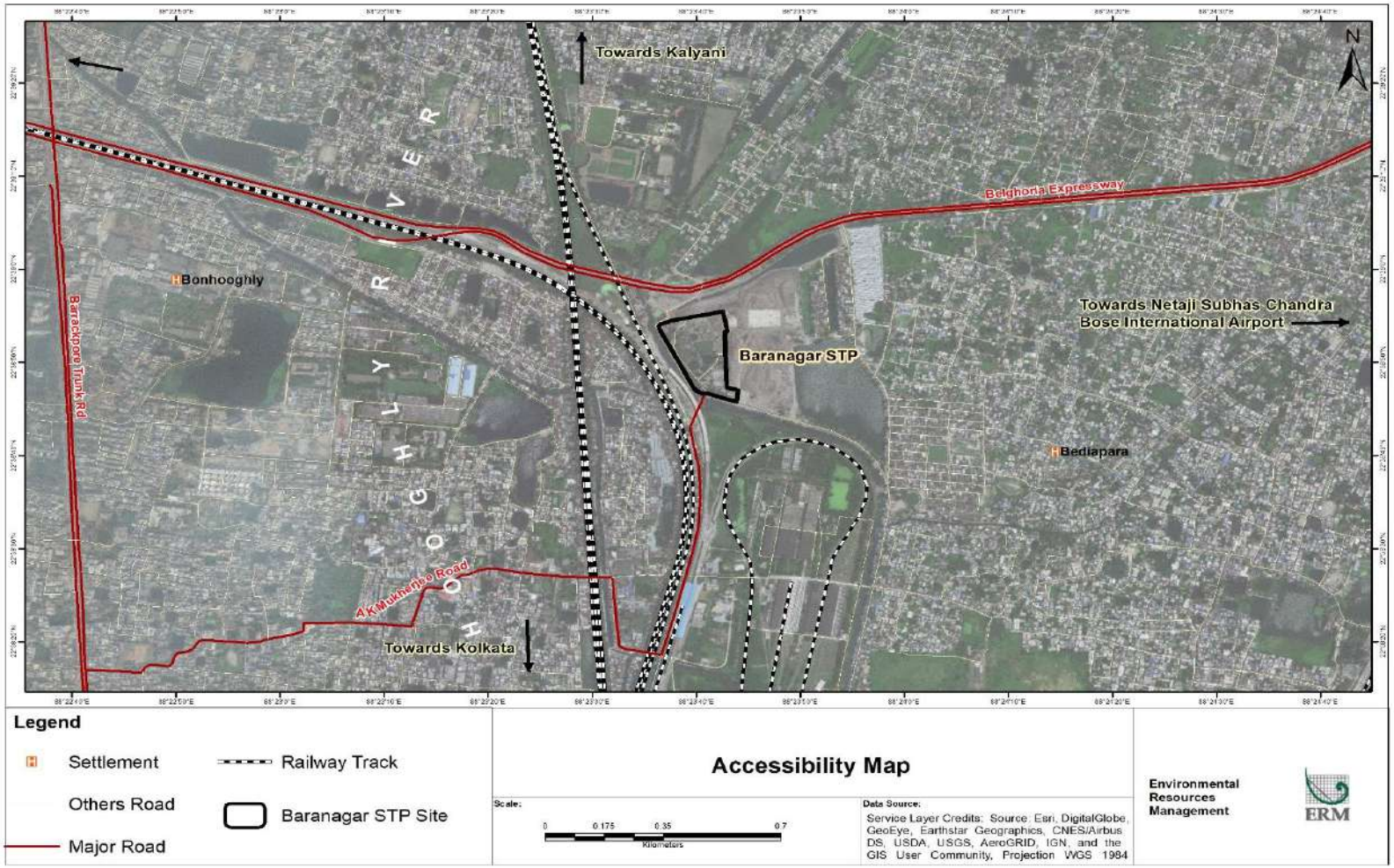
Figure 2.2 Accessibility Map of the Project Site



2.4 Environmental Setting

As discussed in **Section 2.2** above, the Baranagar STP is located in South Dumdum municipality. The STP facility is surrounded by the municipal solid waste dumpyard on North and East direction. The Western part of the STP facility is bounded by an unpaved road beside Udaypur Canal which also provides road access to the STP site and southern part of the STP is bordered by a black topped road (abount 20m from the western boundary of the STP project area). Belghoria Express Way is located approximately 80 m away from the northern boundary of the STP at an elevation of 6 to 8 m from the dirt road. A greenbelt is present within the STP facility along its western boundary. The environmental sensitivities present in the immediate vicinity of the STP site are given below:

a) The site is surrounded by settlements of Pramod Nagar at an aerial distance of 0.35 km east, Satin Sen Nagar at an aerial distance of 0.24 km west and Adarsha Nagar at an aerial distance of 0.21 km north.

b) Kolkata metro railway yard is present within 0.28 km south of the STP location. The boundary of the Kolkata metro railway facility is surrounded a green belt.

c) The site is surrounded by few ponds, the nearest pond is at Pramod Nagar adjacent to the dumping yard at an aerial distance of 0.2 km from the eastern boundary of the STP facility. The ponds are used for recreational fishing and occasional bathing by the local people.

d) Sen-Mahasay Colony of Railways is located at an aerial distance of 0.37 km from the eastern boundary of the STP facility.

e) The nearest market is located at Pramod Nagar at an aerial distance of 0.35 km South-East boundary of STP.

f) There are 3 schools present within 1km of the STP. Kalyani Public School is located about 0.51 km and Tirtha Bharati School located at an aerial distance of 0.58 km from SW corner of the STP. Ramkrishna Mission Shilpapitha is located at an aerial distance of 0.81 km north of the STP in Adarsha Nagar area.

g) Bonhooghly College of Commerce is located at an aerial distance of 1.16 km west from the western boundary of the STP facility.

Figure 2.3 Site Setting Photographs

Baranagar Dumpyard beside STP facility

Leachate generated from the Dumpyard

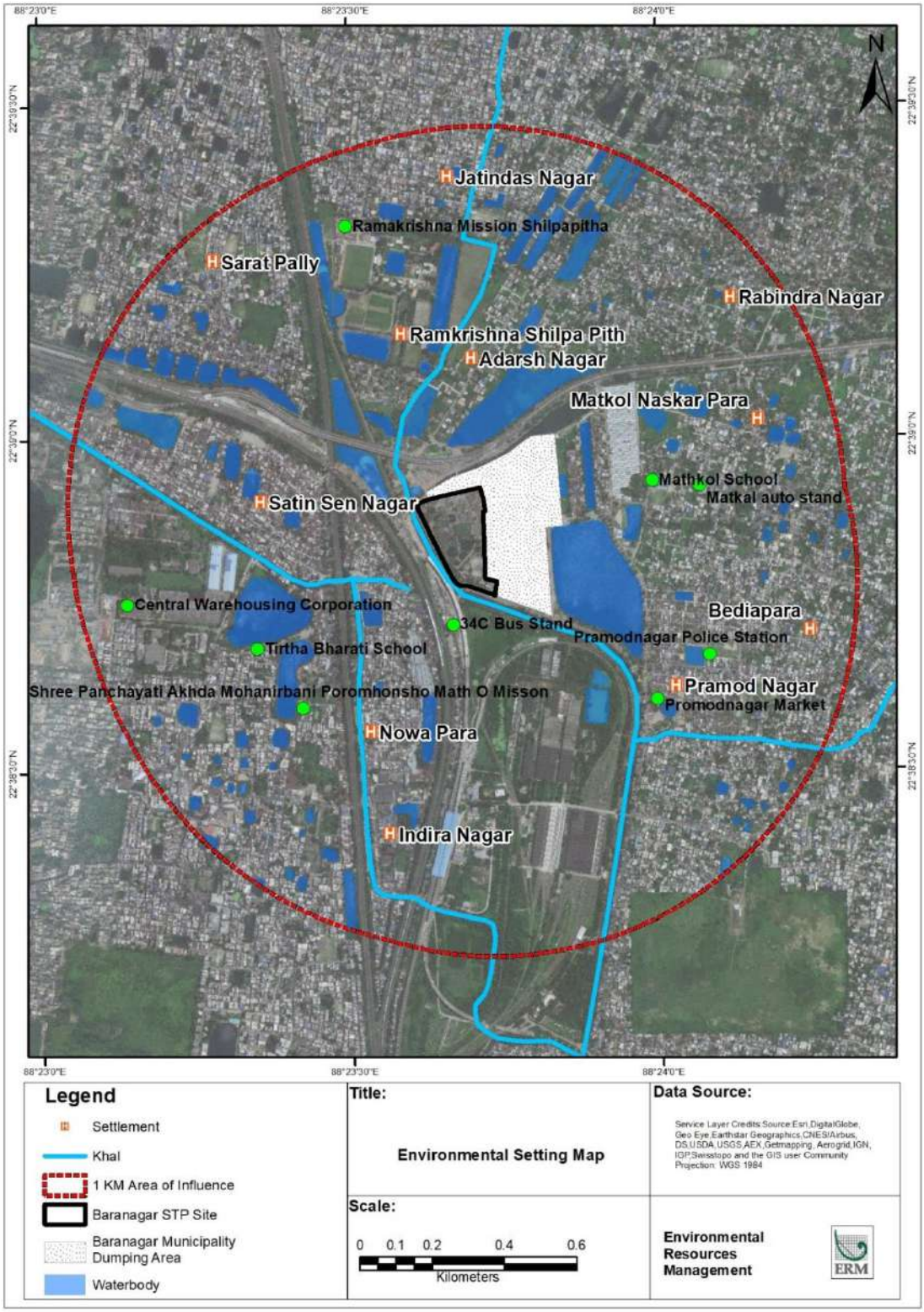
Adjacent Udaypur Canal

Green belt present along the western boundary of the STP facility

Belghoria Express Way

Pramod Nagar Pond near STP

Figure 2.4 Environmental Settings Map of the STP Site



2.5 Project Components

As a part of the re-development project, sewage from Kamarhati and Baranagar municipality areas will flow towards I&D structures which will then divert to the MPS through gravity sewer line. From MPS, the raw sewage water will go to STP via raising main. The treated sewage water from the STP will be discharged to Udaypur canal via output pipeline. The major components of the STP project are:

a. I&D Structures

b. Sewer line network

c. Main Pumping Station (MPS)

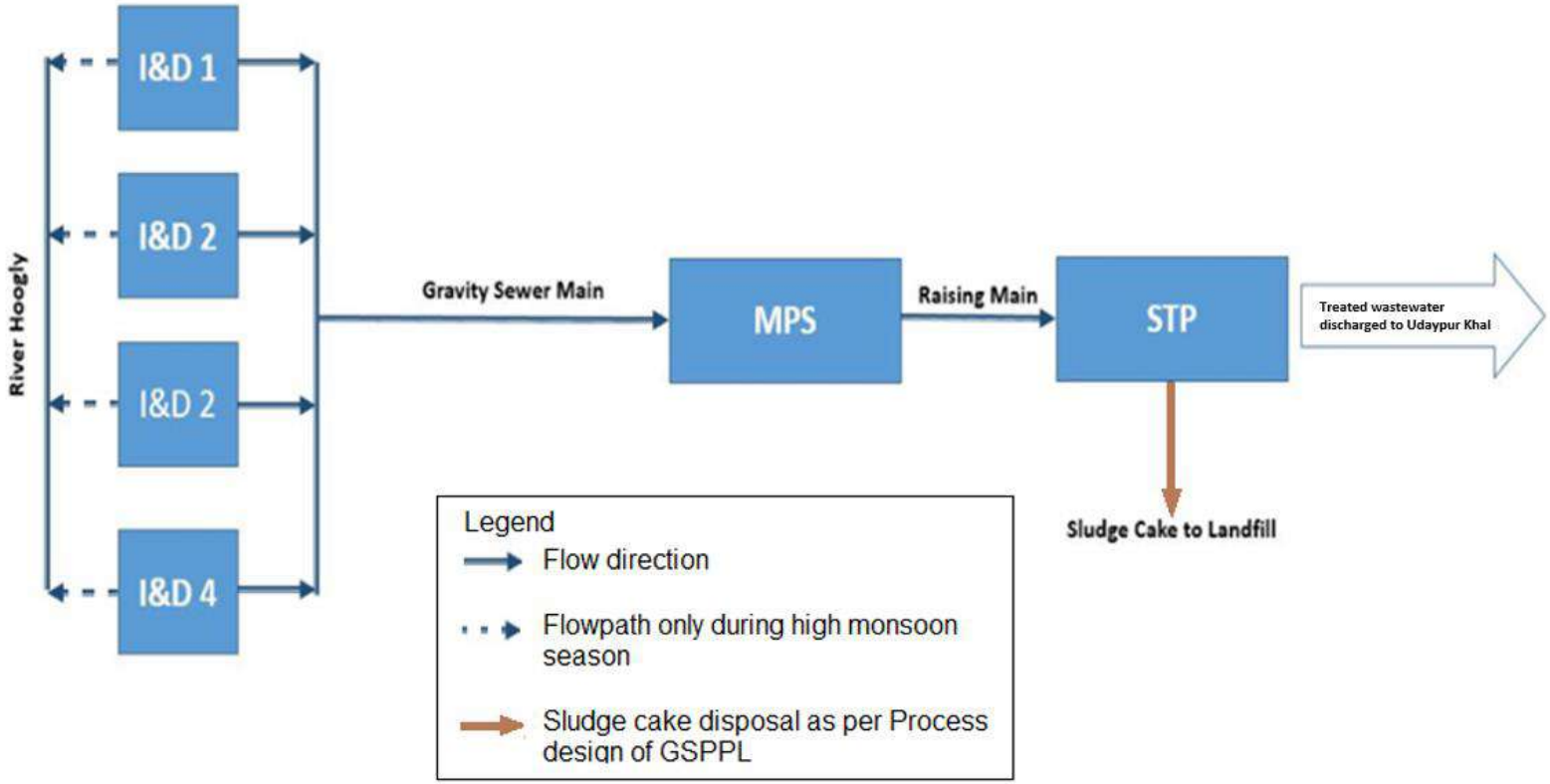
d. Raising Main

e. STP

f. Outlet Pipeline

The project components are shown in **Figure 2.5**.

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



2.5.1 I&D Structures

In the present project, there are four existing Interception & Diversion (I&D) structures present for diverting the flow of sewage to the STP. However, they are not operational due to end of life damage and will be replaced during the construction phase of the project. I&D structures help to maintain flow of sewage water to the MPS and STP as a common practice in India. During operational phase, I&D structures will divert the excess load which is generated due to rainfall to Hooghly River through gravity drains, but without any treatment. The existing and proosed locations of the ID structures are shown in **Figure 2.6** and the associated sewer network and structures in **Figure 2.7, Figure 2.7 and Figure 2.7**.

Figure 2.6 Photograph of Proposed Locations for I &D Structures

Interception & Diversion (I&D) 1 Structure Location, Hanuman Jute Mill Road, Kamarhati

Close up of Proposed Location for I&D 1

I &D 1 Proposed Location and Surrounding

Interception & Diversion (I&D) 2 Location near Anna Kali Devi Road

Close up of Proposed Location for I&D 2

I&D 2 Proposed Location and Surrounding

Interception & Diversion (I&D) 3 Structure Location near Dakshineshwar Bus Stand

Close up of Proposed Location for I&D 3

I&D 3 Proposed Location and Surrounding

Figure 2.7 I&D-1 Outfall

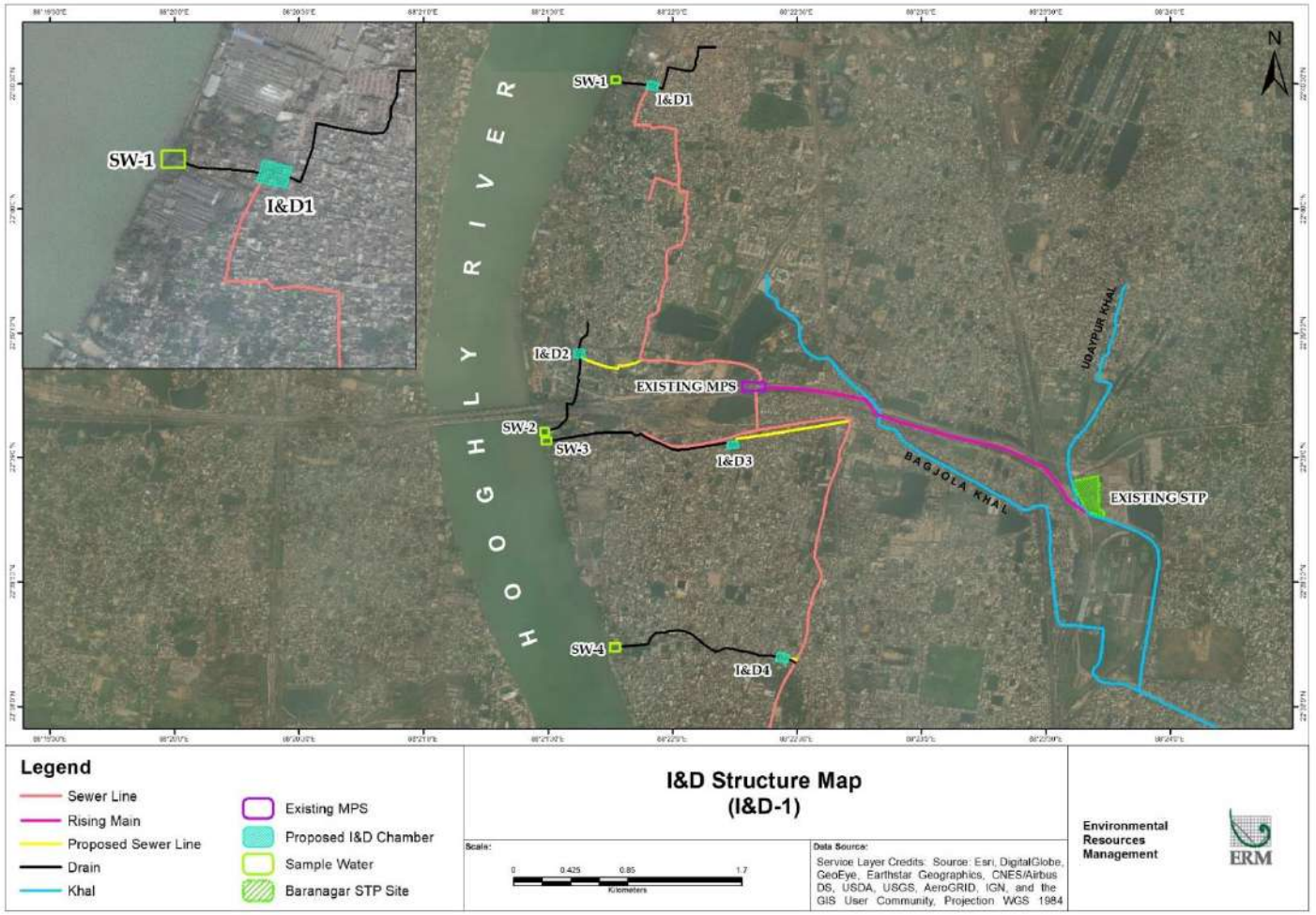


Figure 2.8 I&D-2 and I&D-3 Outfall

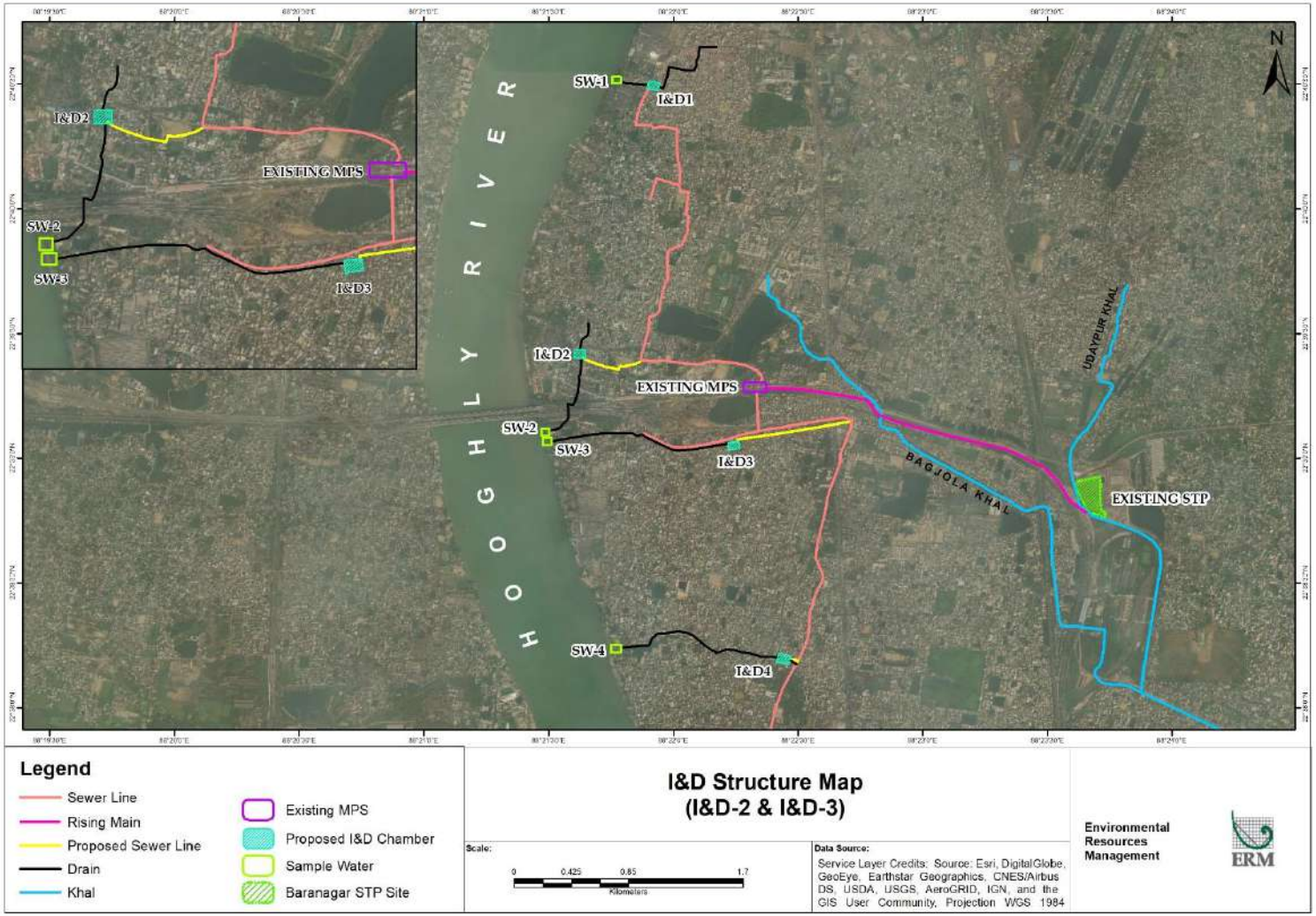
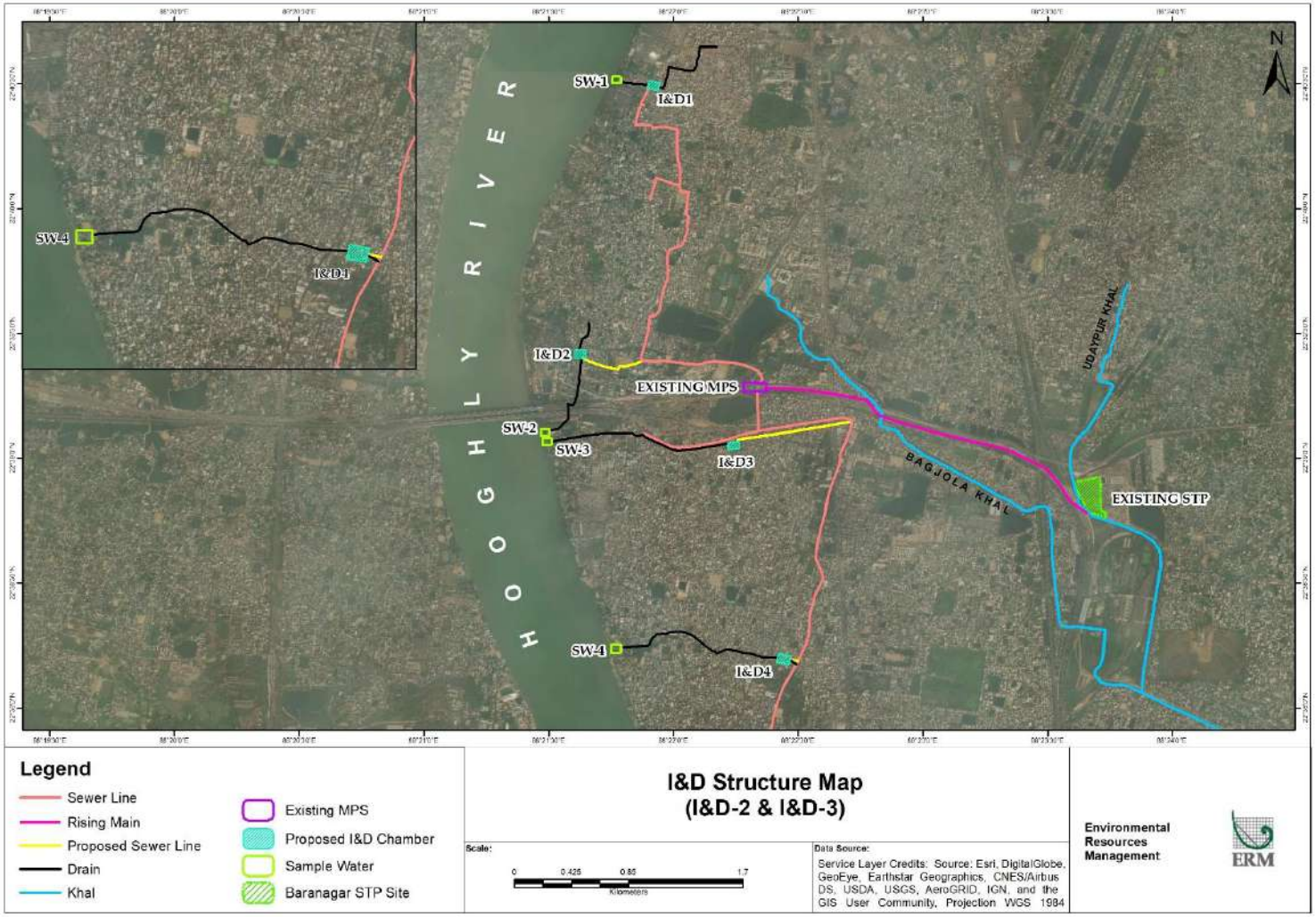

HOOGHLY RIVER
SW-1
I&D1
I&D2
EXISTING MPS
SW-2
SW-3
I&D3
SW-4
I&D4
UDAYPUR KHAL
BAGJOLA KHAL
EXISTING STP
N
Legend
Sewer Line
Rising Main
Proposed Sewer Line
Drain
Khal
Existing MPS
Proposed I&D Chamber
Sample Water
Baranagar STP Site
I&D Structure Map
(I&D-2 & I&D-3)
Scale:
0 0.425 0.85 1.7
Kilometers
Data Source:
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Projection WGS 1984
Environmental Resources Management
ERM

Figure 2.9 I&D-4 Outfall



2.5.2 Gravity Sewer Line

The sewage water from I&D structures flowed towards the MPS through existing gravity sewer lines. The diameter of the gravity sewer lines varies from 300mm to 900mm. The diameter of the gravity sewer line increases towards the MPS and the depth varies from 1.5 to 2.5 m below the surface. As discussed in **Section 2.2**, part of the gravity sewer line is located within Baranagar municipality area whereas rest is located within Kamarhati municipality area. In Baranagar area, approximately 1.5 km of new gravity sewer line will be laid along Gopal Lal Tagore Road. In Kamarhati area, approximately 1 km of gravity sewer line will be replaced located along the Rabindranath Tagore Road. Open-cut method will be used for laying of the new pipeline.

2.5.3 Main Pumping Station (MPS)

The existing Main Pumping Station (MPS) is located on Rabindranath Tagore Road in Kamarhati municipality covering 380 m^2 area, with a boundary wall and restricted access. A wet well, with inner diameter and depth of 17.80 m and 12.50 m respectively, is present within the MPS and stores the sewage water before pumping it towards the STP. The MPS presently has two (2) pumps with 650 LPS capacity and one (1) pump with 250 LPS capacity. A grit chamber is also 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 before being sent to the KMDA MSW disposal site. Under the proposed project, the existing building structure will be renovated and the existing pumpsets will be changed. 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. Presently the sewage water from MPS is directly discharged in to the Bagjola Khal.

Figure 2.10 Photographs of Baranagar and Kamarhati MPS

MPS at Kamarhati Municipality

Existing Pumpsets at the MPS

Inlet point at MPS

By-pass Discharge arrangement at Bagjola Canal

2.5.4 Raising Main

The existing raising main pipeline, of 2.7 km length, was designed to carry pumped sewage from MPS to the STP facility. The pipeline is presently damaged and will be replaced by new raising main in the proposed project. Open-cut method will be used for laying the new raising main at a depth of 1 m from the surface. The raising main pipeline will be laid along the R N Tagore road which runs parallel to the Belghoria expressway with certain sections traversing through congested areas and more information has been provided in **Table 5.10**, finally connecting to the STP location. The detailed alignment for the raising main is yet to be finalised.

2.5.5 Sewage Treatment Plant

The proposed 60 MLD STP will involve four (4) sequential treatment stages including preliminary treatment, primary treatment, secondary treatment and Chlorine based disinfection stages. Considering the required treated wastewater characteristics, land availability and ease of operation, Conventional Activated Sludge Process has been considered by the Concessionaire for secondary treatment process. Further, the sludge generated from the treatment plant will be anaerobically digested to produce Biogas which in turn will be used for power generation through Gas Engines. Details of the process are described below and represented in **Figure 2.11**.

In general, sizing criteria for the units will be 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 operating parameters will be considered from standard literature and based on WABAG's operational experience of similar plants in India and other countries.

The STP will comprise of the following units:

- 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 will comprise of screening and grit removal operations. During this operation, solid substances like floatables, rags, grit, etc. will be removed from the sewage. This will be achieved in two process steps:

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

This preliminary treatment section will comprise of the following units:

Stilling Chamber

The Stilling Chamber will be designed to arrest the turbulence of flow from the rising main and to ensure smooth gravity flow of sewage to the downstream units. The inlet chamber will recieve flow from the Main Sewage Pumping Station and the chamber will be designed with adequate depth and free board above top water level to avoid splashing. Necessary valves will be provided for flow control and the waste water drain pipe will connect to the subsequent STP stages.

Mechanical Fine Screen

Raw sewage from the Stilling Chamber will flow downstream by gravity to 2 Nos. (2W) Screen Channels. The Mechanical Fine Screens will remove fine solids (exceeding 6 mm in size) from the sewage and protect the subsequent components against blocking and damage. Beside the screen, an automated screen cleaning system will periodically trigger the deposition of the screenings accumulated as a mat of wastes upon the screen using a set of movable bars. The collected screenings from the screen chamber will be transported through a conveyor, washed and collected in screening containers and will be disposed off to a KMDA municipal waste disposal site. Isolation of the screen from the flow during either repairs or due to low flow conditions will be made through the sluice gates, placed in the upstream and downstream of each screen chamber.

The expected quantity of grit generation at the proposed Arupara STP will be 5 m^3/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 from the preliminary treatment stage. 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 will comprise of the following units:

Primary Clarifier Distribution Chamber

The de-gritted sewage will be 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 will be 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. Drain arrangement is provided with necessary valves for draining the unit to next stages of treatment process.

Primary Clarifier

Clarification comprises of 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 subsequent biological unit. Two Nos. Inclined Plate type Primary Clarifiers with integral thickener will be constructed as square concrete structures.

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

- Primary sludge will be major contributor to gas generation due to its rich VSS content;
- Reduction in inorganics load which has escaped screening and grit treatment to biological 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 inerts to biological treatment section.

In addition to above, co-settling of waste activated sludge from biological treatment will also be considered in Primary Sedimentation Units. This will be a recirculation system for obtaining feedstock from biologically treated activated sludge from treatment process. Primary settling

units will also be provided with integral thickening mechanism to improve the thickening of the sludge and the resultant thickened sludge will be fed for anaerobic digestion. Considering land availability and space saving requirements, plate type lamella sedimentation tanks with integral thickener scrapper mechanism will be built.

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 involves converting 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°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 Baranagar STP will be 350 m^3/d (6% DS) and 90 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.'s) of 2150 m^3 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 (H_2S) which is present as an impurity in the biogas has to be removed because of its corrosive characteristic. The presence of H_2S causes corrosion, especially in pressure regulators, gas flow meters, valves and steel parts of equipment. Also, SO_2, which is the combustion product of H_2S, 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 H_2S content to meet the requirement of Biogas Engine. Caustic Soda solution will be used for biogas scrubbing so as to reduce the H_2S 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)[5]. 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's 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 system. Biogas engine and the associated utilities to be installed with the biogas engine will be a

[5] 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.

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^oC 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 ^{o}C. 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 Baranagar STP is estimated to be 650 kW. However, value as stated is tentative and will be subject to equipment specification.

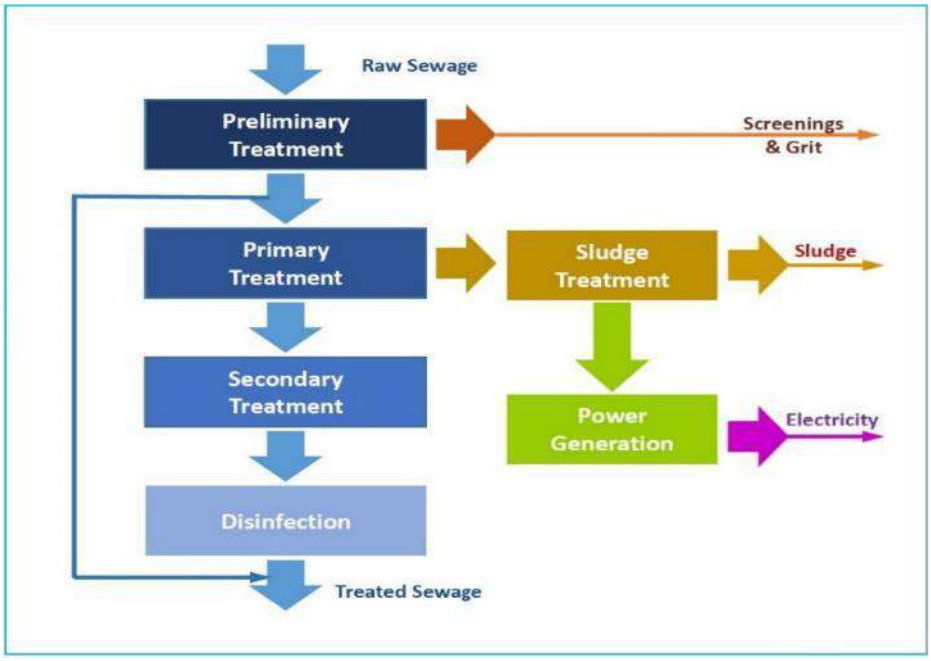
All necessary pipelines, valves for isolation will be provided for this circuit. An electrically operated modulating Three Way Diverter Dampener will be provided in the Exhaust Gas line from the Gas Engine to the stack arrangement. Whenever there will be no requirement for heating of sludge, this diverter 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.

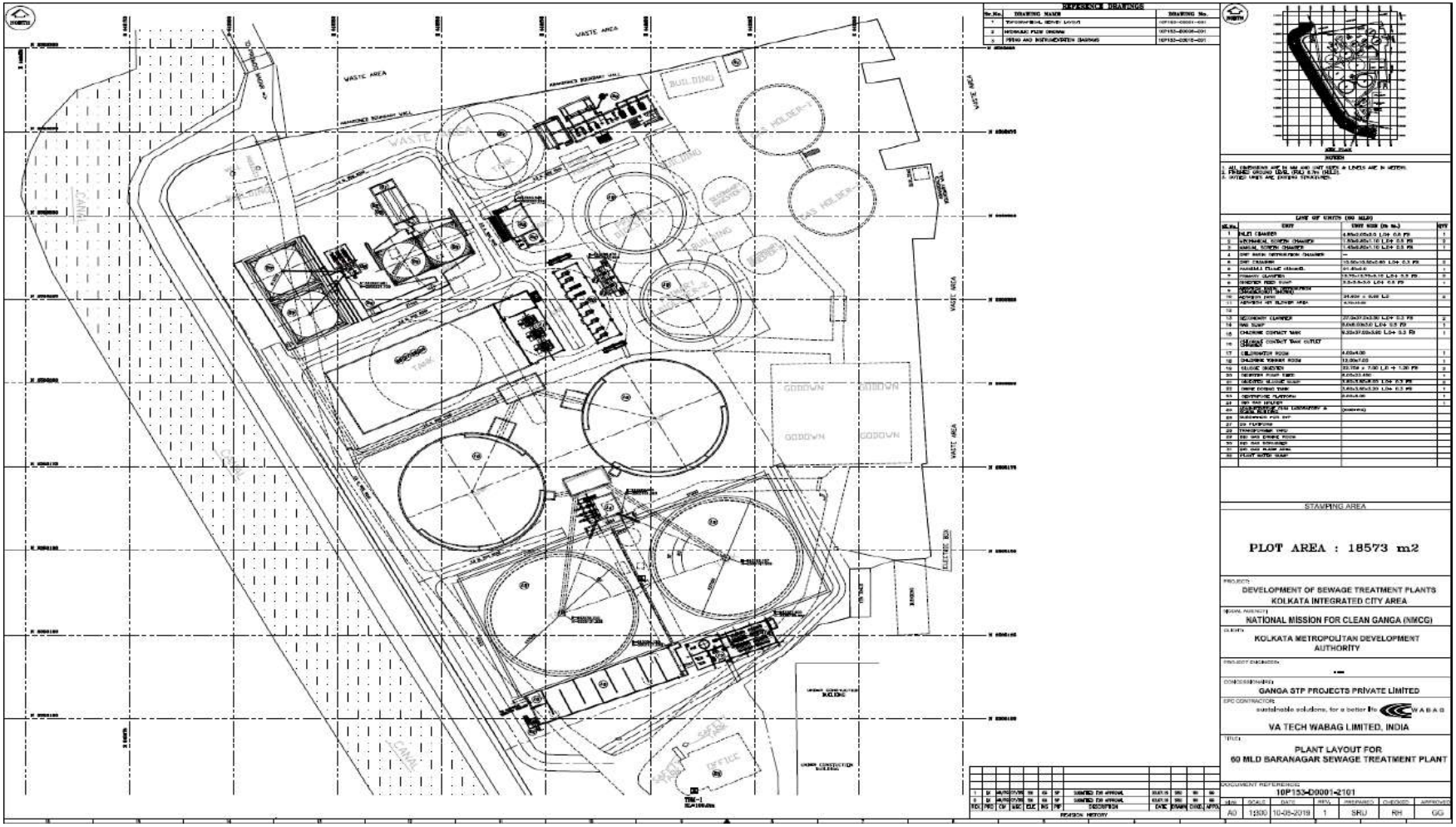
- Ultrasonic Flow Meter at the Parshall Flume and Chlorine Contact Tank Outlet
- TSS Analyser at Grit Distribution Chamber and Chlorine Contact Tank Outlet
- COD Analyser at Grit Distribution Chamber and Chlorine Contact Tank Outlet
- BOD Analyser at Grit Distribution Chamber and Chlorine Contact Tank 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 2.11 Proposed Treatment Scheme



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

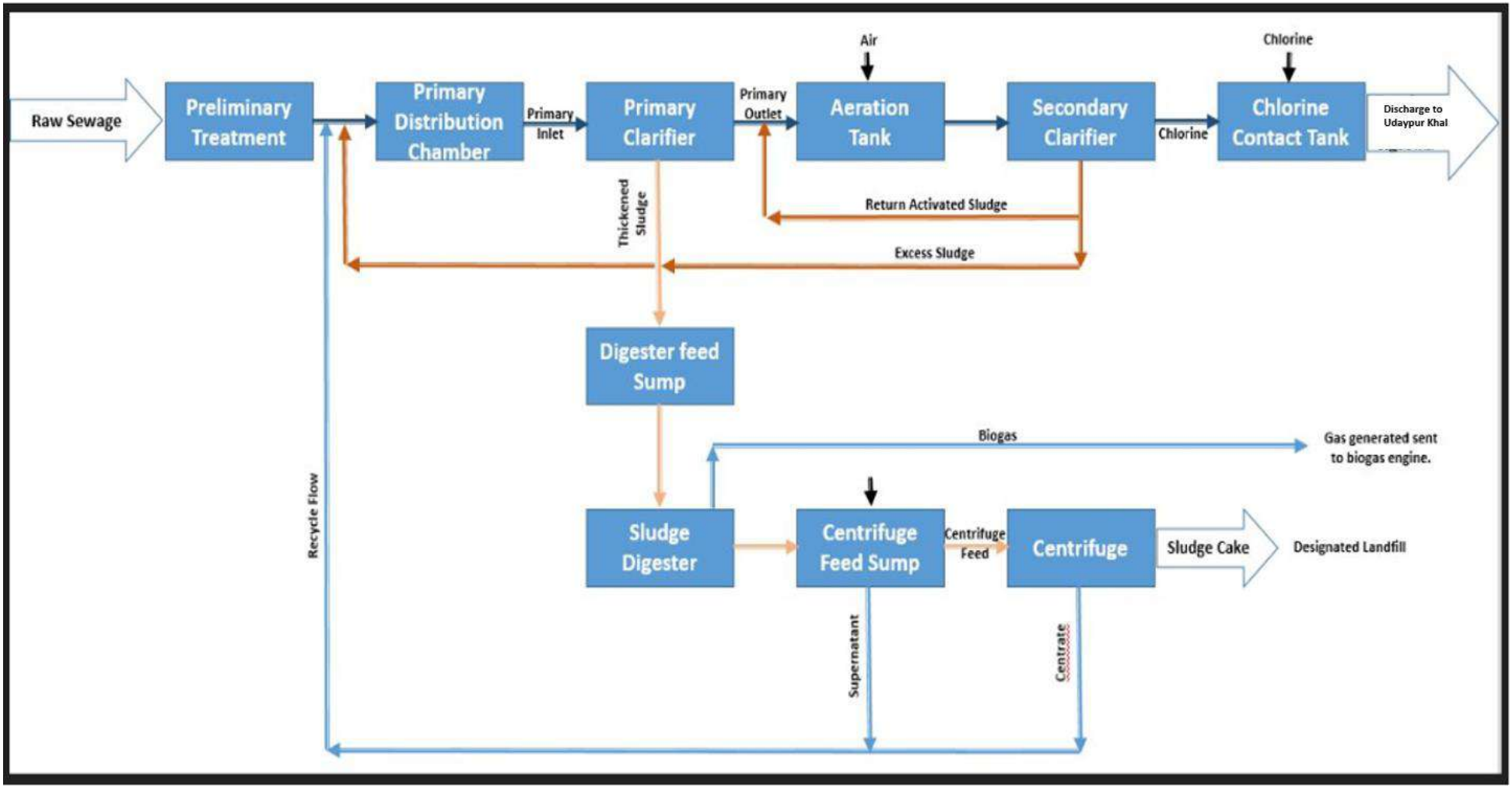
Figure 2.12 Proposed Site layout of STP structure



Source: Information supplied by Wabag (Plant Layout for 60 MLD Baranagar Sewage Treatment Plan

Figure 2.13 Proposed Site layout of STP Units on Existing Facility

Figure 2.14 Process Block Diagram of Proposed Baranagar STP



2.5.5.8 Adequacy Assessment of STP Project

The proposed STP will be designed to treat 60 MLD of sewage. The raw sewage parameters based on which treatment considerations have been planned is provided in **Table 2.1**.

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, as per design crietria, are provided in **Table 2.2** and

Table 2.3 respectively.

Table 2.2: Treated Effluent Characteristics

Parameter	Treated Value as per Concessionaire Agreement[6]	Environment (Protection) Amendment Rules, 2017[7]
pH	6.5-9.0	6.5-9.0
TSS, mg/L	< 50	< 50
VSS, mg/L	-	-
BOD, mg/L[8]	< 20	30
COD, mg/L	< 100	< 100
Faecal coliform, MPN/100ml	< 1000	< 1000

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

[6] Project output performance will be governed by the stipulated Indian regulatory standard as specified under Concessionaire Agreement.
[7] Traceability: http://www.indiaenvironmentportal.org.in/files/file/Sewage%20Treatment%20Plants_2.pdf (last accessed on 24/03/2020).
[8] The referred Indian standard has not specified testing period for this BOD limit. In general, most other Indian standards for BOD limit in waste water are prescribed in terms of 5 days at 20°C.

Table 2.3: Treated Sludge Cake Characteristics

Parameter	Value
Outlet concentration of dewatered sludge, %	≥20
Fecal 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" [9] as issued by Central Public Health & Environmental Engineering Organisation (CPHEEO), Ministry of Housing and Urban Affairs, Goverment of India.

The project design consideration aims to attain water quality compliance with the national effluent discharge standrds[10] for STPs. Further, the sludge generated from the STP will be anaerobically digested to produce Biogas which in turn will be used for generation of power from the gas engines. After energy recovery from sludge, the remaining waste sludge will be disposed to the KMDA designated site near the STP facility.

2.5.6 Outlet Pipeline

The treated sewage water would be discharged into the Udaypur (Khal) Canal. The discharge point for the new STP will be same as the present location, as shown in **Figure 2.15**.

Figure 2.15 Outlet Point at Udaypur Canal

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 Background of Bagjola Canal System

The primary drainage system of the project area is catered by Bagjola Canal system. Historically, during the early phase of urbanisation in the city of Kolkata, the areas around the central part of the city (Fort William, Esplanade areas) was part of the active deltaic region of the Hooghly and

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

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

comprised of a low lying swampy zone which were drained by creeks and waterbodies under tidal influence from the river. Thereafter, because of population ingress to the city and need for more land, the swamps were drained through the construction of drainage canals and low lying areas and waterbodies were filled up. The Bagjola canal was constructed in the 1882 having a width of around 12 m with the objective of carrying excess rainwater runoff from catchment areas and for draining sewage. Starting from an area called Rathkhola near Dakhineswar in the northern part of the city and about 3 kms upstream of the Baranagar STP site, the canal flows roughly in a south, south-eastern direction, drains the catchment of the densely populated municipalities of South Dum Dum, Panihati, Baranagar, Kamarhati and North Dum before moving further east through the Kestopur area to less populated areas of Rajarhat, Bhangor and Haroa. After traversing a length of 28.5 km and draining a basin area of about 115 sq km, the Bagjola canal finally discharges to the Kultigong near Ghusighata through two sluice gates[11]. The upper part of Bagjola canal receives sewage as well as effluents from different sources along it's course, including discharges from small scale industries, cattle sheds, etc.

The immediate discharge of treated effluents from the STP would be discharged to the Udaypur Canal (Khal) which is a part of larger Bagjola Canal system. The Udaypur Canal (Khal) flows for a total length of about 3.75 km before it meets Bagjola Canal near Khudiram Sarani, about 1 kms south of the STP site. At Pramod Nagar, another small Canal from eastern side meets the Udaypur Canal. The Udayapur Canal receives mainly sewage water from the urban catchment of East Belghoria, Udaipur, Alipur, Rabindra Nagar, Adarsha Nagar etc. to the North of the STP site and the total catchment area is approximately 3.5 sq kms. The width of the Canal varies from 1 - 32 m, being narrow upstream and then becoming wider before it meets the Bagjola Canal.

During the ESIA study, it has been observed that the canals mostly carries dark coloured sewage water, sometimes with limited flow, and supports anaerobic and eutrophic conditions[12]. Such conditions cause adverse odour conditions to prevail in the immediate vicinity of the canal's alignment. The canal is presently maintained by the West Bengal State Irrigation & Waterways Department and they carry out periodic maintenance works to improve the drainage capacity of the canal through excavation, desilting and bottom sludge removal in order to prevent water logging of neighbouring areas during high rainfall events.

2.8 Resource Requirement

The resources required for the project are discussed below.

2.8.1 Land

The proposed project will utilize the existing land and infrastructure. The total area available for the proposed STP facility is 18,687 m^2 (about 1.87 ha). Also as part of the project activity old defuncted I&D structures will be replaced with new I&D structures. Installation of these new I&D structures will require 1 m^2 of area each. The renovation work at the MPS will be done within the MPS facility, so no land will 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. There may be minor change in the area requirement with the depth of pipeline laying or depth of existing pipelines to be replaced.

The land for the STP linked facilities belong to the KMDA and the same has been confirmed through a declaration provided to the WABAG. The Declaration further points out that there are no land ownership issue, disputes, grievances or court case raised against the land area of the STP and its linked facilities. Moreover, during execution of the project, if any requirement for land acquisition

[11] https://shodhganga.inflibnet.ac.in/bitstream/10603/154829/13/13_chapter%206.pdf

[12] https://shodhganga.inflibnet.ac.in/bitstream/10603/208526/8/08_chapter%204.pdf

arises, this will be carrried out as per the direction of the Governemnt of West Bengal. The Declaration from KMDA is attached in the ***Appendix C*** for reference.

It is also to be noted that if any land required for construction back up area/ lay-down area for the construction equipments would be limited within the STP site boundary only.

2.8.2 Workforce

The existing workforce deployed at the Baranagar STP and linked Main Pumping Station are engaged by KMDA through two O&M agencies namely M/s Kakinara Engineer's Co-operative Society Ltd. and M/s. Sunny Enterprise respectively, being provisioned for through the Ganga Action Plan (GAP). A total of 31 workers are presently engaged for the operation and maintenance of the STP and the MPS.

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 have 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 **Appendix A.**

2.8.3 Water

Water will be required for both constrction 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 supression and meeting drinking water requirements 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.

Operational Phase:

Water for routine operations 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 will be 0.5 KLD. Another 0.1 KLD 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.

2.8.4 Power

During decommissioning and construction phase of the project portable DG sets will be used as a common practice in India. The power requirement for construction phase has been estimated as 75 KW (47 to 50 KVA, depending upon varying power factor) by the Concessionaire. During operational phase, existing grid will be used as the primary electricity source with a power drawal of 8000 kWh/d, based on current design considerations. A back up Diesel Generator (DG) set of 800 KVA will also be installed as standby for emergency purpose during the operational phase of the project. The capacity of biogas plant will be to generate 800 kW of power. The power from bio-gas generation plant will also proposed to be utilized within the STP facility. 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 10,500 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.

2.8.5 Chemical Requirements

The required chemicals for the treatment of sewage water at the STP are Chlorine gas, Caustic Solution and Poly-electrolytes. Accounting for any hazardous property, the chemicals will be stored in a dedicated area, conforming to standard safeguards for storing and handling. More specific details of onsite chemical storage area specification will be updated on completion detailed design engineering for the project site.

2.8.5.1 *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 tonner each of 900 kg capacity will be present at the site. Details of the Chlorination process is described in ***Section 2.5.5.4.***

2.8.5.2 Poly-electrolytes:

Liquid Poly-electrolytes will be used in the centrifuge system. Monthly requirement will be 10 kg (approx.). Total 6 months stock will be present at a designated chemical storage space within the site.

2.8.5.3 Caustic Solution:

Caustic solution will be used for neutralizing the Chlorine gas at bio-scrubbers. The requirement of caustic solution is 10 KLD and will 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.

2.9 Project Activity

The activities for the Project can be divided into three (3) phases, namely: a) Decommissioning; b) Construction; and c) Operations and maintenance. Decommissioning and construction phase will overlap due to similar resource utilization as per the project schedule provided by the concessionaire.

The key project activities during these phases of the Project have been summarised below:

2.9.1 Decommissioning Phase

During decommissioning phase, the existing STP structures which include Aeration Tank, Sedimentation Tank, Primary Clarifier and Electrical Sub-station etc. will be decommissioned and demolished. As the STP is not functioning for more than a year, Clarifiers and sludge digesters need de-watering activity prior to demolition work. This phase will also include dismantling of existing electro-mechanical equipments. It will also include on-site storage of demolition waste and off-site disposal of demolition waste. Based on the proposed project implementation schedule the decommissioning phase will be part of the total 24 months of demolition and construction phase.

2.9.2 Construction Phase

The Construction phase will start once the demolition of existing STP structures are completed. The construction activity will involve construction of new 60 MLD STP, renovation of MPS facility, laying of

gravity sewer line and raising main and installation of four (4) I&D structures. The construction work will include excavation, pilling, backfilling etc. Construction work will also include desilting work of the existing gravity sewer line. At MPS, replacement and installation of pumps will also be carried out during construction phase.

2.9.3 Operation and Maintenance Phase

During Operation and Maintenance the sewage water from Kamarhati and Baranagar municipalities will be treated at the new STP as per the CPCB prescribed standards. Biogas and sludge will be generated from the treatment of sewage water. Bio-gas will be utilised in the bio-gas plant for power generation whereas the sludge will be utilised for composting after dewatering of the sludge. The treated water will comply with effluent discharge standards and will be discharged into the Udaypur canal.

2.10 Pollution Source and Control Measures

a) ***Air Emissions:*** Decommissioning of existing STP, including demolition activities and construction of new the new facility involving 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 will lead to emission of fugitive dust. 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 √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-scrubbers will be used to remove the hydrogen sulphide (H_2S) present in the biogas.

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 Geeneration:*** During construction and decommissioning 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.

Embedded 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, the only source of potential liquid discharge is the wastewater that is presently stored within the existing STP structures. As the STP is non-functional over two years, the stored waste water has more or less similar characteristics of rainwater, with possibility of some sedimented organic material. It is unlikely that the stored waste water would have high pollution potential and in all likelihood would be discharged through a pumping arrangement into the Udaypur Canal. During the operations phase, the STP will be treating sewage water and discharge into the Udaypur Khal 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 Udaypur Khal. The treated sewage water from the proposed 60 MLD STP operation will be discharged into adjacent canal 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:*** During demolition of existing building structures at the STP site, C&D waste will be generated. The demolition waste will include existing electrical station and motorized instruments present at the STP which will qualify as electrical-waste. Mechanical instruments present at the site will generate metal scraps. 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 operations phase, solid wastes from grit chambers and screens will be generated at the pumping stations and STP. Sludge will be generated during dewatering of existing Clarifier and occasional desilting of gravity sewer lines. Sludge will be also generated due to treatment of sewage water.

Any 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 4.6 m^3/day quantity of grit will be generated during operation of the proposed Baranagar 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.

Embedded Control Measures

i. The C&D waste generated during the demolition activity will be kept separate at a designated place in the STP.

ii. The concessionaire will reuse a portion of the waste for backfilling activities, to the extent required.

iii. The concessionaire will dispose the waste at a designated landfill site of KMDA near the STP facility in conformance to the Construction and Demolition (C&D) Waste Management Rules, 2016.

iv. The sludge generated from the sewage water treatment will be used for the bio-gas generation and composting (end-use).

v. The Residual Grit, the Screenings and silt will be disposed at the relevant Waste Disposal Site to be identified by the KMDA within a radius of 10 km from the relevant Site, in accordance with the Technical Specifications.

e) ***Hazardous Waste:*** Construction and decommissioning 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. These materials may also be encountered during decommissioning activities involving STP components. 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

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

2.11 Project Schedule

The project schedule is given in **Table 2.4**. The zero date for the project is 11th September, 2019.

Table 2.4: Project Schedule for Baranagar STP Project

Activities/Month	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Basic Engineering																													
Detailed Engineering																													
Order Placement																													
Manufacturing & Supply																													
Information Disclosure																													
Stakeholder Engagement & Grievance Redressal																													
Mobilization at Site																													
Demolition Work																													
Civil Work (Construction)																													
Erection Work																													
Final Documentation																													
Commissioning and Trail Run																													

2.12 Project Cost

The total cost for STP at Baranagar is Rs. 172.10 crores including 15 years O&M with an estimated environmental and social management cost being Rs. 4.08 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 demolition of old 40 MLD STP, construction as well as operation and maintenance (O&M) of a newly constructed 60 MLD STP. During the demolition and construction phase wastewater generated will be discharged, and during O&M phase treated sewage water will be discharged into existing drainage channel i.e. Bagjola khal. 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 different phases of the project must comply with notified environmental standards;	Applicable The proposed project has two phases, Demolition of existing 40 MLD STP, construction of 60 MLD STP, building a new STP of capacity 60 MLD along with renovation of existing linked

<table>
<tr><th>National Legislations</th><th>Applicability</th></tr>
<tr><td>■ Effluent discharge standards for Sewage Treatment Plants stipulated under Environment (Protection) Amendment Rules, 2017.</td><td>sewerage infrastructure 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*(see note below):
<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>Applicable
There is a significant amount of water requirement for proposed project activities, as per site visit and consultation only source of water is an existing borewell within the boundary of facility. It is envisaged that the proposed project scenario involves installation of new/ augmented groundwater abstraction structures through mechanical devices.</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 and demolition wastes 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 at 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 electronic 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 would involve 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 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, installation, protection, operation and maintenance of electric supply and apparatus*)*.	Applicable The proposed project activity would involve installation and operation of medium to high voltage electrical installations (transformers, pumps, DG sets, panels etc.) at the existing LS and MPS as well as in the proposed 60 MLD

National Legislations	Applicability
	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 would 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 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[13].

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

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 Concessionnaire 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. [14]
■ **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 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.

[14] 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
■ **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*).*[15]	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** 12)	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 *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 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.*)*	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' State Insurance Act, 1948* will

[15] 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
	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 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.).	Applicable, only if five or more inter- State migrant workmen to be hired from outside the state of West Bengal.
■ **The Child Labour** (**Prohibition and Regulation**) **Act, 1986** (This Act prohibits engagement of children	This act specifies that no child below the age of fourteen years shall be employed to work in any

National Legislations	Applicability
in certain employments and regulates the conditions of work of children in other certain employments)	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 CSR Act 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 has 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 Environmnetal 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 categorised 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 SafeguardStandards

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** [*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*	Applicable 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

IFC PS	Description	Applicability to the Project
	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*.]	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 associated 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 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*.]	Applicable The proposed STP is located at South Dumdum municipality area. The linked sewage infrastructures are spread across densely populated municipal area under Baranagar and Kamarhati Municipality. 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 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.

IFC PS	Description	Applicability to the Project
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 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***.**]	Not Applicable It is understood based on the site reconnaissance that the existing project STP facility and associate sewerage infrastructure are located 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 60 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.
PS 7	**Indigenous Peoples** [*This Performance Standard applies to communities or groups of Indigenous Peoples who maintain a collective*	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,

IFC PS	Description	Applicability to the Project
	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.]	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. s

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 has been discussed in Table 3.5 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
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	Not-Applicable since the concessionaire is

Guideline Aspect	Description	Applicability
	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	indemnified from not to be held responsible related to environmental pollution by a declaration given by KMDA dated 17.12.19 stating that soil and groundwater of the subject site is already contaminated due to surficial intrusion and spillage of MSW leachate situated beside the site. (Refer to Appendix)
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 and decommissioning 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 Sanitaion sectoral guideline outlines measures to minimize potential community health risks can be implemented both in the collection and treatment of wastewater and sludge.

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 Odors	Odors from wastewater treatment facilities can be a nuisance to the neighboring community. Bioaerosols can also carry disease-causing microorganisms. Furthermore, releases of hazardous gases, such as chlorine, could adversely affect nearby residents. The following measures are recommended to prevent, minimize, and control community exposure to dust and odors from waste	Applicable

Sanitation	Description	Applicability to the Project
	management facilities: ■ Provide adequate buffer area, such as trees, or fences, between processing areas and potential receptors; ■ Avoid siting facilities near densely populated neighborhoods 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 neighbors, 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

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[16] of impacts:

- Air Quality: Gaseous pollutants (e.g. NOx and SO_2) and fine particulate matter (PM_{10} and $PM_{2.5}$)– typically up to 1 km from projects site during decommissioning, 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. Grundwater impact will be within 1 km of the project footprint (as the velocity is very slowalmost imperciptable).
- 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 main pumping station (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 and I&D structure area. The study area was selected based on the AOI of the project.

4.1.3 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.

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

Note:

The ESIA scope included plans for 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 Air 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.

4.1.4 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 of North 24 Parganas has flat topography with average elevation from MSL (mean sea level) of about 5-6 m and having a gentle slope. In the early days of the urbanisation of Kolkata, the area within the boundaries of the city had an abundance of depressions, low-lying waterlogged areas, ponds, ditches and tidal creeks with some of them housing mangrove swamps. Thereafter, rapid urbanisation has led to filling of the depressions through continuos dumping with river side levee being the highest feature in the city and overall slope being towards the east[17]. For a narrow stretch along the river, some of the drainages slope towards the river Hooghly which is the main drainage channel governing the watershed and because of which some of the I&D structures discharges to the river through surface drains.

[17] Ria Roy and Md. Kutubuddin Dhali, Seasonal Water logging Problem in a Mega City: A study Kolkata, India, Quest Journal, Volume 4, pp01-09, April, 2016

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[18]. The study area is characterized by thick quaternary alluvium deposit, laid down by Ganga-Bhagirathi River system. The alluvium deposit can be divided into Recent Alluvium deposit and Older Alluvium deposit. Recent alluvium deposit consists of grey sand, silt and semi-plastic grey clay. Older alluvium deposit occurs beneath recent alluvium deposit and consist of fine to coarse grained sand (grey to brown in colour), gravel, and clay (grey to yellow in colour) with kankar and ferruginous concretions. Top-Clay thickness varies across the district. Maximum clay thickness of 25 mbgl (meter below ground level) was observed in south-eastern part of the district[19].

The STP area is located approximately 3.5 km to the east from the Hooghly River. The Baranagar area is situated in the South-western part of the district. The area is characterized by varied thickness of top-clay. From the limited Phase-2 investigation conducted at the site, it was evident that a thick clay layer of more than 15 m of thickness present in the area from the available drilling data. Although silt proportion in this clay layer upto a depth of 8 mbgl but from 8 to 15 mbgl (meter below ground) clay layer changed to clayey silt or silty clay. Due to presence of high proportion of silt in the clay layer in this zone, the permeability of this zone is relatively higher compared to the rest of the clay layer. The layer is also saturated with water as observed during phase 2 study and this zone feed water to the ponds present within the area. The depth of ponds in the area varies from 8 to 12 m (as described by the local people) and these ponds are perenial, retaining water throughout the year. The clay layer present below this zone shows plastic characteristics and acts as a protective cover from downward percolation of water from the surface.

4.2.3 Land use

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

[18] 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.

[19] CGWB district report of North 24 Paragana.

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

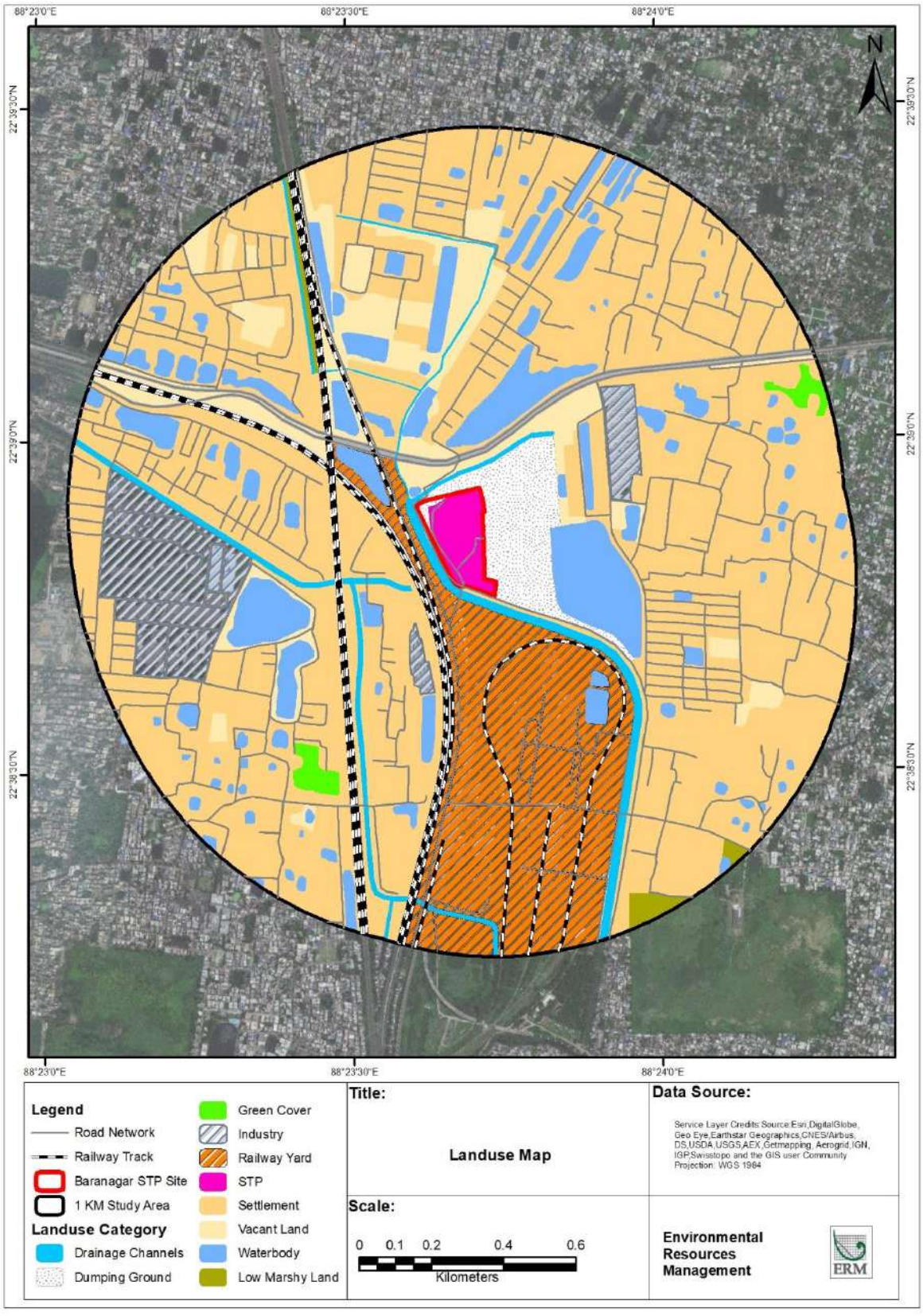


Table 4.1: Area-wise Land Use Classification around the STP

Land use Category	Area sq.M	Area sq.Km	Percentage
Drainage Channels	92547.00	0.09	2.32
Dumping Ground	101425.80	0.10	2.55
Green Cover	20521.12	0.02	0.52
Industry	173621.89	0.17	4.37
Railway Track	84753.17	0.08	2.13
Railway Yard	455014.73	0.45	11.45
Road Network	286358.18	0.28	7.20
Settlement	2070402.60	2.07	52.08
STP	31441.34	0.03	0.79
Vacant Land	251505.93	0.25	6.32
Waterbody	388360.99	0.38	9.77
Low Marshy Land	19101.81	0.02	0.48
Total	**3975054.60**	**3.98**	**100.0**

Figure 4.2 Land Use Map of Existing Sewer Network

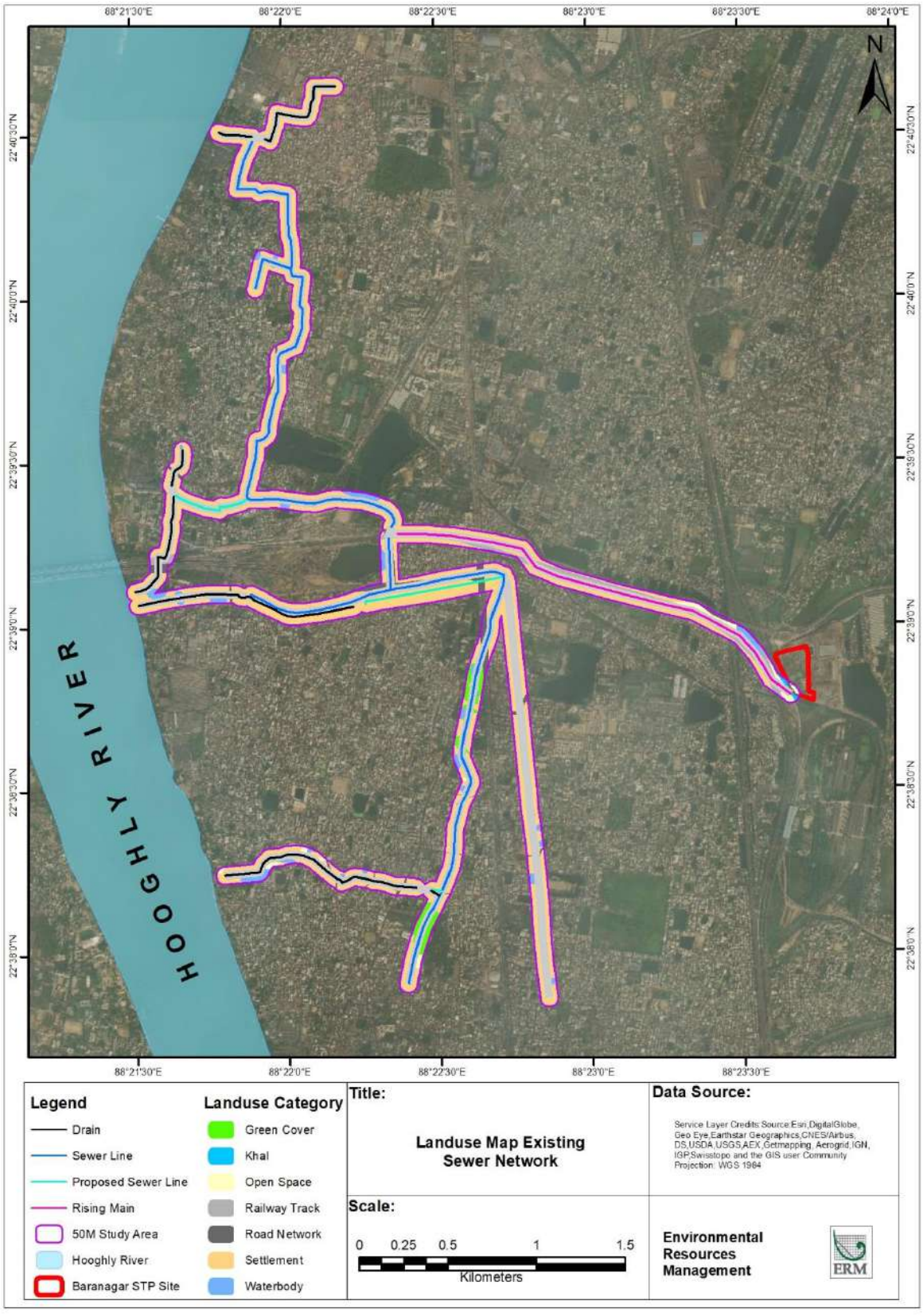


Figure 4.3 Land Use Map of Existing Sewer Network in Kamarhati Municipality

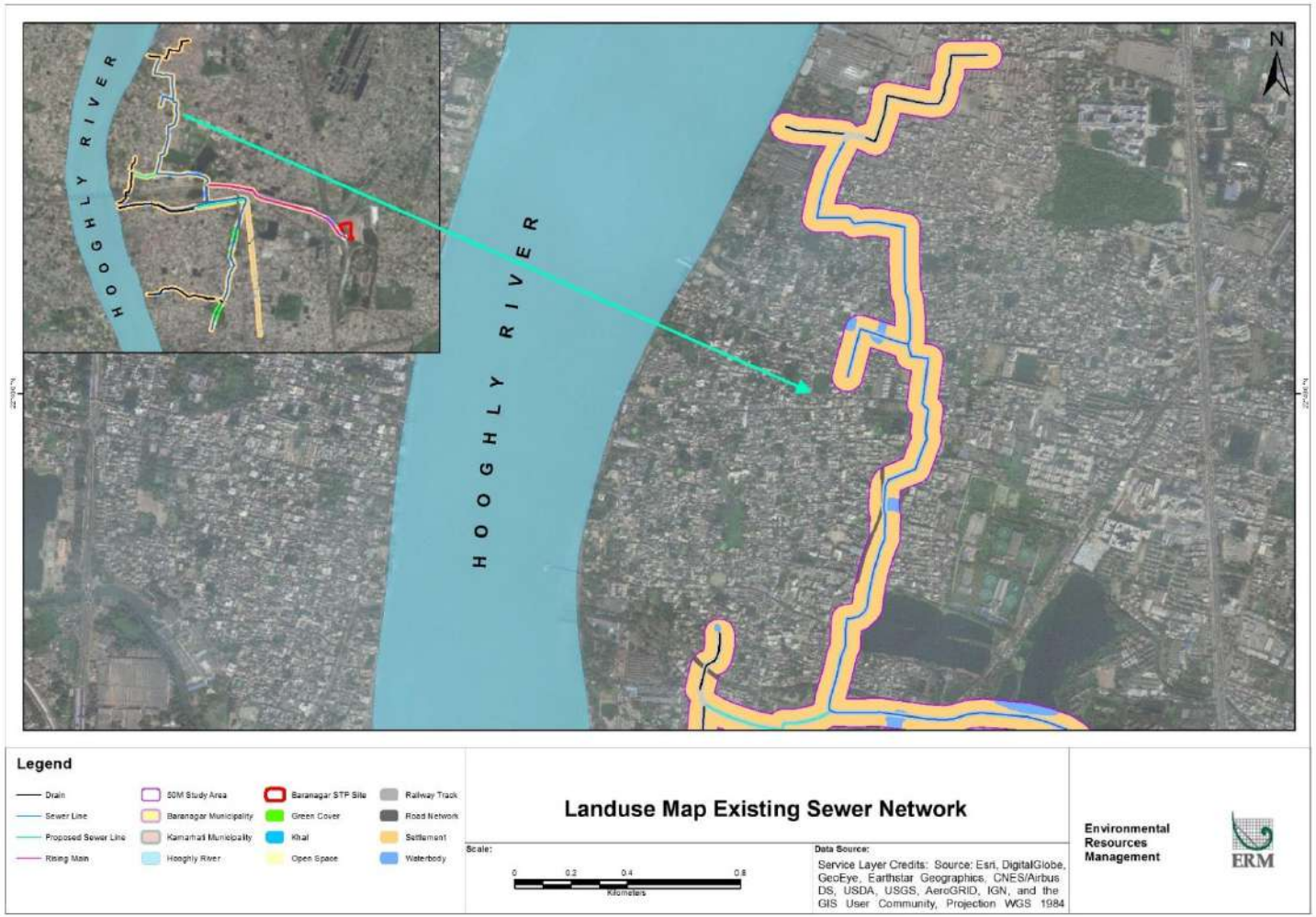


Figure 4.4 Land Use Map of Existing Raising Main

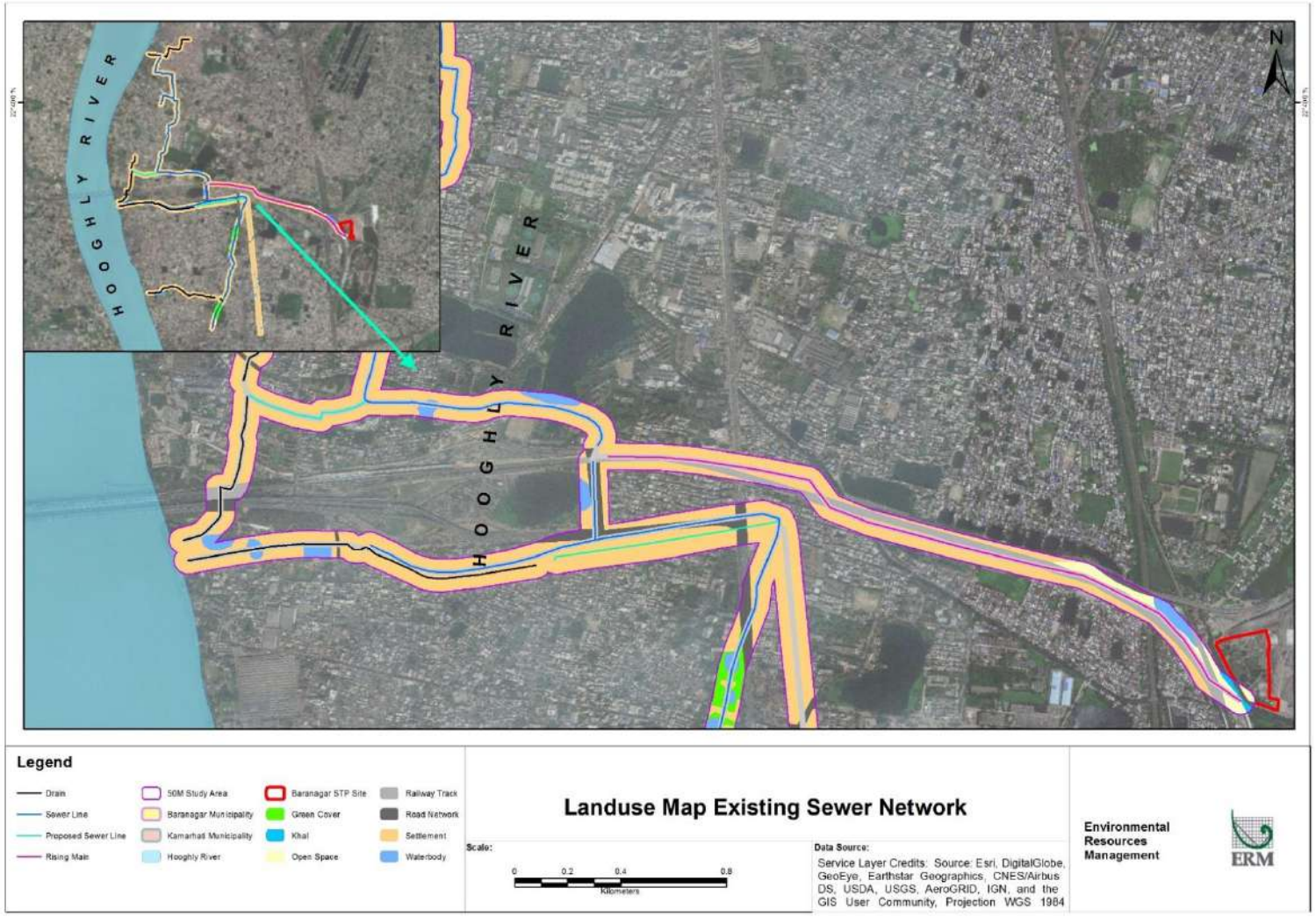


Figure 4.5 Land Use Map of Existing Sewer Network in Baranagar Municipality

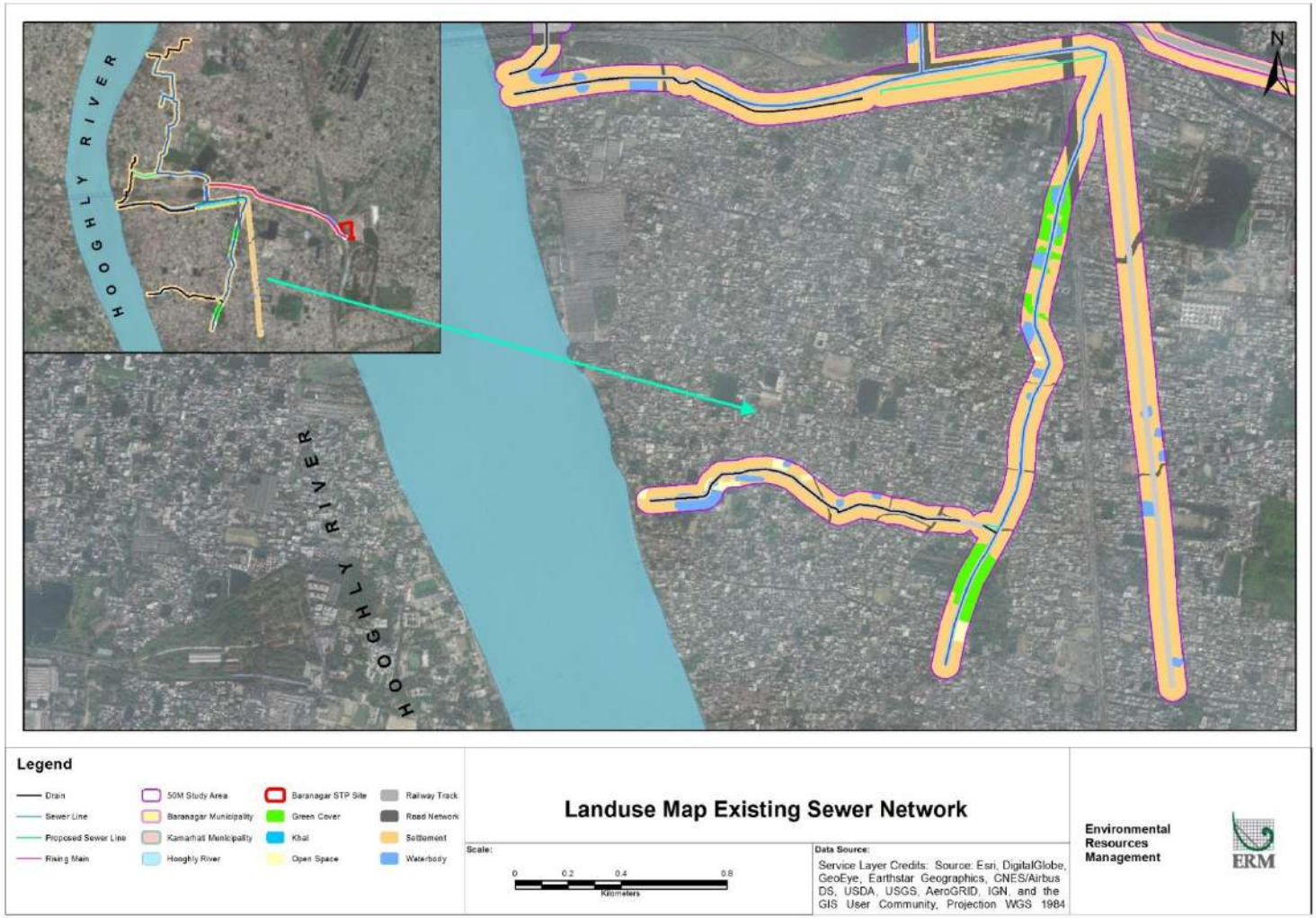


Table 4.2: Area-wise Land Use Classification adjoining Sewer Line Network

Landuse Category	Area Sq.M	Area Sq.KM	Percentage
Green Cover	45980.26	0.05	2.61
Khal	2586.37	0.00	0.15
Open Space	40268.14	0.04	2.28
Railway Track	79474.68	0.08	4.50
Road Network	77918.85	0.08	4.42
Settlement	1440990.22	1.44	81.67
Waterbody	77099.17	0.08	4.37
Total	**1764317.69**	**1.76**	**100.00**

4.2.4 Soil Quality

The district of North 24 Parganas falls within the new alluvium sub-region of the lower Gangetic Plain (Zone-Ill) and is considered as being very fertile for crop production. The soil type varies from sandy to clay sandy loam being the predominant ratio of high: medium: low land is 17:33:39. The soil of northern part of district is sandy, in the central middle part it is sandy with clay loam and in southern side it is clay loam. The soil data were collected mainly from the top-soil (within 15 cm depth) layer. The physiographic structure of the district is mostly plain.

4.2.4.1 Primary Soil Monitoring

The site is located immediately adjacent to the reportedly unlined and active Municipal Solid Waste (MSW) dumpsite, jointly operated by the municipalities of Baranagar, Dum Dum, South Dum Dum and Kamarhati. A limited Phase –II study has been conducted to assess the potential contamination of soil and groundwater at the Site due to the surficial intrusion of MSW on some of the land areas adjacent to the dumpsite, MSW leachate run-off on the surface and/ or percolation through the bottom of the unlined dumpsite by undertaking a limited soil and groundwater quality monitoring and hydrogeological investigation. The location details of the borewells are given in **Table 4.3** and represented in **Figure 4.6.**

Table 4.3: Soil and Groundwater Sampling Location

Sl. No.	Location at Site	Coordinate of Location	Rationale	Sample ID	
				Soil	Groundwater
1	North-East corner	22°38'55.212" N 88°23'42.184" E	Closest to the MSW dumpsite with visible surficial disposal of MSW at the particular location and well on groundwater flow direction potential up-gradient	SB-01	MW-01
2	North-West corner	22°38'53.962" N 88°23'36.881" E	Proximity to MSW dumpsite and well on groundwater flow direction potential cross-gradient	SB-02	MW-02
3	South-East corner	22°38'48.138" N 88°23'42.817" E	Proximity to MSW dumpsite and well on groundwater flow direction potential cross-gradient	SB-03	MW-03
4	West	22°38'50.215" N 88°23'38.933" E	Furthest from MSW dumpsite with no visible surficial disposal of MSW at the	SB-04	MW-04

Sl. No.	Location at Site	Coordinate of Location	Rationale	Sample ID	
				Soil	Groundwater
			particular location and well on groundwater flow direction potential down-gradient		

Figure 4.6 Soil and Groundwater Sampling Locations

Soil sample analytical results for the brownfield suite screened against the Dutch and USEPA standards indicated:

- Exceedance of Arsenic in all the four (4) soil boreholes w.r.t. the USEPA RSL limit. The Arsenic concentrations in the soil boring locations viz., SB-01, SB-02, SB-03 and SB-04 were 4.3, 7.1, 6.5 and 7.2 mg/kg respectively against the limit of 3.0 mg/kg.
- Exceedance of Copper in one (1) soil boring location w.r.t. the Dutch standard. The copper concentrations in the soil boring locations viz., SB-03 was 266.0 mg/kg against the limit of 190.0 mg/kg.

The chemical of concern in soil in all the four (4) boreholes is Arsenic. Per the CGWB 'Bhu-Jal News' journal (volume no. 24, no. 2 and 3, Apr-Sep 2009) the groundwater in the upper aquifer of the North 24 Parganas district, where the site is located, is naturally affected by Arsenic beyond the 'permissible limit in absence of alternate source (0.05 mg/L)' as per the Indian drinking water standard. According to the report 'Arsenic and fluoride in drinking water in West Bengal: Characteristics, implications, and mitigation'[20] North 24 Parganas is one of the worst affected districts of West Bengal by Arsenic, situated on the east of the Ganga (Hooghly) River. Also per the CGWB – North 24 Parganas District

[20] [West Bengal Drinking Water Sector Improvement Project (RRP IND 49107-006), https://www.adb.org/projects/documents/ind-49107-006-rrp]

Report, the groundwater upper aquifer of the North 24 Parganas district has been designated to be naturally affected by Arsenic. In addition, several studies done in and around the city of Kolkata show high level of Arsenic being present in near surface soil samples, which have primarily been attributed to natural geogenic existence in the environment. Consequently, the Arsenic concentration exceedance in soil above the screening criteria related to the subject site may not indicate contamination caused by any anthropogenic activity.

Note: A detailed Phase II, Environmental Site Assessment adopting ASTM 1903-11 standard, is recommended to explore probable sources and causes of elevated levels of potential heavy metal and other chemical contaminants in the sub-surface soil.

Apart from these, surface level soil quality at surface was monitored from another two (2) different locations in the Baranagar area. The soil samples were collected from the top-soil within 15 cm depth and analysed to estimate the extent of soil pollution due to previous operation of STP or because of the influence of other anthropogenic activities in the vicinity of the site. One sample was collected within the Baranagar facility and another sample was collected outside the STP facility area to estimate the baseline condition and understand any difference in the quality of the soil samples. The details of the soil monitoring locations are provided in **Table 4.4** and the soil locations have been shown in **Figure 4.7**.

Table 4.4: Surface Soil Monitoring Locations in Study Area

S. No.	Monitoring Location	Station Number	Land Use	Latitude	Longitude	Rationale for Selection
1.	Baranagar STP	SS1	Within The STP Area	22° 38' 49.29" N	88° 23' 40.43"E	To predict soil contamination within the site
2.	Indira Nagar	SS2	Residential Settlement	22°38'47.76"N	88° 23' 39.26" E	To predict soil contamination outside the STP facility

Table 4.5: Results of Surface Soil Monitoring

Parameters	Location	Baranagar STP	Indira Nagar
	Sample Id	*SS1*	*SS2*
Texture	-	loam	clay loam
Particle Size Distribution	%	sand:44%, silt:29%, clay:27%	sand:35%, silt:26%, clay:39%
Specific gravity	-	2.15	2.21
Permeability	Cm/hr	2.4	1.1
Water Holding capacity	%	29	36
Porosity	%	45	43.5
Bulk Density	gm/cc	1.18	1.25
Moisture	%	16	18
pH value	-	7.32(1:2.5) at 25^{0}C	7.80(1:2) at 25^{o}C
Boron (as B)	mg/kg	24	22
Calcium (as Ca)	mg/kg	4900	5950
Chloride (as Cl)	mg/kg	150	260
Sulphate (as SO4)	mg/kg	250	480
Alkalinity (as CaCO3)	mg/kg	340	380

Parameters	Location	Baranagar STP	Indira Nagar
	Sample Id	*SS1*	*SS2*
Arsenic(as As)	mg/kg	4.7	5.1
Available Nitrogen (as N)	mg/kg	401	255
Sodium (as Na)	mg/kg	470	508
Electrical conductivity	us/cm	1015(1:2) at 25 ^{0}C	1380 (1:2) at 25 ^{0}C
Available Potassium (as K)	mg/kg	352	421
Sodium Adsorption Ration (as SAR)	-	1.17	1.67
Available Phosphorus (as P)	mg/kg	12	9.9
Cation Exchange Capacity	meq/100 gm	32	38
Hexavalent Chromium (as Cr+6)	mg/kg	<2.0	<2.0
Acidity	mg/kg	NIL	NIL
Carbonate as CO3	mg/kg	NIL	NIL
Infiltration Capacity	Mm/hrs	14 mm/hrs	8.5 mm/hrs
Copper (as Cu)	mg/kg	67	40
Iron (as Fe)	mg/kg	5.1	4.0
Magnesium (as Mg)	mg/kg	1200	510
Manganese (as Mn)	mg/kg	349	343
Cadmium (as Cd)	mg/kg	<2.0	<2.0
Lead (as Pb)	mg/kg	43	23
Mercury (as Hg)	mg/kg	<0.1	<0.1
Nickel (as Ni)	mg/kg	27	21
Zinc (as Zn)	mg/kg	153	80
Total Chromium (as Cr)	mg/kg	42	26

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

Figure 4.7 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 loam and 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. The high sand content in the soil increase the permeability of the soil and indicate light soil.

Porosity

The porosity of the soils are 45% and 43.5% respectively for SS1 and SS2. These high value of porosity of soil indicates sandy clay.

Permeability

The permeability of the soils are 2.4 and 1.1 cm/hr respectively for SS1 and SS2. 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 soils indicates sandy clay for SS1 and clay loam to loam for SS2[21].

pH

pH values in soils were 7.32 and 7.80 respectively for SS1 and SS2. pH values in both the soil samples indicated slightly alkaline soil.

Electrical Conductivity

The EC values for the soils monitored at the study area were 1015 and 380 µs/cm. 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** 4.6. Nitrogen contents in the soil samples were 401 and 255 mg/kg (178.99 and113.82 kg/ha), phosphorus content in the soil samples were 12 and 9.9 mg/kg (5.35 and 4.42 kg/ha) and potassium contents ranges between 352 and 421 mg/kg (157.12 and 187.92 kg/ha) for SS1 and SS2 respectively. With comparison to the rating chart nitrogen status was good to better, phosphorus status was very less and potassium status was less to medium. The variarion of available nitrogen concentration in soil is due to the fact that the soils were sampled from different locations.

Metals

a) **Copper:** Copper concentration of the soil samples are 40 and 67 mg/kg respectively for SS1 and SS2. 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 43 and 23 mg/kg respectively for SS1 and SS2. 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.

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

c) **Zinc:** Zinc concentration of the soil samples are 153 and 80 mg/kg respectively for SS1 and SS2. 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) Metals such as Iron (5.1 and 4 mg/kg), Magnesium (1200 and 510 mg/kg) and Manganese (349 and 343 mg/kg) were detectable in the soil of the study area. Cadmium (<2.0 mg/kg) and Mercury (<0.1mg/kg) concentrations were found to be below detectable.

Sodium Absorption Ratio (SAR)

Sodium absorption ratio for the soil samples were 1.17 and 1.67 respective for SS1 and SS2.

Overall, there have been some exceedances for heavy metals like Arsenic (4 locations) and Copper (1 locations) for soil samples analysed from the site. For the samples which were collected for analysis of nutreints and other soil properties, considerable variability has been noticed with respect to parameters like Chloride, Sulphate, Available Nitrogen, Manganese and a few other parameters. The settings of the STP and immediate surroundings are predominantly urban in nature and can be characterised by partially planned, non-uniform and often conflicting land uses (residential areas, slums, small industries, cattle sheds, vehicle layby's, roads, railway and metro corridors, open and unlines waste disposal grounds, septage dumping area, canals and waterbodies, etc.) and has the potential to exhibit considerable heterogeneity in quality of environmental media like soil, surface and ground water. In addition, the influence of the open SWM dump on such media makes it difficult to evaluate based on a limited primary monitoring program.

4.2.5 Climate and Meteorology

The climate of North 24 Paraganas 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 a summer from March to May. Winter season is characterized by dry weather. Rainfall occurs primarily during the south-west monsoon months i.e. June to September and constitutes about 74% of the total annual rainfall. Sometimes sporadic showers takes places in summer accompanied by high winds, which are locally called 'Kal Baisakhi'.

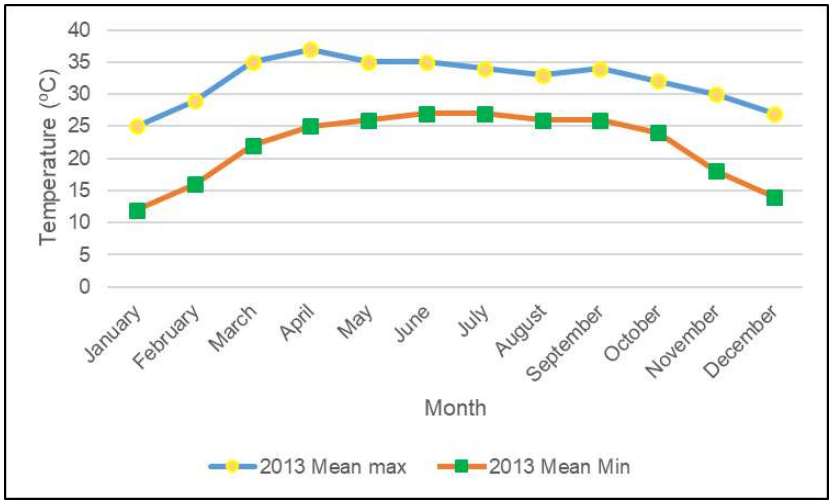
Following are the well-defined seasons of the region:

- 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** 4.8.

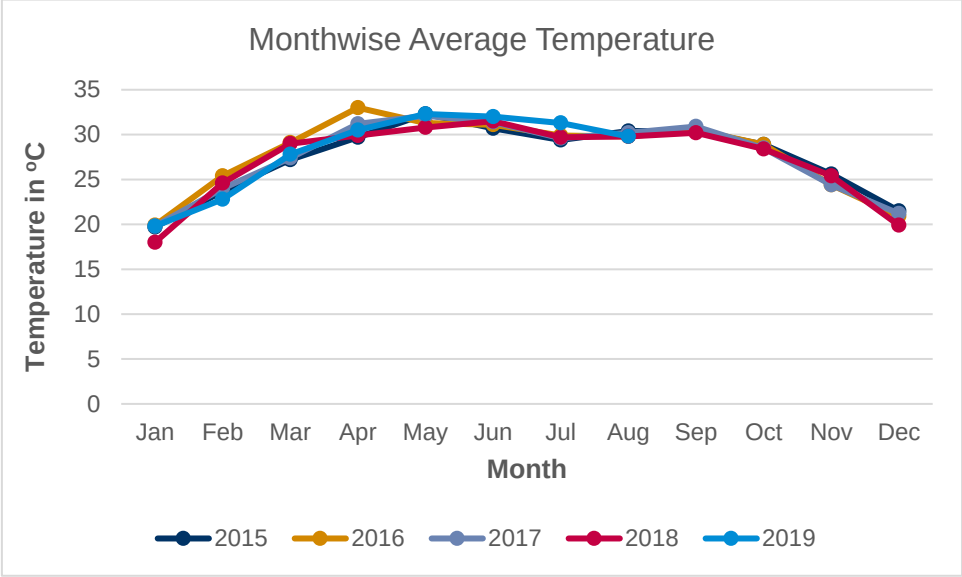
Figure 4.8 Monthly Mean Minimum and Maximum Temperature Variations



Source: District Statistical Handbook of North 24 Paraganas, 2013

Monthly average temperature data from 2015 to 2019 was colected from Weather -Online[22].The monthwise average temperature data is given in **Figure 4.9**. Highest average temperature occur in the month May.

Figure 4.9 Monthly Average Temperature data from 2015 to 2019



Relative Humidity

The relative humidity of South 24 Paraganas district is reported to be high (71% to 85%) throughout the year.

Rainfall

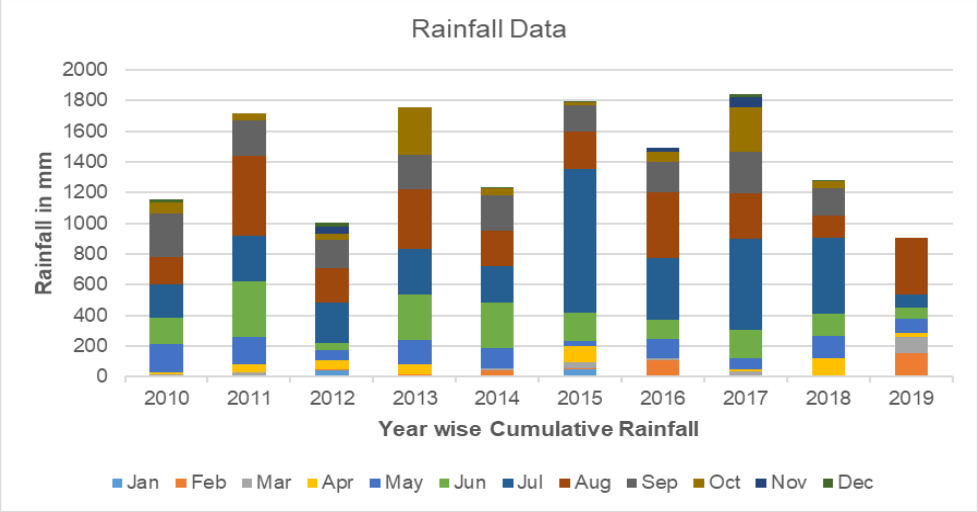
The period between June to September is the monsoon season with the average annual rainfall of the district being about 1579 mm[23]. Monthly cumulative rainfall data from 2010 to 2019 was reviewed from Weather-Online to estimate the rainfall pattern of the area. The yearwise cumulative rainfall data

[22] 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

[23] Disaster Management Plan- North 24 Paraganas -2017-2018

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-August.

Figure 4.10 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 about 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.[24]

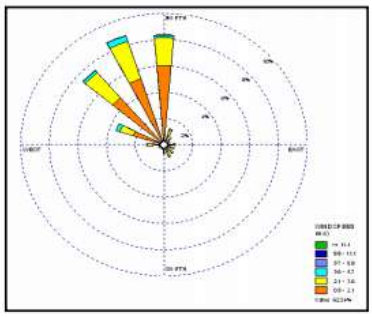
The wind is most often from the west for the time period of 1.2 months, from February 13 to March 20. The wind changes and blows from the south for 6.6 months, from March 20 to October 9. During rest of the year, for about 4.1 months between October 9 to February 13, the wind blows from the north.[11]

Wind Rose

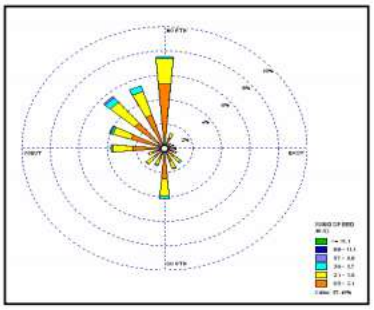
Average monthly wind roses from January to December between the years 1998 to 2007 are given in **Figure 4.11**. Analysis of monthly wind rose data reveals that from March to September, the predominant wind direction is from S or SSE direction. From November to February, the wind direction is predominantly 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).

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

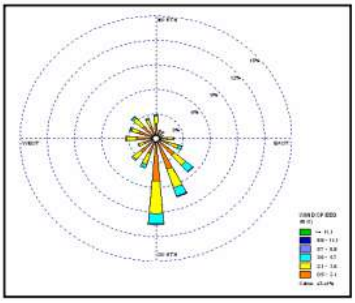
Figure 4.11 Annual Monthly Wind Rose Diagram



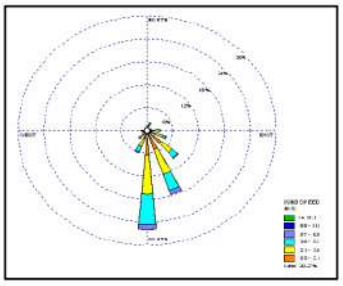
January



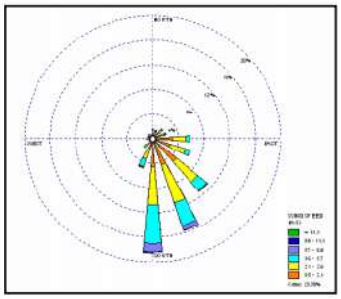
February



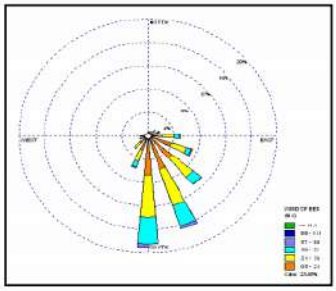
March



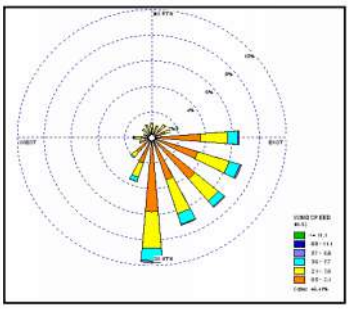
April



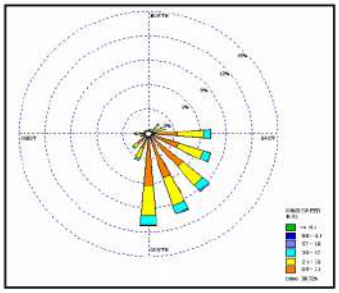
May



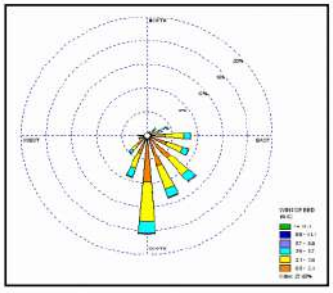
June



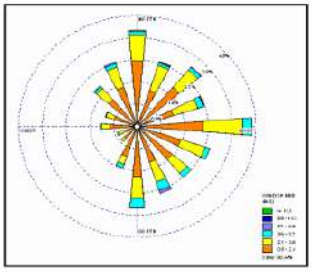
July



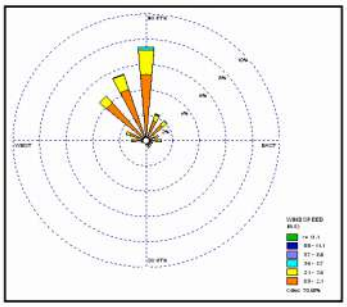
August



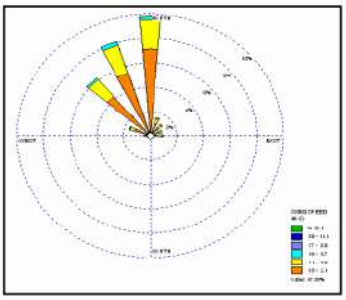
September



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 located on the northern edge of Kolkata urban area and generally exhibits moderate to poor air quality and relatively high Air Quality Index. The local air shed in the study area of the STP site has several air emission sources, notable being vehicular emissions from the highway, fugitive emission from construction sites in the vicinity (metro corridor, residential buildings, etc.) and from industrial sources located nearby. A major contributor to adverse air quality in the study area also happens to be wind blown dust / particulates and also emissions from open burning of wastes originating from the adjacent Baranagar dumping ground.

Review of secondary air quality data of 2018 from the Dumdum air quality monitoring station (Latitude 22°38'03.5''N, Longitude 88°25'11.0'' E) of WBPCB (West Bengal Pollution Control Board) which is located about 3 km east of the STP site, show weekly data available for PM_{10}, NO_2 and SO_2 was collected and analysed to determine the baseline condition of the area. Data showing monthly average, min and max values of PM_{10}, NO_2 and SO_2 is given in **Table 4.6**.

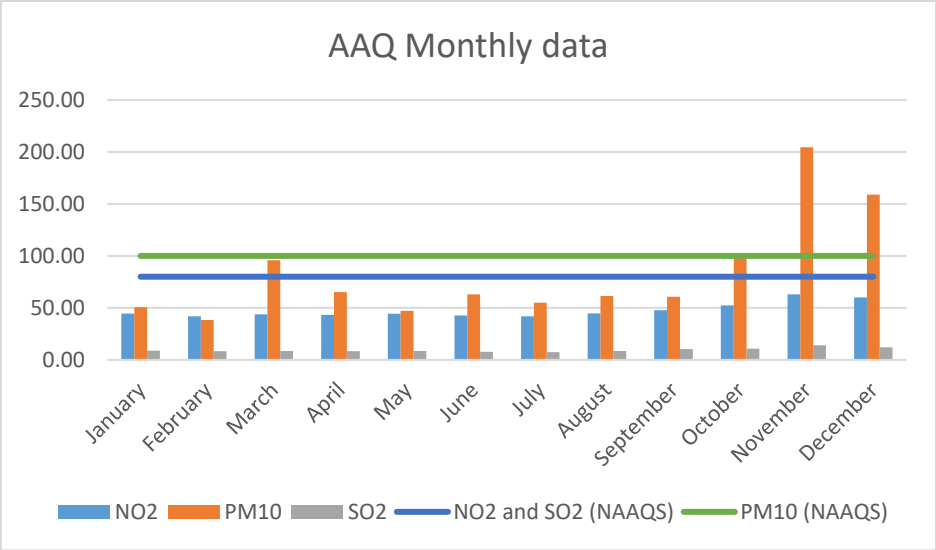
Table 4.6: AQM Data from Dumdum Monitoring Station of 2018

Month	NO_2 (µg/m^3)			PM_{10} (µg/m^3)			SO_2 (µg/m^3)		
	Monthly			Monthly			Monthly		
	Average	Max	Min	Average	Max	Min	Average	Max	Min
January	44.54	46.92	42.11	50.73	58.53	38.65	8.77	9.29	8.33
February	41.97	44.90	39.45	38.42	43.18	32.21	8.29	9.01	6.76
March	43.74	48.01	41.07	95.85	181.22	36.29	8.53	9.83	7.45
April	43.34	46.34	41.21	65.13	97.61	52.6	8.30	8.76	7.39
May	44.40	48.48	42.37	47.11	66.35	32.55	8.58	9.42	7.04
June	**42.71**	**46.44**	**33.85**	**62.99**	**94.37**	**46.34**	**7.67**	**9.74**	**4.32**
July	41.91	49.87	38.17	55.07	64.46	46.56	7.39	9.89	5.91
August	44.76	47.14	41.25	61.46	79.87	50.53	8.56	9.55	7.34
September	47.72	50.51	46.41	60.63	82.19	37.19	10.33	11.44	8.66
October	52.37	59.6	48.53	98.64	137.39	62.6	10.86	11.58	10.19
November	62.95	73.45	53.73	204.43	467.89	92.86	14.07	25.81	10.47
December	60.06	62.9	56.22	158.95	235.98	87.27	12.01	12.98	11.25
Annual	**47.54**			**83.28**			**9.45**		

Source: WBPCB

It was found that the maximum concentration of all three pollutants were highest in the month November which can be attributed to regional atmospheric build up of air pollutants resulting from low wind speed and limited mixing height resulting in inadequate dispersion of PM and gaseous pollutants emitted from different urban sources. The average PM_{10} concentration was also high during December and exceed the National Ambient Air Quality Standard. The annual average concentration of NO_2, PM_{10} and SO_2 were 47.54, 83.28 and 9.45 µg/m^3 respectively. The monthly air quality levels with respect to NAAQS values is presented in **Figure 4.12**. The detailed ambient air quality results are given in **Appendix E.**

Figure 4.12 Monthly average concentration of NO_2, PM_{10} and SO_2



4.2.6.1 Primary Air Quality Monitoring

Ambient air quality was monitored at three locations across the study from 11th June to 17th June, 2019. The parameters studied were Particulate Matter (PM_{10} and $PM_{2.5}$), Oxides of Nitrogen (NOx), Sulphur dioxide (SO_2), Carbon Monoxide (CO), Ammonia (NH_3), Hydrocarbon and H_2S. Air quality monitoring locations were selected in residential areas. The monitoring locations were Upwind, downwind and crosswind direction with respect to the STP facility to understand the baseline air environment in the study area. No air monitoring locations was selected at the western part of the project site due to the prevailing wind direction which is south to north. The prevailing wind direction wind direction is from south to north. The monitoring location details are given in **Table 4.7.** The air monitoring locations have been provided in **Figure 4.13.**

Table 4.7: Ambient Air Quality Monitoring Locations

Sl. No.	Monitoring Location Number	Geo-coordinates		The Distance From the STP	Rationale for Selection
AAQ1	Baranagar West Dumping site	22° 38' 49.848" N	88° 23' 42.5472" E	0 km	Within the STP facility
AAQ2	Adarsha Nagar	22° 39' 0.3024" N	88° 23' 37.644" E	0.18 km	Upwind with respect to STP facility
AAQ3	Pramod Nagar	22° 38' 58.9344" N	88° 23' 52.0332" E	0.29 km	Crosswind with respect to STP facility

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 given in **Table 4.8**.

Figure 4.13 Ambient Air Quality Monitoring Location Map

Table 4.8: Summary of Ambient Air Quality Monitoring

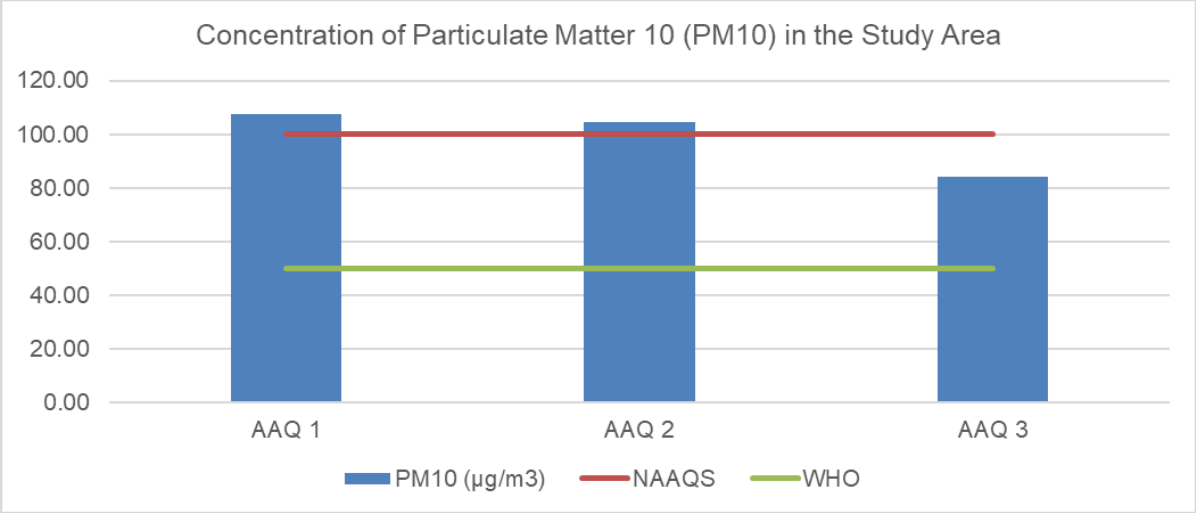
	PM_{10} ($\mu g/m^3$) (24 hours)	$PM_{2.5}$ ($\mu g/m^3$) (24 hours)	SO_2 ($\mu g/m^3$) (24 hours)	NO_2 ($\mu g/m^3$) (24 hours)	CO (mg/m^3) (8 hours)	NH_3 (mg/m^3) (24 hours)	Hydrocarbon (as Non-Methane) ppm (24 hours)	H_2S ($\mu g/m^3$) (24 hours)
Baranagar West Dumping site								
Average	107.43	50.00	7.67	44.60	0.77	23.70	1.58	<10.0
Max	142.50	55.20	8.60	51.70	0.86	28.80	1.61	<10.0
Min	84.70	42.90	7.00	38.60	0.68	19.60	1.52	<10.0
98th Percentile	140.60	55.07	8.55	51.37	0.86	28.56	1.61	
Adarsha Nagar								
Average	104.50	54.17	6.90	38.07	0.69	18.87	1.64	<10.0
Max	123.60	58.50	7.30	43.80	0.76	21.60	1.76	<10.0
Min	94.90	51.10	6.60	35.20	0.57	16.50	1.48	<10.0
98th Percentile	122.46	58.28	7.28	43.46	0.76	21.48	1.76	
Pramod Nagar								
Average	84.20	47.73	6.63	32.90	0.66	17.27	1.29	<10.0
Max	96.30	54.90	7.20	41.30	0.82	19.80	1.45	<10.0
Min	72.60	40.90	6.20	26.80	0.54	14.70	1.16	<10.0
98th Percentile	95.80	54.60	7.17	40.87	0.81	19.70	1.44	

Particulate Matter (PM_{10})

The average concentration of PM_{10} in the Study Area ranged between 84.20 and 107.43 $\mu g/m^3$. The average concentration of PM_{10} values at Pramod Nagar station was found to be in compliance to the NAAQS value of 100 $\mu g/m^3$ but exceeding the WHO air quality guideline value of 50 $\mu g/m^3$. The Variation average concentration of PM_{10} values at Baranagar West Dumping site and Adarsha Nagar stations were exceeding the NAAQS value. As per the 'Average Weather of Kolkata' report of Weatherspark, the predominant wind direction from March 20 to October 9 is from South[25]. AAQ-1 station is located very close to the Dumpyard (only 10m away) and due to the southerly wind high PM10 concentration found in AAQ-1 station. In AAQ-2 station is located north side of the Belghoria Express Way. Due to southerly wind direction the high value of PM10 found in AAQ-2 station. AAQ-3 station is located at an aerial distance of 100 m east of dumpyard and at an aerial distance of 150 m south of Belghoria express way. The average PM10 value of AAQ-3 station does not show very high variation with respect to the reported PM10 value of 83.28 µg/m3 of Dumdum Air quality monitoring station. The low value of PM10 in AAQ-3 compared to the other 2 stations is due to its location and the southerly wind direction during monitoring. Variation of PM10 values at the monitoring stations are presented in the Figure 4.14.

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

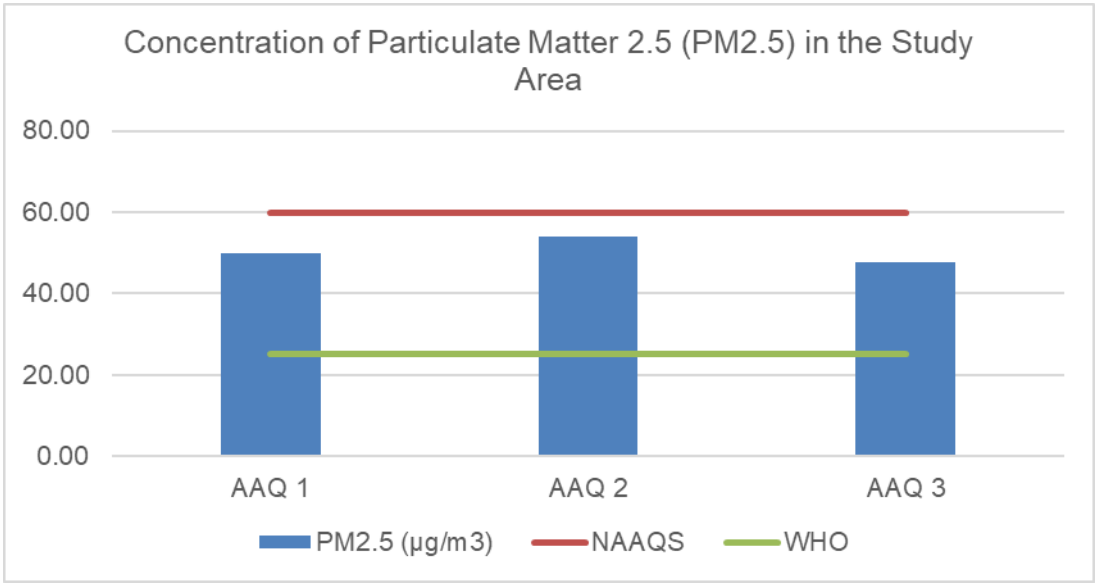
Figure 4.14 Concentration of Particulate Matter (PM_{10}) in the Study Area



Particulate Matter ($PM_{2.5}$)

The average concentration of Particulate Matter ($PM_{2.5}$) in the study area ranged between 47.73 and 54.17 µg/m^3. The average concentration was within the stipulated standard of 60 µg/m^3 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 4.15.**

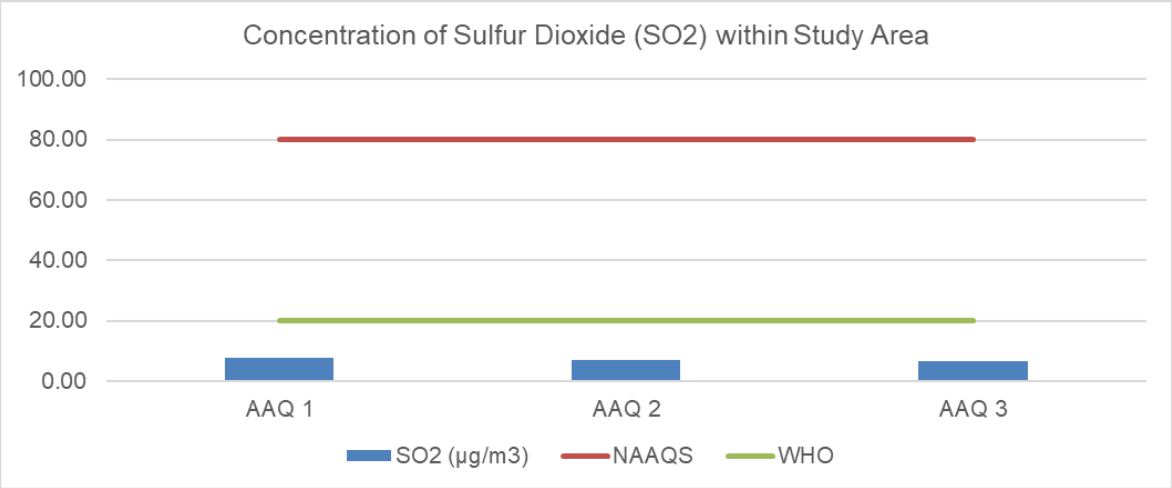
Figure 4.15 Concentration of Particulate Matter ($PM_{2.5}$) in the Study Area



Sulphur Dioxide (SO_2)

The average concentration of Sulphur Dioxide (SO_2) in the study area ranged between 6.90 and 7.67 µg/m^3. The average concentration reported across all the three (3) monitoring locations were below the 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 4.16.**

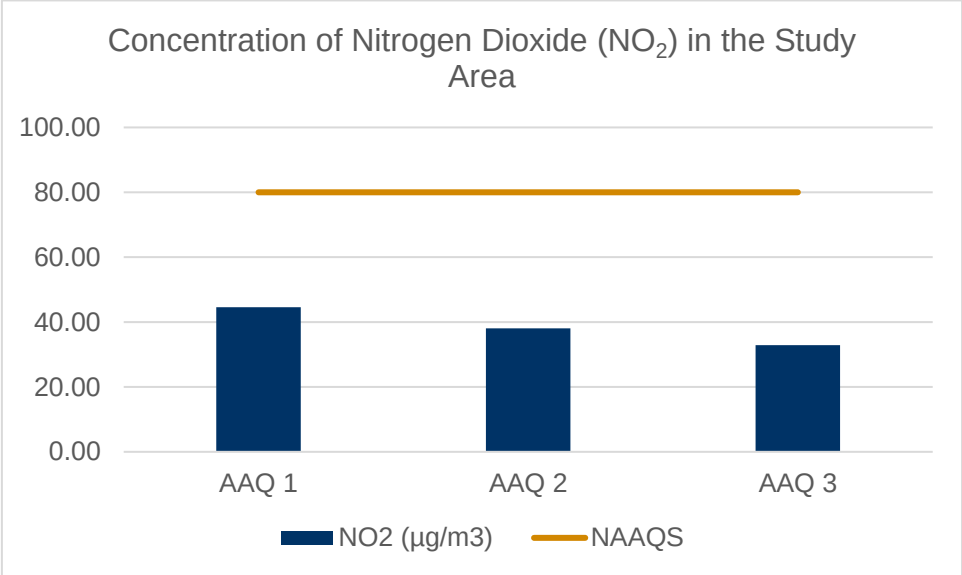
Figure 4.16 Concentration of Sulphur Dioxide (SO_2) in the Study Area



Nitrogen Dioxide (NO_2)

The average concentration of NOx in the study area ranged between 32.90 and 44.60 µg/m^3. The average concentration reported across all the three (3) monitoring locations were below the NAAQS value of µg/m^3. WHO 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 4.17.**

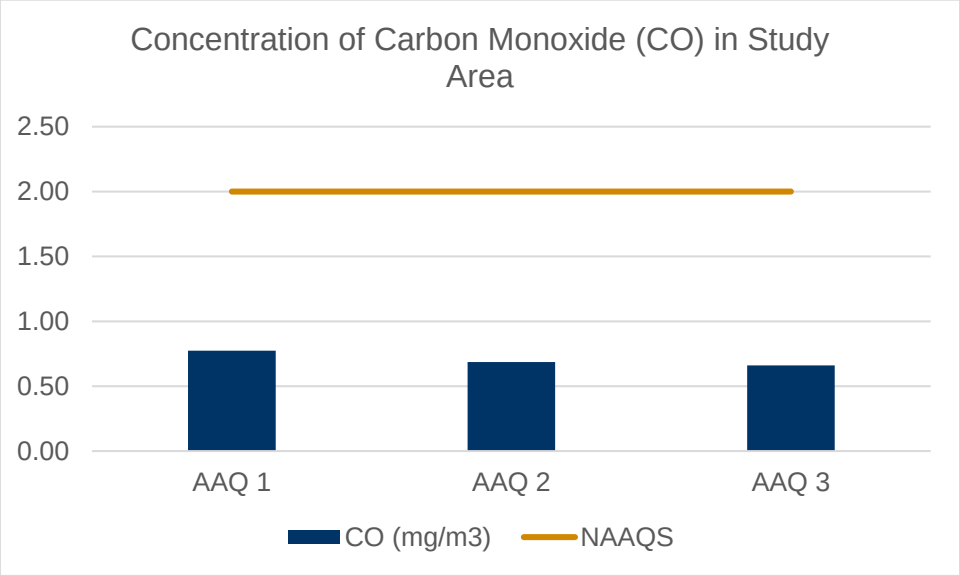
Figure 4.17 Concentration of Nitrogen Dioxide (NO_X) in the Study Area



Carbon Monoxide (CO)

The 8 hour average concentration of Carbon Monoxide in the study area ranged between 0.66 and 0.77 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 4.18**.

Figure 4.18 Concentration of Carbon Monoxide (CO) in the Study Area



Hydrocarbons

The average methane concentration in the study area ranged between 1.29 and 1.64 ppm. There is no standard value for Methane in NAAQS.

Ammonia

The concentrations of ammonia concentration in the study area ranged between 17.27 and 23.70 µg/m^3. The average concentration of NH3 reported across monitoring locations were in compliance the NAAQS value of 400 µg/m^3.

Hydrogen Sulphide (H_2S)

The concentrations of H_2S in the study area were recorded less to be than 10 µg/m^3.

Overall, the study area represents urban environmental setting with several sources of air pollution being present. However, except for the values of PM10, all the values of other pollutants were in compliance with the National Ambient Air Quality Standards during the monitoring period. The secondary data available from Dumdum air quality station indicates that the concentration of NO_2 and SO_2 concentration found in June, 2019 were similar with the previous year's data. The primary PM_{10} monitoring data collected in June, 2019 showed higher concentration with respect to previous year data in the same month. The higher concentration of PM_{10} may be due to the fact that construction of the metrl corridor extension to Dakhineswar is presently going on at a rapid pace contributing to higher levels of fugitive dust emissions, leading to a local increase in particulate matter concentrations. In addition, the air quality monitoring stations were located near to Belghoria Express way and vehicular emissions from road may have contributed to the higher PM_{10} values.

4.2.6.2 Odour:

As discussed in ***Section 2.4,*** Baranagar municipal solid waste dumping ground is located eastern side of the STP project area and share a common boundary. The total area of dumping ground is 20 acre (approx.). The dumping ground is a major source of bad odour within the area. The odour producing compounds are mainly Hydrogen Sulfide (H2S) and Volatile Organic Compounds potentially arising from a combination of sources – Baranagar dumping ground, Udaypur Canal and

other sewer lines present in the area. 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 site.

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[26].

4.2.7 Noise Quality

Ambient noise monitoring was conducted at four (4) stations within the study area to understand prevailing noise levels in the project area and its vicinity. The noise levels have been monitored primarily in residential zones to assess and evaluate prevailing baseline noise levels. The location NQ2 and NQ3 were selected near Belghoria Express Way and A. K. Mukherjee road as these roads will be used during construction period. The baseline data of these areas will help to estimate the possible effects of incremental load during construction will have on the ambient noise quality of the area. The location of NQ-1 is selected within the facility to record prevailing noise levels prior to project activities commencing and to help to assess the impact on ambient noise levels at site, post commencement of construction activities. No noise monitoring station was selected at the western part of the project site due presence of Railway lines, metro station (Noapara Metro station), metro yard and bus stand, all of which act as a noise sources within the study area. The location of the noise monitoring stations have been presented in **Table 4.9** and depicted in **Figure 4.19** for reference.

Table 4.9: Ambient Noise Monitoring Locations

Sl. No	Monitoring Location	Station Number	Geographical Coordinates		Category of Area/Zone
			Latitude	Longitude	
1.	Baranagar Site West Dumping Site	N-1	22° 38' 49.3908"	88° 23' 42.8856"	Residential
2.	Adharsha Nagar	N-2	22° 39' 0.3168"	88° 23' 37.8132"	Residential
3.	Pramod Nagar	N-3	22° 38' 58.9236"	88° 23' 51.882"	Residential
4.	Baranagar Site	N-4	22° 38' 44.9808"	88° 23' 40.6428"	Residential

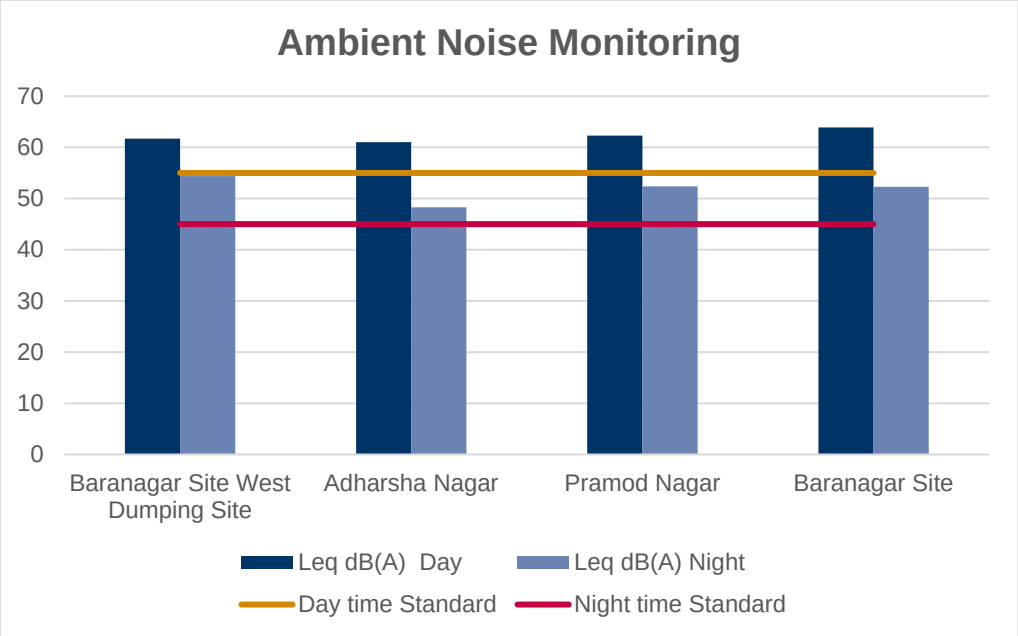
The 24-hour baseline noise monitoring was conducted by using the portable sound meter (Lutron, SL-0423SD, unit: dB(A). Noise level (LAeq) were measured and recorded at a one hour interval and averaged at a daily (i.e. 24-hour) interval using the following formula:

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 4.20** below.

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

Figure 4.19 Ambient Noise Monitoring Location Map

Figure 4.20 Ambient Noise Monitoring Results



4.2.7.1 Interpretation of Primary Noise Monitoring Results

The equivalent noise level as measured at the residential areas range between 61 -63.9 dB(A) at day time and between 48.3-54.4 dB(A) at night time. The equivalent day time noise values at all the locations (Baranagar West Dumping Site, Adharsha Nagar, Pramod Nagar and Baranagar Site) exceed the day time standard of 55 dB(A) for residential areas. Similarly, the equivalent night time noise values in all the locations (same locations as mentioned for day time) exceed the night time standard of 45 dB(A) for residential areas. The noise values of the areas also exceeds the LAeq values of Outdoor living area prescribed by WHO for day (55 dB(A)) and night (50 dB(A)) time. The noise monitoring stations were close to the Belghoria Expressway and other infrastructural corridors and there is contribution from vehicular traffic, train plying on the adjacent railway lines as well as heavy equipment functioning at the Baranagar dumping ground, located adjacent to the site. The detailed ambient noise quality results are given in **Appendix F.**

4.2.8 Drainage

The study area is part of Kolkata Metropolitan Area (KMA). Most areas of KMA have century old drainage and sewerage systems. The drainage system has been divided into 25 drainage basins (Catchment Area) with 18 basins on the east bank and 7 on the west bank of the river Hooghly. Similarly, the entire metropolitan area of KMA is divided into 20 sewerage zones, 14 on the east bank and 6 on the west bank. These drainage used to drain both the storm water and sewage water. These drainage system is located in east-west direction to carry the wastewater and storm runoff from the western part of the city to the eastern part through different pumping stations for disposal into the Kulti River which is located at an aerial distance of 36 km from the city[27].

The important canals are Bagjola Khal flowing from the eastern side of the STP facility area, Circular Canal flowing from the western side of the study area and Udaypur Canal flowing from west and southern side of the study area. Udaypur Canal meets the Bagjola khal on southern side of the study area. Bagjola khal meets the circular canal on the western part of the district. The Bagjola khal is a major drainage artery catering discharges from a large part of areas comprised of 5 to 6 municipalities in northern part of the city of Kolkata. The Bagjola khal drains both gravitational and pumped flow from its basin area due to tidal effect of outfall river Kultigong. The study area is part of Upper part of Bagjola Khal which starts from B.T. Road and ends at VIP road crossing. The length of this stretch is 9.235 km. Upper Bagjola Khal is the main drainage artery for the urban areas of Panihati, Kamarhati, Baranagar, North Dum-Dum, Dum Dum, South Dum Dum and adjoining Kolkata Municipal Corporation areas. The basin area of upper Bagjola canal covers about 56.57 sq.km. The present system of Upper Bagjola Canal have Drainage Index of 3 inch per day[28]

The drainage system near the STP facility area is controlled by the Udaypur Canal and Bagjola Khal located further west of the STP facility. Near the Pramod nagar area at the south from the STP a small canal from the Udaypur canal flows to the east direction whereas the main canal flows in the South direction and meets the Bagjola canal.

Micro-Drainage: The STP site is surrounded by elevated road (Belghoria Express Way) on the northern part of the site and solid waste dumpyard on the eastern and southern part. In the present site setting, the slope of surface within the STP facility is towards the Udaypur Canal. The slope of the surface surrounding the STP area is also towards the Udaypur Canal.

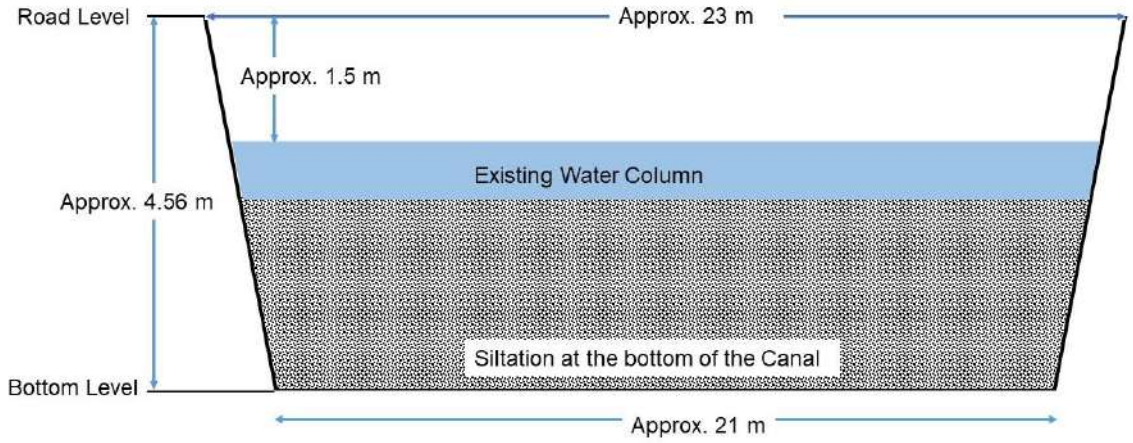
4.2.8.1 Primary Study of Udaypur Canal

The initial depth of the canal was 15ft or 4.56m as revealed from the consultation with the local people and STP workers. During initial assessment it was found that the canal was heavily silted. The effective depth of the canal was estimated to be approximately 2.11m below the road level and the current (post-monsoon) height of water column in the canal was estimated to be approximately 0.61 m. It was visually observed that the flow of water in the canal was visually unrecognisable. Near the STP discharge area some segmented flow in the canal was observed due to the pillars constructed for metro railways. The velocity of the canal near the STP gate was estimated to be approximately 800 m/hour. The approximate features of the cross sectional area of the canal is outlined in **Figure 4.21**.

[27] 'Vulnerability of Kolkata Metropolitan Area to Increased Precipitation in a Changing Climate' – World Bank Document, June 2011.

[28] An Overfall Overview of Kolkata Drainage Channels and Major Outfall Points, an article by Anjan Chatterjee https://medium.com/@anjan.chatterjee/an-overview-of-kolkata-drainage-system-major-outfall-channels-7fdff15d8aa2

Figure 4.21 Cross-sectional Area of Udyapur Canal



In present scenario the carrying capacity of the canal with 2.45 m siltation at the bottom is estimated to be 38,040 m^3/hour. Presently, the canal is approximately carrying 10,848 m3/hour of untreated water, thus approximately carrying capacity 27,192 m3/hour will be available for accommodating additional discharge of treated water from the Baranagar STP. The carrying capacity of the canal indicates it can accomodate the effluent discharge from the STP. The primary data for the canal was collected during post-monsoon season. The water level of the canal is expected to be high during this time as it already contain the storm water genetrated during monsoon season.

It is difficult to predict the catchment area for sewage canal especially in a flat low-lying area like Kolkata. Kolkata, North 24 Paraganas and South 24 Paraganas districts are divided into micro-watersheds of different artificial canals present in the area. An attempt was made to identify the storm water catchment area for Udaypur sewage canal in the upstream area of the sewage canal with respect to the site based on available DEM of the area and field visits to identify elevated roads areas, existing other surface water bodies like ponds & sewage canals. The demarcated catchment area is shown in **Figure 4.22**.

Figure 4.22 Micro-watershed of Udaypur Canal

The catchment area of Udaypur Sewage Canal is estimated to be approximately 3.46 sq.km. The highest rainfall for a day in West Bengal was found to be 100 mm in September, 2019[29]. Assuming that there will be no percolation of rain-water and all the rainwater from catchment area will be drained to the Udaypur Sewage Canal through run-off. The excess water load for 100mm rainfall in a day in above condition will increase the water load in the Udaypur canal. The excess load of Udaypur canal in this condition will be $3.46X10^5$ m^3/day. As discussed above, the available carrying capacity of Udaypur canal is estimated to be greater than $6.52X10^5$ m^3/day. Therefore, the available carrying capacity of Udaypur Canal will be approximately $3.06X10^5$ m^3/day after accommodating the highest rainfall run-off water from the surrounding catchment area.

Note:
Dredging/desilting operation schedule **for Udapur canal is under the juridiction of** 'West Bengal State Irrigation & Waterways Department' which is an independent department out of KMDA purview. Major desilting activities are undertaken every 5-6 years and it is unlikely that such activities would coincide with constuction phase of the STP.

[29] https://weather.com/en-IN/india/monsoon/news/2019-09-25-tuesday-rainiest-september-day-of-2019-kolkata-west-bengal (last accessed on 15th November, 2019)

Figure 4.23 Drainage Map

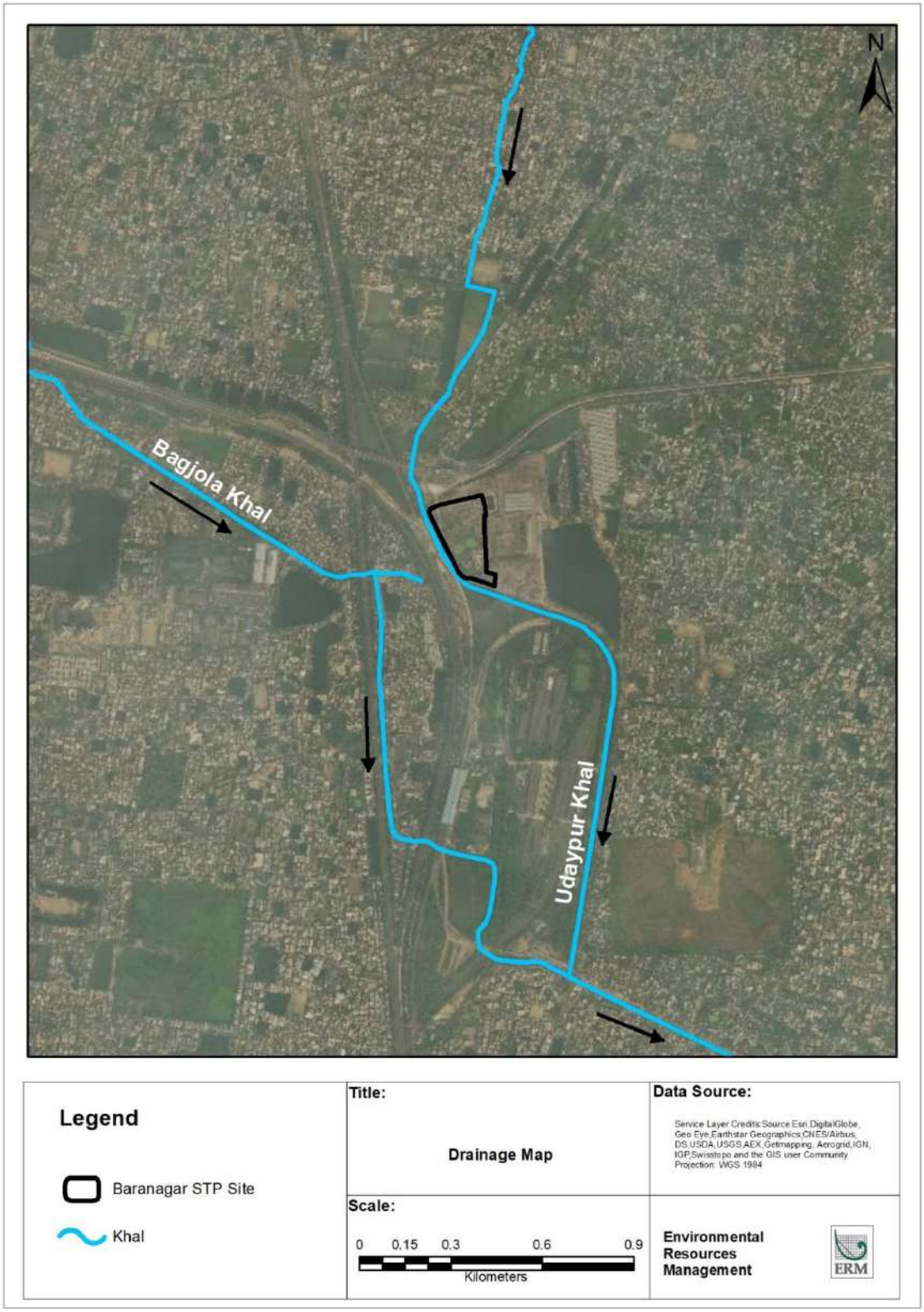
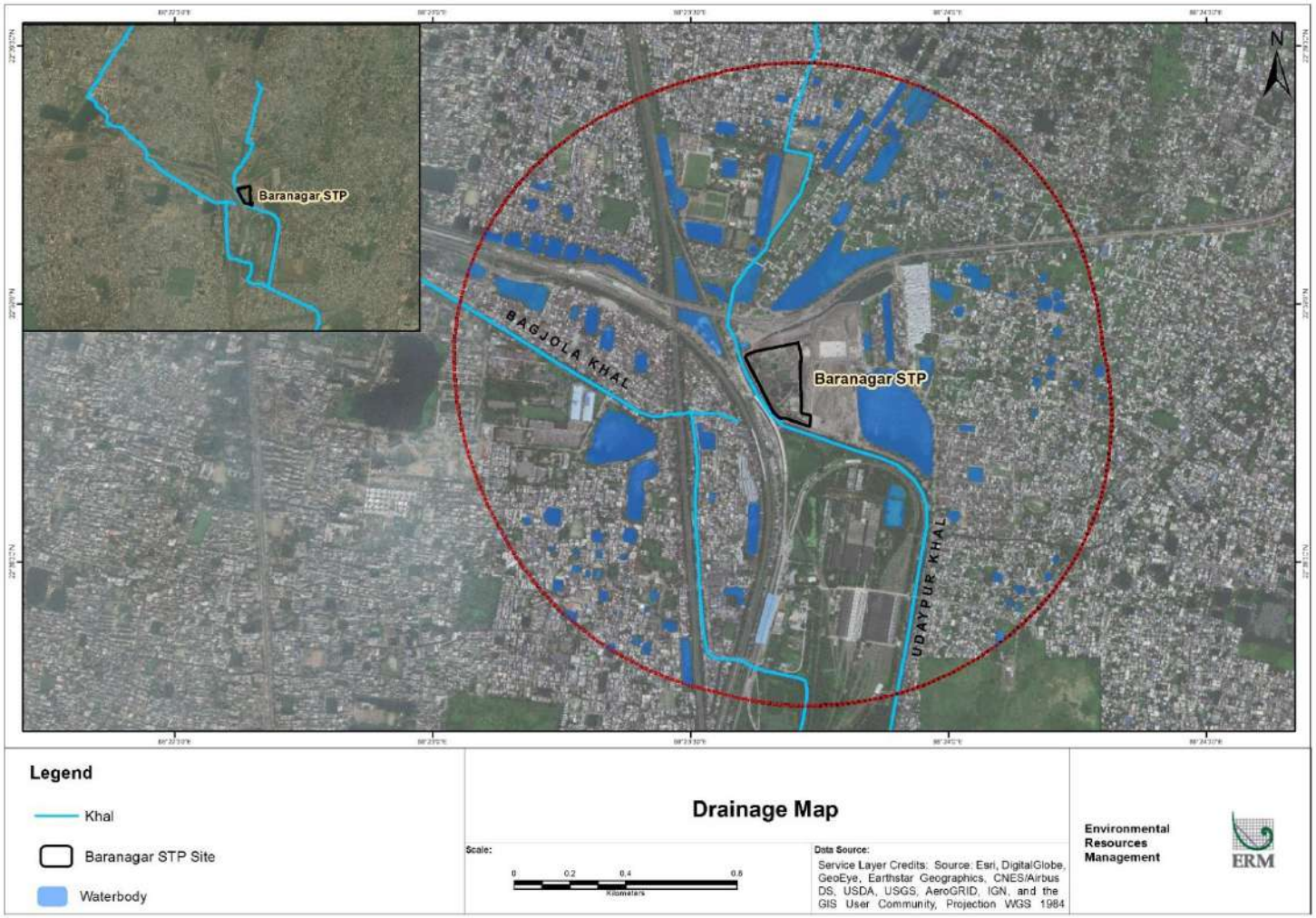


Figure 4.24 Drainage Map within 1 km of Baranagar STP



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 water bodies within the study area that could potentially be impacted due to the operation of STP, including the Udaypur canal which would directly receive the treated discharge from the STP. Initial sampling exercise was conducted on 29th June, 2019 at a time when monsoon rainfall was occuring in the area. It was noted that because of rainfall runoff, the water quality of the canal, as analysed, was not representative of the normal water quality that prevails for most of the non-monsoon period. So, another sampling exercise (for sample locations SW-2 & SW-3) was undertaken at the canal on 6th November, 2019 and analysed for prescribed parameters[30]. The sample collected from pond at Pramod Nagar (SW 1) and Satin Sen Nagar (SW 4) reportedly are used for recreational fishing and occasional bathing by the local people.

The surface water monitoring locations in detail has been provided in **Table 4.10** and the locations are shown in **Figure 4.25.**

Table 4.10: Surface Water Monitoring Locations

Sl No	Location	Station No	Latitude	Longitude
1	Pramod Nagar (pond adjacent to dump site)	SW 1	22° 38' 47.1984" N	88° 23' 57.5628"E
2	Pramod Nagar (Udaipur canal, downstream to project site)	SW 2	22° 38' 38.0724" N	88° 23' 57.3108"E
3	Adarsha Nagar (Udaypur canal, upstream to project site)	SW 3	22° 38' 59.0712" N	88° 23' 34.4328"E
4	Satin Sen Nagar (pond)	SW 4	22° 38' 44.0952" N	88° 23' 32.9388" E

Field parameters viz. temperature, pH, dissolved oxygen were analysed at the site. Samples were collected from upstream and downstream of the Udaypur Canal with respect to the STP site to estimate the quality of the Udaypur canal prior to the implementation of the project and be able to predict potential impacts from STP discharges in downstream streches. Samples were also collected from ponds present on both sides of the STP to estimate possible condition of the ponds which are used for fishing (for recreational purpose not for livelihood). The pond in Pramod Nagar is adjacent to the dumpyard and can possibly capture pollution cased by flow of leachates from the solid waste dump. The results of the samples collected from the drainage channels in the study area have been discussed below with respect to CPCB's Water Use Criteria and classified into A, B and C category. (*as provided in* ***Appendix G)***.

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

Figure 4.25 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	Pramod Nagar (Pond)	Pramod Nagar (Udaypur Canal)	Adarsha Nagar (Udaypur Canal)	Satin Sen Nagar (Pond)
		Sample Code	SW 1	SW 2	SW 3	SW 4
1	pH value	-	7.83 at 25°C	7.74 at 25°C	8.14 at 25°C	7.94 at 25°C
2	Turbidity	N.T.U.	2	4.3	2.8	1.4
3	Chloride (as Cl)	mg/l	134	136	69	158
4	Copper (as Cu)	mg/l	<0.02	<0.02	<0.02	<0.02
5	Fluoride (as F)	mg/l	0.42	0.33	0.25	0.41
6	Iron (as Fe)	mg/l	0.31	1.4	0.35	0.16
7	Manganese (as Mn)	mg/l	<0.02	<0.02	<0.02	<0.02
8	Nitrate (as NO3)	mg/l	0.9	60	36	34
9	Sulphate (as SO4)	mg/l	0.07	0.14	0.17	0.12
10	Total Hardness (as CaCO3)	mg/l	129	290	196	208
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	73	81	36	92
17	Electrical conductivity	us/cm	758	512	285	472
18	Potassium (as K)	mg/l	43	22	7.1	18
19	Total Nitrogen (as N)	mg/l	3.7	16	8.1	7.7
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	5.6	1.2	0.8	5.7
24	Biochemical Oxygen Demand (as BOD)	mg/l	12	20	26	6
25	Chemical Oxygen Demand (COD)	mg/l	40	52	67	24
26	Salinity	-	0.44	0.29	0.16	0.27
27	Phenol	mg/l	<0.001	<0.001	<0.001	<0.001
28	Total Alkalinity (as CaCO3)	mg/l	158	292	143	143
29	Total Phosphorous	mg/l	<0.05	<0.05	<0.05	<0.05

Sl No.	Parameter	Location	Pramod Nagar (Pond)	Pramod Nagar (Udaypur Canal)	Adarsha Nagar (Udaypur Canal)	Satin Sen Nagar (Pond)
		Sample Code	SW 1	SW 2	SW 3	SW 4
30	Faecal coliform	MPN/100ml	22	2800	2830	26
31	Total coliform	MPN/100ml	11000	260000	280000	280

4.2.9.2 Interpretation of Surface water Monitoring Results

Results of the water quality sampled from pond in Pramod Nagar, Udaipur Khal in Pramod Nagar, Bagjola Khal in Adarsha Nagar and pond in Baranagar are discussed below:

- ***pH*** – The range of pH value of the samples collected from 4 locations was 7.74 to 8.14. pH values of the samples indicate Alkaline water.
- ***Dissolved Oxygen (DO)*** – DO concentrations of the water samples collected from upstream and downstream of Udaipur Canal were 0.8 mg/l ad 1.2 mg/l respectively. DO values of ponds at Pramod Nagar and Baranagar were found to be 5.6 mg/l and 5.7 mg/l respectively.
- ***Biochemical Oxygen Demand (BOD)*** – The concentration of BOD for surface water samples varied from 6 mg/l to 26 mg/l. The highest BOD value was found in SW 3 collected from Udaypur Canal Upstream. The BOD levels in the ponds (6, 12) are lesser as compared to the Udaypur Canal (20, 26) as it carries considerable sewage loads from its catchment area before draining into the Bagjola Canal, resulting in high level of organic pollution. The ponds are also polluted to some level, as they are used for bathing and for meeting other domestic needs like washing, etc.; there is also a possibility of transfer of organic leachates from the open waste dumping site or inflitration of polluted water from the adjoinig Canals.
- ***Chemical Oxygen Demand (COD)*** – The concentration of COD for surface water samples varied from 24 mg/l to 40 mg/l. The highest COD value was found in SW-1 collected from pond at Pramod Nagar. The variation of COD values and the higher noted value in the Udaypur Canal as compared to the ponds can be attributed to the same reasons as for BOD variations.
- ***Faecal Coliform***– Faecal Coliform is present in all the sample. The concentration of faecal coliform in samples are varied from 22 to 2830 MPN/100ml. The highest Faecal Coliform concentration was found in the sample from Udaypur Canal (SW-3) upstream with respect to the STP facility.
- ***Total Coliform***- The range of the total coliform values found in the sample was 280 to 280000 MPN/100ml. The highest Total Coliform concentration was found in the sample from Udaypur Canal (SW-2) upstream with respect to the STP facility. The load of total coliform is higher in Udaypur Canal but the concentration is higher in the downstream side compared to the upstream side. The reason for concentration could possibly be the direct discharge of leachate generated from the adjoining solid waste dumpyard into the canal. 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 0.16 to 0.44.
- ***Turbidity***- turbidity values in the samples were varied from 1.4 to 4.3 N.T.U.
- The concentration of parameters of Copper, Phenol, Manganese, Cadmium, Lead, Mercury, Nickel, Arsenic, Hexavalent Chromium (as Cr+6), Total Phosphorous and Zinc were found below the detection limit.
- ***Sodium***- The values Sodium in the samples varied from 36 to 92 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 143 to 292 mg/l.
- ***Total Nitrogen (as N) and Potassium (as K)*** - The concentration of total nitrogen varied from 3.7 to 16 mg/l and for Potassium, it varied from 7.1 to 43 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 recorded ranges between 129 to 290 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 0.16 to 1.4 mg/l and 0.25 to 0.42 mg/l respectively.
- ***Nitrate and Sulphate***- The values of Nitrate and Sulphate in the sample varied from 0.9 to 60 mg/l and 0.07 to 0.14 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 water quality analysis of samples drawn from the Udaypur canal (sampling locations SW-2 and SW-3) indicate that the water quality of the canal is quite poor, exhibiting low DO levels in the range of 0.8 – 1.0 mg/lt and high BOD level in the range of 20 – 26 mg/lt. This is probably due the fact that the canal receives untreated sewage and waste water from densely populated residential areas of Belgharia, which is about 1 – 2 kms to the north of the site. This coincides with the purpose for which the Udaypur and over a larger area, the Bagjola canal system was dug up in early 19th century for draining waste water from a rapidly urbanising part of the city, finally discharging into the Kultigang river about 28 km to the east of the site.

Also, due to high concentration of BOD and Total Coliform in the surface water bodies or the Canal systems, it was not possible to classify them as A, B and C category as per CPCB Guideline for Classification of Surface Water Bodies.

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 compaired 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 ganga-Brahmaputra river system. 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 transmissivity values of aquifers ranges from 699-8127 m^2/day. The transmissivity values of both the aquifers indicate that these are highly productive aquifers. The storativity value of confined aquifer ranges from 1.05 X 10-3 to 1.45 X 10-4. The specific yield of unconfined aquifer ranges from 0.035 to 0.765. The dynamic groundwater resource of the district is 157640 ham which is estimated jointly by CGWB and SWID.

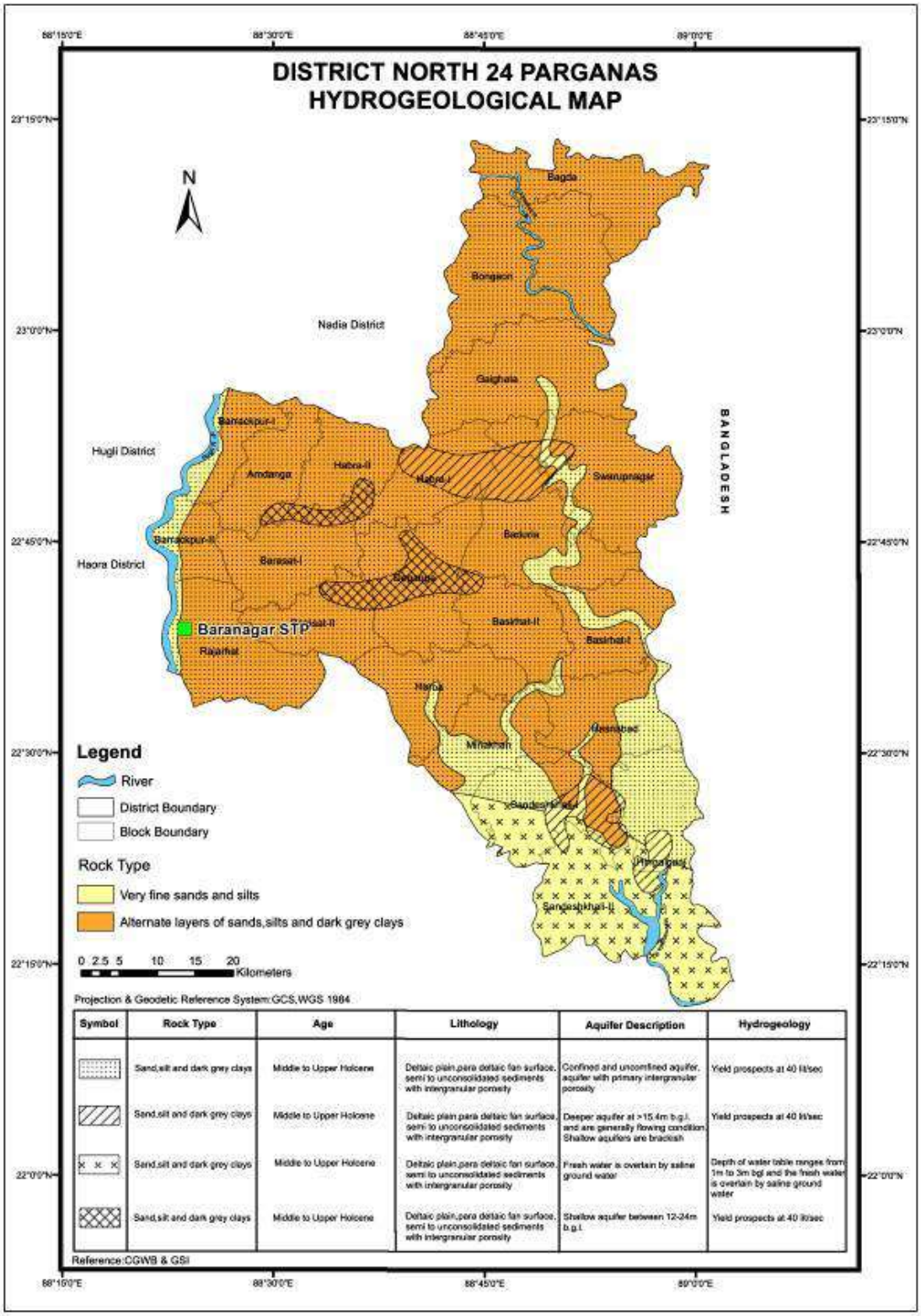
The depth of water table for unconfined aquifer varies from 2.60 to 13.65 mbgl during pre-monsoon and during post-monsoon season the water table varies from 1.64 to10.66 mbgl. The depth of piezometric surface for confined aquifer varies from 3.47 to 6.25 mbgl during pre-monsoon and during post-monsoon season the water table varies from 1.91 to 5.89 mbgl. As per Central Ground Water Board, Government of India, all the blocks of the district are categorized under ‘Safe’ category. The shallow aquifers upto a depth of 100 mbgl shows high concentration of As (>0.05 mg/L) where deeper

aquifers down to a depth of 350 mbgl are Arsenic free[31]. The hydrogeological map of the district is shown in **Figure 4.26.**

In Baranagar area, groundwater related information have been collected through field surveys and based on consultation with local people. There are two motor-fitted boreholes present within the STP facility. The depth of these boreholes are 60 to 80 m (200 to 250 feet), tapping the shallow aquifer occuring upto a depth of 100 mbgl as reported by CGWB. In Indira Nagar area which is located within 100 m from the STP facility, is a groundwater dependent area due to absence of pipe-water supply in this area. A number of tubewells and dugwells are present in this area. The depth of the dugwells varies from 10 to 18 mbgl. The dugwells are tapping the Silty-Clay zone exists at a depth of 8 to 14 mbgl as reported in Section 4.2.2. This zone acts as an aquitard and supply water to the Dugwell. Water levels in dugwells were 8 mbgl and 1.5-2 mbgl respectively during pre-monsoon and post-monsoon season as reported by the local people. The water from the dugwells are used for washing and bathing purpose. The depth of tubewells presents in this area varies from 60 to 80m mainly constructed by the municipality and other agencies. The groundwater tubewells in this area used for drinking and cooking purpose. Platform colour of the tubewells are red which indicates presence of Iron in the groundwater.

[31] CGWB, Ground Water Information Booklet, North 24 Paraganas

Figure 4.26 Hydrogeological Map of N 24 Pargana District



Symbol	Rock Type	Age	Lithology	Aquifer Description	Hydrogeology
	Sand,silt and dark grey clays	Middle to Upper Holocene	Deltaic plain,para deltaic fan surface, semi to unconsolidated sediments with intergranular porosity	Confined and unconfined aquifer, aquifer with primary intergranular porosity	Yield prospects at 40 lit/sec
	Sand,silt and dark grey clays	Middle to Upper Holocene	Deltaic plain para deltaic fan surface, semi to unconsolidated sediments with intergranular porosity	Deeper aquifer at >15.4m b.g.l. and are generally flowing condition. Shallow aquifers are brackish	Yield prospects at 40 lit/sec
	Sand,silt and dark grey clays	Middle to Upper Holocene	Deltaic plain,para deltaic fan surface, semi to unconsolidated sediments with intergranular porosity	Fresh water is overlain by saline ground water	Depth of water table ranges from 1m to 3m bgl and the fresh water is overlain by saline ground water
	Sand,silt and dark grey clays	Middle to Upper Holocene	Deltaic plain,para deltaic fan surface, semi to unconsolidated sediments with intergranular porosity	Shallow aquifer between 12-24m b.g.l.	Yield prospects at 40 lit/sec

Source*:* CGWB

Figure 4.27 Dugwell present in Indira Nagar

Figure 4.28 Tubewells present in Indira Nagar

4.2.11 Groundwater Quality

The primary ground water monitoring studies has been carried out with dual objective:

- First, to assess the suitability of existing drinking water sources in the immediate vicinity – as a part of this objective, ground water from one tube well drawing from the deeper aquifer at around 60 – 65 m (GW1) and one tube well drawing from the shallow aquifer at a depth of 8 – 10 m (GW2) from the area to the south of the site boundary was sampled and analysed – the location details are captured in **Table 4.12** and shown in **Figure 4.29**. The analysed parameter values were compared with ISO 10,500 Standards to evaluate the suitability with respect to each parameter.
- Second, to assess the potential contamination of groundwater from the existing unlined dumpyard, seepage and percolation of polluted water from existing STP tanks and the Udaypur canal, a limited soil and groundwater study have been conducted. Four (4) borewells (MW1 – MW4) were drilled within the boundary of STP facility upto a depth of the perched ground water zone at a depth of 12 m – the location details are captured in **Table 4.3** (refer Section on Soil) and shown in Figure 4.29. The collected samples were and screened against the Dutch and USEPA ground water contamination standards as well as Indian drinking water standards.

Figure 4.29 Groundwater Sampling Locations Map

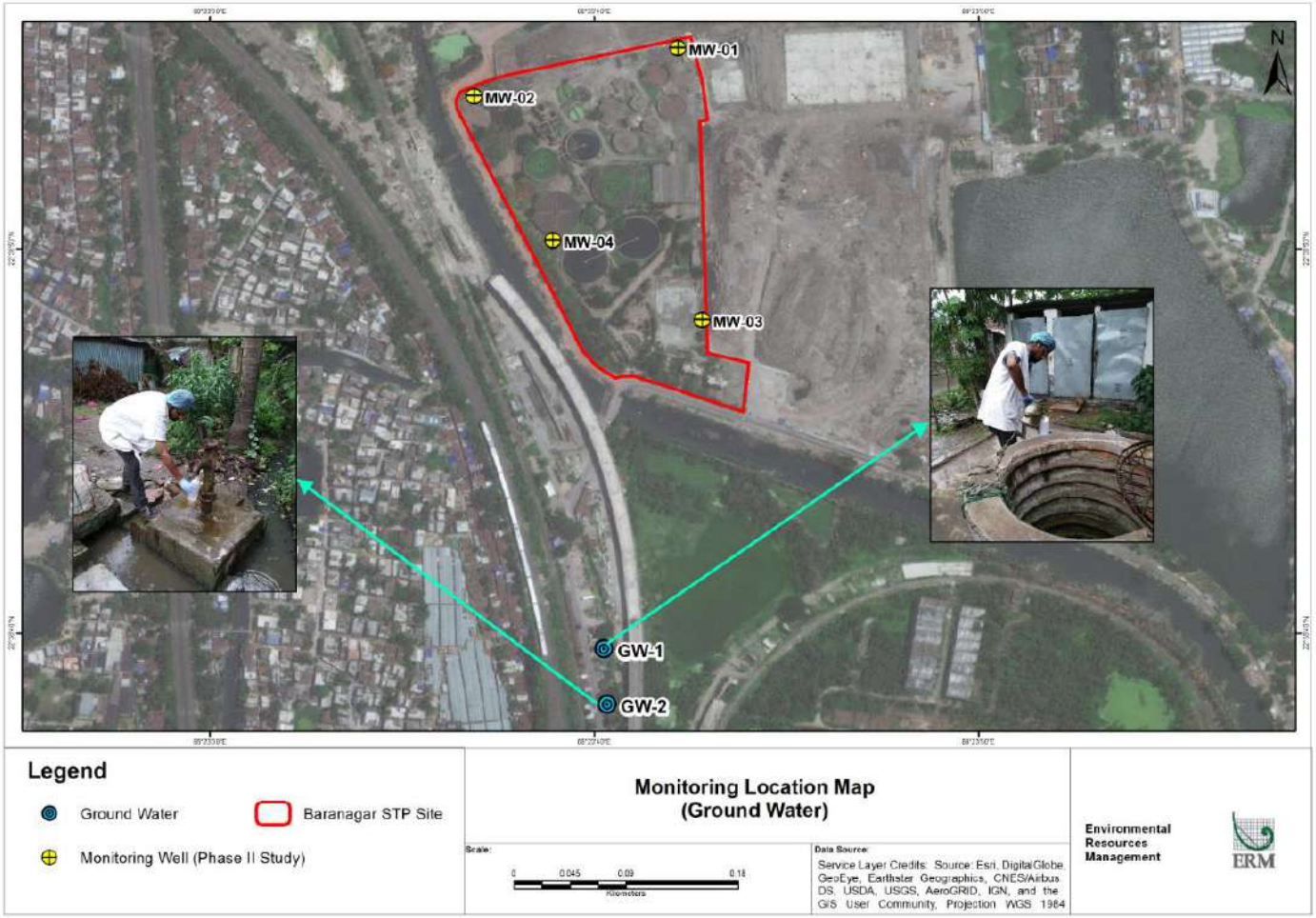


Table 4.12: Groundwater Monitoring Locations - Drinking Water Suite

Sl No.	Monitoring locations	Station No	Latitude	Longitude	Source
1.	Indira Nagar	GW 1	22° 38' 39.5916" N	88° 23' 40.2576" E	Tubewell
2.	Indira Nagar	GW 2	22° 38' 38.1444" N	88° 23' 40.3368" E	Dugwell

4.2.11.1 Groundwater Quality Results for GW-1 and GW-2

The results of groundwater quality samples from wells GW1 & 2 are provided in **Table 4.13**.

Table 4.13: Groundwater Monitoring Results – Drinking Water Suite

Sl No.	Parameter	Location	Indira Nagar Dugwell	Indira Nagar Tubewell	IS 10500, 2012	
		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	-	7.42 at 25°C	7.28 at 25°C	6.5-8.5	No relaxation
4	Turbidity	N.T.U.	3.7	<1.0	1	5
5	Total Dissolved Solids (as TDS)	mg/l	1630	1118	500	2000
6	Aluminium (as Al)	mg/l	<0.01	<0.01	0.03	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
9	Boron (as B)	mg/l	<0.5	<0.5	0.5	1.0
10	Calcium (as Ca)	mg/l	238	124	75	200
11	Chloramines (as Cl2)	mg/l	<0.3	<0.3	4	No relaxation
12	Chloride (as Cl)	mg/l	487	349	250	1000
13	Copper (as Cu)	mg/l	<0.02	<0.02	0.05	1.5
14	Fluoride (as F)	mg/l	0.34	0.45	1.0	1.5
15	Free Residual Chlorine	mg/l	<0.1	<0.1	0.2	1.0
16	Iron (as Fe)	mg/l	0.44	0.17	0.3	No relaxation
17	Magnesium (as Mg)	mg/l	87	5.5	30	100
18	Manganese (as Mn)	mg/l	<0.02	0.31	0.1	0.3
19	Mineral Oil	mg/l	<0.01	<0.01	0.5	No relaxation
20	Nitrate (as NO3)	mg/l	16	47	45	No relaxation
21	Phenolic Compounds (as C_6H_5OH)	mg/l	<0.001	<0.001	0.001	0.002
22	Sulphate (as SO4)	mg/l	1.6	<0.01	200	400

Sl No.	Parameter	Location	Indira Nagar Dugwell	Indira Nagar Tubewell	IS 10500, 2012	
		Sample Code	GW 1	GW 2	Acceptable Limit	Permissible Limit
23	Total Hardness (as $CaCO_3$)	mg/l	956	333	200	600
24	Cadmium (as Cd)	mg/l	<0.001	<0.001	0.003	No relaxation
25	Lead (as Pb)	mg/l	<0.005	<0.005	0.01	No relaxation
26	Mercury (as Hg)	mg/l	<0.001	<0.001	0.001	No relaxation
27	Nickel (as Ni)	mg/l	<0.02	<0.02	0.02	No relaxation
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
31	Zinc (as Zn)	mg/l	<0.02	<0.02	5	15
32	Hexavalent Chromium (as Cr+6)	mg/l	<0.01	<0.01	0.05	No relaxation
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 $CaCO_3$)	mg/l	775	735	200	600
36	Faecal coliform	/100ml	Detected	Detected	Shall not be detectable in any 100 ml sample	Shall not be detectable in any 100 ml sample
37	Total coliform	/100ml	Detected	Detected	Shall not be detectable in any 100 ml sample	Shall not be detectable in any 100 ml sample

The interpretation of the analysis results show:

- pH of the groundwater samples were 7.42 and 7.28 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 limit of 7.0 to 8.0.
- Turbidity values of the groundwater samples ranged from <1.0-3.7 NTU. Turbidity values were within the permissible limit 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 1630 and 1118 mg/l GW 1 and GW 2 respectively. The values were above the acceptable limit of 500 mg/l but below the permissible limit of 2000 mg/l. Both the samples have higher TDS values compared to the WHO limit of 1000 mg/l.

- Total hardness (as $CaCO_3$) –The values of total hardness in groundwater samples were 956 and 333 mg/l GW 1 and GW 2 respectively. The value of GW 2 was below the permissible limit 600 mg/l but the total hardness value of GW 1 was above the permissible limit. CGWB district wise report of North 24 Paraganas have also indicated presence of higher concentration of $CaCO_3$ in the district. 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 487 and 349 mg/l. Chloride concentrations in both the sample is above the acceptable limit but below the permissible limit of 1000 mg/l. Chloride concentrations in both the sample is above the WHO limit of 250 mg/l. CGWB district wise report of North 24 Paraganas have indicated similar results.
- Total Alkalinity (as $CaCO_3$)– The alkalinity of the water samples monitored at study area ranged between 775 and 735 mg/l. Alkalinity were reportedly above the permissible limit (600 mg/l) at all the locations.
- Fluoride- Fluoride levels in the groundwater samples were 0.34 and 0.45 mg/l for GW-1 and GW-2 respectively. The samples were found to be in compliance to the acceptable limit of 1.0 mg/l.
- Sulphate- Sulphate concentrations in the groundwater samples were 1.6 and <0.01 mg/l for GW 1 and GW 2 respectively. Sulphate concentrations in all the samples were found to be within the acceptable sulphate concentration limit of 200 mg/l as IS 10500, 2012 and WHO limit of 250 mg/l.
- Nitrate- Nitrate concentrations in all groundwater samples were found to be 16 and 47 mg/l for GW 1 and GW 2 respectively. Nitrate concentrations in GW 1 samples was found to be within the acceptable nitrate concentration limit of 45 mg/l but in case of GW 2 nitrate concentration exceeds the acceptable limit as per IS10500, 2012. Both the samples have nitrate concentration within the WHO limit 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 0.44 and 0.17 mg/l for GW 1 and GW 2 respectively. Iron concentrations in GW 2 was found to be within the acceptable iron concentration limit of 0.3 mg/l as per IS 10500, 2012 and WHO limit but in case for GW 1, the concentration exceeds the limit. CGWB district wise report of North 24 Paraganas have also indicated presence of higher concentration of iron in groundwater within the district. 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 238 and 124 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 GW 2 was within the permissible limit of 200 mg/l as per IS 10500, 2012. The calcium concentration in both the samples exceeds WHO limit of 75 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 87 and 5.5 mg/l for GW 1 and GW 2 respectively. Magnesium levels at GW 2 were found to be in compliance to the acceptable limit of 30 mg/l and in GW 1 the Magnesium concentration was below the permissible limit of 100 mg/l as per IS 10500, 2012. Magnesium concentration in GW -2 is within the WHO limit of 30 mg/l but the Magnesium concentration in GW-1 exceeds the WHO limit. 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 0.31 mg/l for GW 1 and GW 2 respectively. Manganese levels at GW 1 were found to be in compliance to the acceptable limit of 0.1 mg/l and in GW 2 the Manganese concentration was above the permissible limit of 0.3 mg/l. 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 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 exceedances of iron and chloride concentrations as well total hardness value in groundwater is more likely to be because of the inherent quality of groundwater of the area as reported by CGWB.

The presence of Total coliform bacteria indicate that the water supply may be vulnerable to contamination by harmful microorganisms. Escherichia coli (E. coli) are the only member of the total coliform group of bacteria indicate recent faecal contamination and the possible presence of disease-causing pathogens, such as bacteria, viruses, and parasites.

4.2.11.2 Groundwater Quality Results – MW1 – MW4

Ground water drawn from the test bore wells which were dug to 12 m and representing the perched water zone, shallow groundwater sample analytical results for the brownfield suite screened against the Dutch, USEPA and Indian drinking water standards indicated a exceedance of Manganese in all the four (4) wells w.r.t. the USEPA RSL and Indian Drinking Water Standard limits. The manganese concentrations in the wells viz., MW-01, MW-02, MW-03 and MW-04 were 1582.0, 801.0, 1558.0 and 581.0 µg/L respectively against the USEPA limit of 430 µg/L and 100 µg/L of Indian Standard for Drinking Water. Elevated Mangenese in groundwater have found to be associated with shallow, anoxic water tables and soils enriched in organic carbon, suggesting soil-derived dissolved organic carbon that supports manganese reduction and mobilization in shallow groundwater, in other geographies. Such conditions have been found to often prevail near rivers and in areas with organic carbon rich soil indicating land surface–soil–aquifer connections that contribute to the build-up. There is also a possibility that such higher Manganese concentrations are contributed from industrial sources or anthropogenic induced activities, though it is diificult to arrive at such attribution based on the limited set of gorund water analysis undertaken.

Perched water zone shallow groundwater sample (from 12 m depth), analytical results for the non-brownfield suite screened against the Indian Drinking Water Standard limits and the observed exceedances are summarized in Table 4.14 below.

Table 4.14: Groundwater Non-brownfield Suite Exceedance

Parameter	Unit	Limit	MW-01	MW-02	MW-03	MW-04
Colour	Hazen	5	<1.0	8.0	<1.0	2.0
Total dissolved solid	mg/L	500	2580	1800	2080	2420
Calcium (as Ca)	mg/L	75	306	69	252	232
Chloride (as Cl^-)	mg/L	250	419	500	588	737
Iron (as Fe)	mg/L	1	1.3	15	20	14
Magnesium (as Mg)	mg/L	30	95	62	137	101
Sulphate (as SO_4^{2-})	mg/L	200	939	293	494	734
Total Hardness (as $CaCO_3$)	mg/L	200	1160	432	1200	1000
Ammonia (as NH_3)	mg/L	0.5	1.3	0.12	2.7	2
Total Alkalinity (as $CaCO_3$)	mg/L	200	972	603	796	659

Parameter	Unit	Limit	MW-01	MW-02	MW-03	MW-04
Faecal coliform	/100 mL	Shall not be detectable	Detected	Detected	Detected	Detected
Total coliform	/100 mL	Shall not be detectable	Detected	Detected	Detected	Detected

As per the CGWB – North 24 Paraganas District Report[32], in the groundwater of the North 24 Paraganas district iron and chloride are present beyond the permissible limit and the total hardness ($CaCO_3$) registered value as high as 670 mg/L, exceeding the permissible limit. Hence, it may be inferred that the exceedances of iron and chloride concentrations as well total hardness value in groundwater above the screening criteria related to the subject site is more likely to be the inherent quality of groundwater of the area and may not indicate contamination due to any anthropogenic activity.

Note: The above stated brown-field suite analysis for groundwater are based on the findings of the preliminary limited Phase II ESA study. A detailed Phase II, Environmental site Assessment adopting ASTM 1903-11 standard, is proposed to explore probable sources and causes of elevated levels of contaminants in the soil.

4.2.12 Traffic and Transport

Traffic monitoring station was undertaken at both up and down directions of Baranagar STP road leading up to the site and on Belghoria Expressway towards Dakhineswar and Airport. 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 4.15**, detail result is provided in ***Appendix H***.

Table 4.15: Traffic Values observed in the Project study area

Description	Baranagar STP Road (Up)	Baranagar STP Road (Down)	Belghoria Expressway (towards Airport)	Belghoria Expressway (towards Dakhineswar)
Heavy Motor Vehicles (in Number), 24 hours	2	6	4238	4617
Light Motor Vehicle (in Number), 24 hours	41	46	12614	13154
Two/Three Wheelers (in Number), 24 hours	45	136	4274	4438
Non-motorized Vehicles	27	61	94	190
Total PCU (Nos.) in 24 Hours (To & From)	94.25	196.5	28580.5	30435
Average PCU Flow/Hr	3.93	8.19	1190.854	1268.104
Max PCU (Nos)/Hr	14.5	19	1608.25	1636
Min PCU (Nos)/Hr	0	0	416	432
Maximum PCU Hours	09:00-10:00	15:00-16:00	15:00-16:00	17:00-18:00

[32] http://cgwb.gov.in/District_Profile/WestBangal/North%2024%20Parganas.pdf

4.2.12.1 Interpretation of Traffic Survey Results

Total 94.25 PCU and 196.5 PCU was recorded at the traffic monitoring station at Baranagar Site Road Up and Down Road respectively, while for Belghoria Expressway were 28580.5 PCU(towards airport) and 30435 PCU (towards Dakhineswar). As per observation made for traffic density, on an average for monitoring location (1) 3.93 PCU and 8.19 PCU and for monitoring location(2) 1190.854 PCU and 1268.104 PCU was recorded per hour at the locations, respectively. It was also noticed that major contributor of the vehicular traffic at Baranagar STP Road Up and Down Road was two/three wheelers (Scooter, Motor Cycles, Autorickshaws, etc.) followed by non-motorized vehicle and Belghoria Expressway were Light Motor Vehicle (Car, Jeep, Van, Metador etc.) and Heavy Motor Vehicle (Truck/Bus/Dumper etc). The vehicular traffic is high at Baranagar Site Down Road compared to Baranagar Site Up Road, while for Belghoria Expressway vehicles moving towards Dakhinewar were higher as compared to Airport direction. Figure 4.30illustrates contribution of different type of vehicle towards total vehicular traffic at Baranagar Up and Baranagar Down routes.

Figure 4.30 Road Traffic Monitoring Results

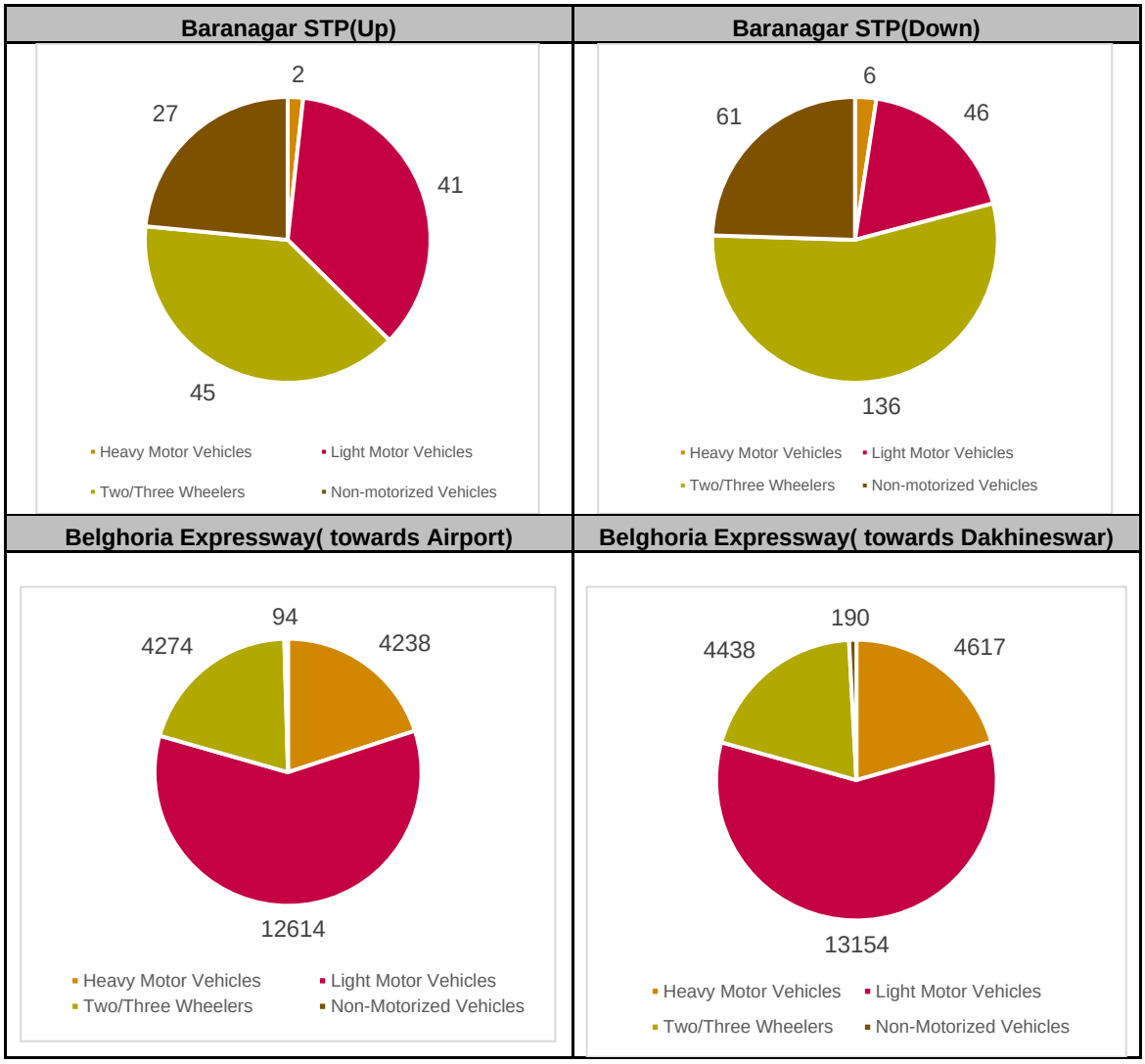


Figure 4.31 Road Traffic Monitoring Location Map

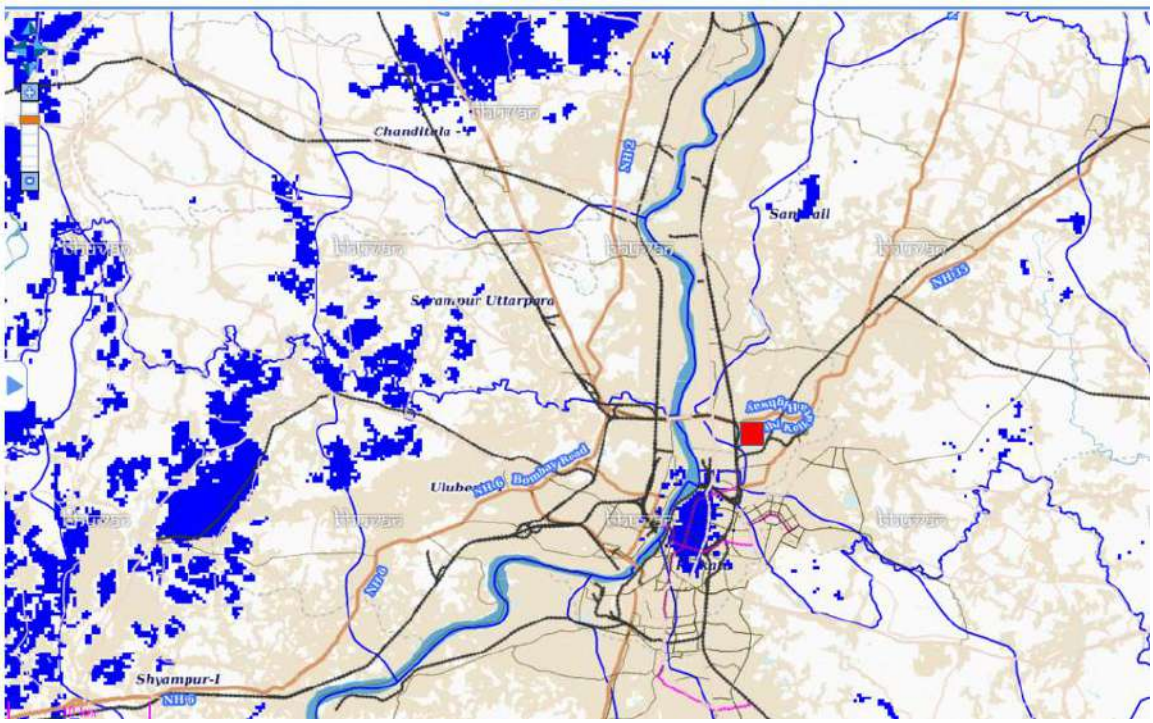
4.2.13 Natural Hazards

The district of North 24 Parganas is vulnerable to certain disasters and the ones particularly applicable to the study area around site are earthquake and floods.

Flooding: A major part of the district is characterized by low-lying areas with respect to the flood levels of the rivers in the respective basins. However, extensive man-made alterations of natural drainages in the Kolkata Metropolitan Area 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 refelected in the flood vulnerability map of the area prepared by NRSC as a part of the NMCG program. However, many areas with the city limits do experience localised water logging events during periods of heavy rainfall, mostly during the monsoon season.

Consultations with stakeholders in the study area indicate area around the STP facility has not recently experienced any flooding or water-logging situation. 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 does not face any water-logging situation even during heavy rainfall as expressed by the local people. As discussed in **Section 4.2.8**, the Udaypur canal is able to accomodate 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 Bagjola khal to flush out the sewage water into Kultigong river during possible backflow due to high tide events. This lock gate remains closed during high rainfall season. So, there is low probability of flooding due to the Hooghly river. Moreover, in consultation with local communities, no occurence of flood has been reported in the area from 2000 to 2014[33].

Figure 4.32 Flood vulnerability map of Study Area



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

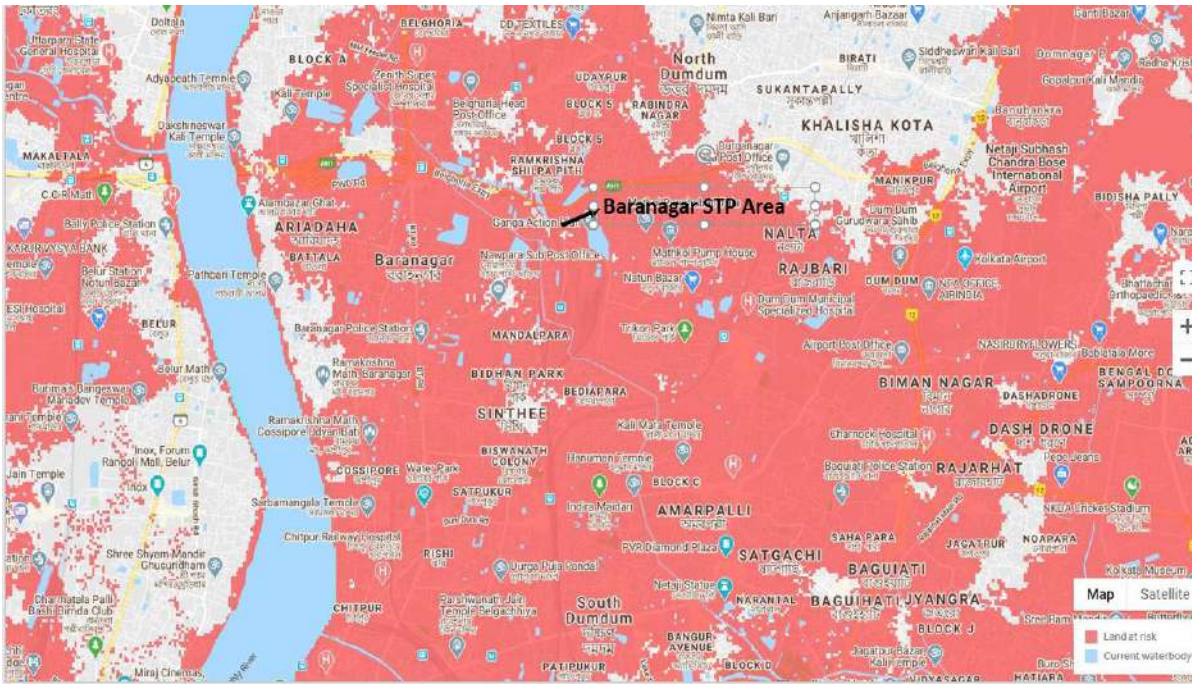
Future Climate Change Induced Flood Risk Scenario

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

Based on the report prepared by Climate Central on 29th October 2019 referring to the peer-reviewed paper published by Nature Communications[34], it is estimated that 237 million people in six Asian countries are at risk due to coastal flooding by 2050[35]. 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[36].

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 vulnerable to flood, post completion of Consession period of 15 years and if appropriate mitigation measures are not adopted. Hence, as stated earlier the proposed project has minimum chances of experiencing such flood related vulnerability even with respect to climate change throughout Consession period i.e. 15 years from the date of project inception.

Figure 4.33 Future Flood vulnerability map of Study Area, 2050



Source: Report: Flooded Future: Global vulnerability to sea level rise worse than previously understood; Climate Central; Published on 29th October, 2019.[37]

Earthquake: As per India earthquake hazard zoning map, part of the North 24 Paraganas district lies in Zone III which comes under Moderate risk zone (MSK VII) and part of the district lies in Zone IV which is considered to be the high seismic zone. The study area lies in the south-western part of the

[34] 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

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

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

[37] https://coastal.climatecentral.org/map/14/88.3981/22.6387/?theme=sea_level_rise&map_type=coastal_dem_comparison&elevation_model=coastal_dem&forecast_year=2050&pathway=rcp45&percentile=p50&return_level=return_level_1&slr_model=kopp_2014

district which comes in seismic zone III. 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 has high population pressures and low ecological sensitivity. The study area falls under the lower Gangetic Delta. 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 predominant land use-land cover of the study area includes urban settlements, surface waterbodies, road, railway, railway-yard and plantation (homestead, besides the road and railway line and railway yard).

4.3.1 Ecological Habitats of Conservation Importance

4.3.1.1 Terrestrial Habitat

The study area can be categorised as urban area, settlement 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

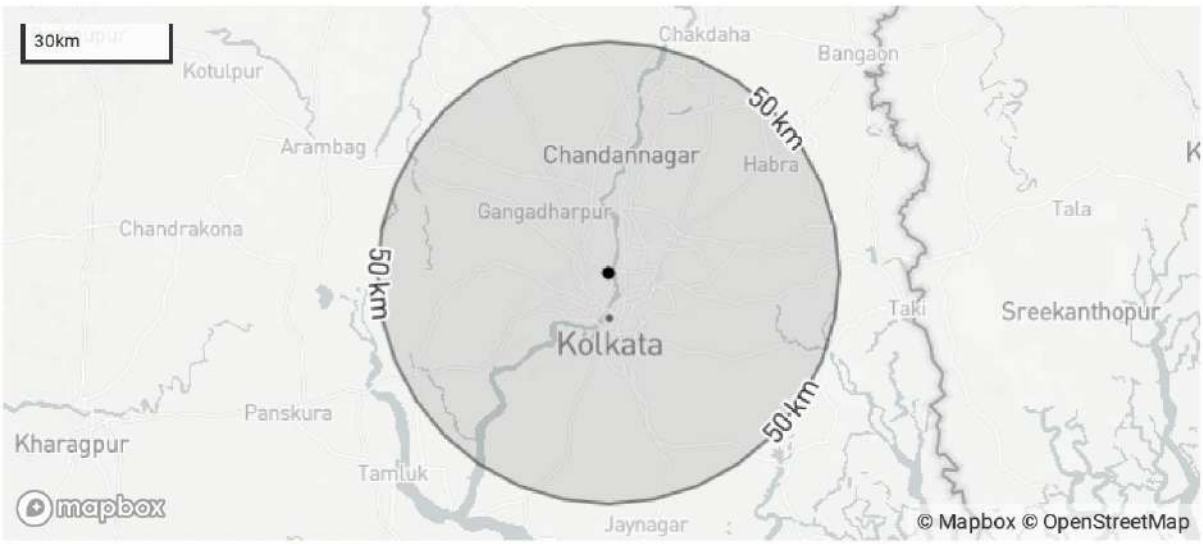
The surface waterbodies are located in the study area. The surface water bodies are mostly man-made and some natural depression area. These surface water bodies are mostly used for pisci-culture (common carps, tilapia and nylontica). Several of the waterbodies, including the Udaypur canal which is part of the Bagjola canal system) 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 iidentified 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.



Displaying project location and buffers: 50.0 km

4.3.2 Terrestrial Ecosystem

4.3.2.1 Flora

4.3.4.1.2 Project Site

The existing STP will be demolished (as required) and new STP will be constructed in the existing STP area. The vegetation was recorded along the site internal road and open area of the STP. The predominant tree species recorded during site visit were *Swietenia macrophylla, Dalbergia sissoo, Phyllanthus emblica, Azadirachta indica, Albizia lebbeck, Moringa oleifera, Terminalia cattapa, Bombax ceiba, Polyalthia longifolia.* 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,* etc.

Figure 4.34 Photographs of Vegetation at the STP Facility

Vegetation besides STP internal Road

Vegetation within the STP site

Vegetation near Clarifier Tank

Vegetation besides STP internal Road

4.3.4.1.3 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 4.35 Photographs of Vegetation Present at the Study Area

Road side vegetation

Vegetation near Surface Waterbody

Road side vegetation

Vegetation near Railway Track

Vegetation on swampy lands

Vegetation at STP side

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 following table.

Table 4.16: Faunal Species Recorded/ Reported in Study Area

S. No.	Common Name	Scientific Name	Wildlife Schedule[38]	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
B.	**Avi-fauna**			
10.	Jungle Myna	*Acridotheres fuscus*	IV	NT
11.	Common Myna	*Acridotheres tristis*	IV	LC
12.	Common Kingfisher	*Alcedo atthis*	IV	LC
13.	White-breasted Waterhen	*Amaurornis phoenicurus*	IV	LC
14.	Asian Openbill	*Anastomus oscitans*	IV	LC
15.	Indian Pond Heron	*Ardeola grayii*	IV	LC
16.	Spotted Owlet	*Athene brama*	IV	LC
17.	Cattle Egret	*Bubulcus ibis*	IV	LC
18.	Purple Sunbird	*Cinnyris asiaticus*	IV	LC
19.	Common Pigeon	*Columba livia*	IV	LC
20.	Oriental Magpie-Robin	*Copsychus saularis*	IV	LC
21.	House Crow	*Corvus splendens*	IV	LC
22.	Asian Palm Swift	*Cypsiurus balasiensis*	IV	LC
23.	Black Drongo	*Dicrurus macrocercus*	IV	LC
24.	Little Egret	*Egretta garzetta*	IV	LC
25.	Intermediate Egret	*Egretta intermedia*	IV	LC
26.	Asian Koel	*Eudynamys scolopacea*	IV	LC

[38] 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[38]	IUCN Status (2017-3)
27.	Coppersmith Barbet	*Megalaima haemacephala*	IV	LC
28.	Green Bee eater	*Merops orientalis*	IV	LC
29.	Black Kite	*Milvus migrans*	I	LC
30.	Common Tailorbird	*Orthotomus sutorius*	IV	LC
31.	House Sparrow	*Passer domesticus*	IV	LC
32.	Little Cormorant	*Phalacrocorax niger*	IV	LC
33.	Baya Weaver	*Ploceus philippinus*	IV	LC
34.	Rose-ringed Parakeet	*Psittacula krameri*	IV	LC
35.	Red-vented Bulbul	*Pycnonotus cafer*	IV	LC
36.	Red wattled Lapwing	*Vanellus indicus*	IV	LC
C.	**Reptiles**			
37.	Common garden lizard	*Calotes versicolor*	-	LC
38.	House gecko	*Hemidactylus flaviviridis*	-	LC
39.	Common Skink	*Mabuya carinata*	IV	LC
40.	Common Rat snake	*Ptyas mucosus*	II	LC
D.	**Amphibians**			
41.	Common Indian Toad	*Duttophrynus melanostictus*	IV	LC
42.	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* (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, 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 falunal 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 Baranagar Municipality as well as Kamarhati Municipality, both of which fall under the North 24 Parganas District of West Bengal. The STP facility of Baranagar is under South Dumdum Mujnicipality. 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 study has been carried out through collection and analysis of primary data (based on a structured tool and provided as ***Appendix J***) as well as secondary data. Over 25 households (HHs) residing in proximity to the STP and its linked facilities in Baranagar and Kamarhati municipalities, 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 Baranagar STP. The settlements within the one kilometre radius are located in various wards across Baranagar, Kamarhati, North Dum Dum and South Dum Dum Municipalities. Not all wards of the above municipalities are within the one km radius, so the ward numbers are not in sequence. Also, as per the 1 km radius drawn on the google earth we will see that a percentage of the respective ward is within the 1 km circle (**Figure 4.36**). The % was calculated based on the google earth map and accordingly that % population was considered out of the total ward population as given in census 2011 data. For e.g. ward no. 2 of Baranagar municipality, 90% area of the ward has been considered, so the total HH representation is 90% of total HHs in ward 2 as per census 2011.

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

A socio- economic baseline has been conducted on the settlements situated within one-kilometre radius of the Baranagar 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. There are five main settlements within the vicinity of the STP namely Nowapara, Pramod Nagar, Satin Sen Nagar, West Rabindra Nagar and Adharsh Nagar. The settlements within the one kilometre radius are located in various wards across Baranagar, Kamarhati, North Dum Dum and South Dum Dum Municipalities. 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 radius of one kilometre from the STP, the proportions have been defined accordingly based on google imagery analysis.

In Baranagar Municipality, the settlements near the STP are Nowapara and Satin Sen Nagar which include ward numbers 1, 15, 17 and 19. An analysis of the google earth map (***Figure 4.35***) indicates that a proportion of the settlements in the wards are located outside the one km radius, therefore,

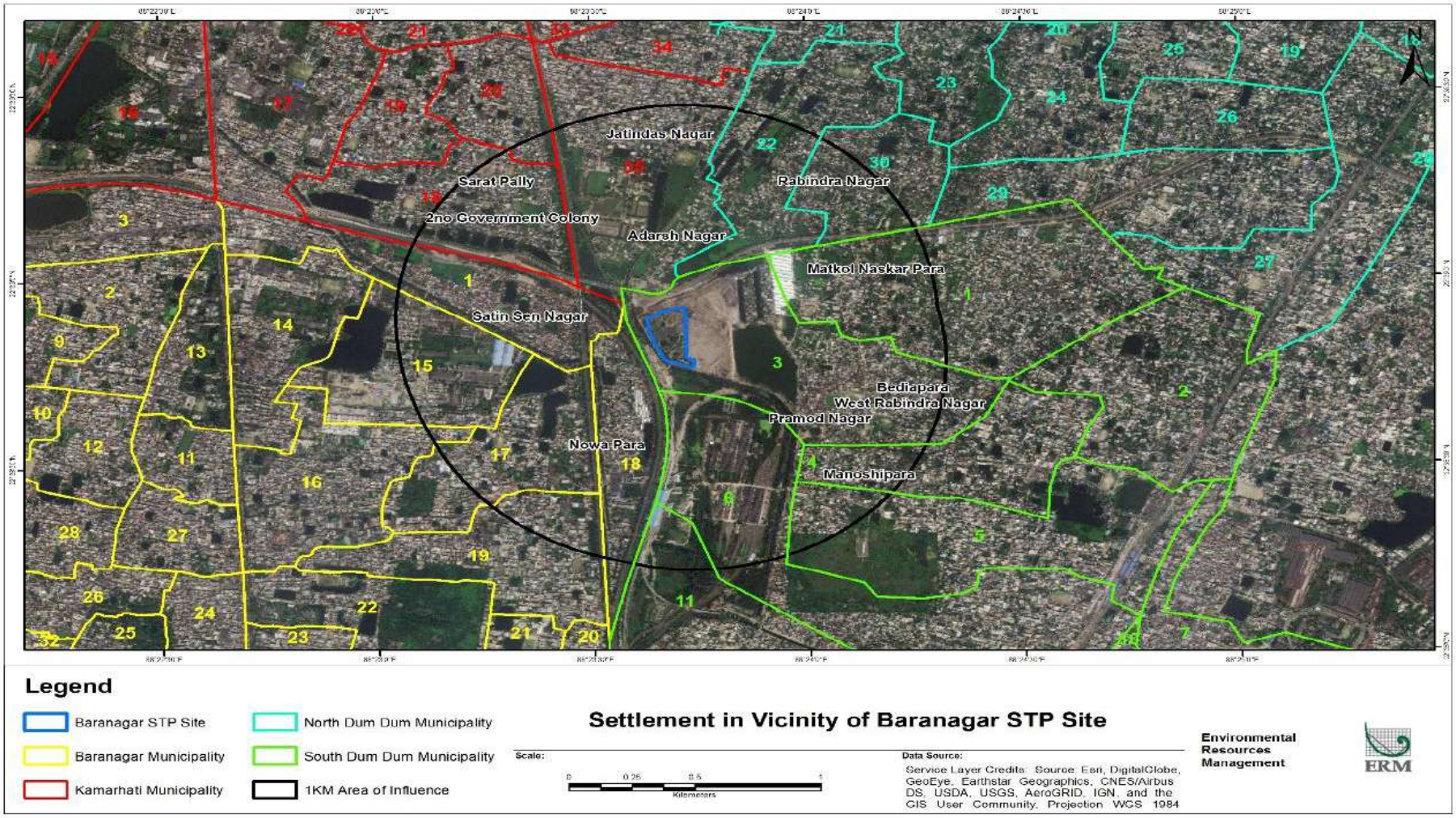
based on the analysis, the following percentage of the respective municipal wards have been considered for the baseline study: 90% of the population in Ward 18 has been considered, 70% of ward 17, 50% of ward 15, and 50% for ward 1 of Baranagar Municipality. In Kamarhati Municipality, the settlements near the STP are Adharsh Nagar, Two (2) Number Government Pally and Saratpally, which includes ward 18 and 35 where 40% of the population in each ward has been considered for the analysis baseline. In North Dum Dum Muninicipality, the settlements near the STP include Rabindra Nagar, situated in ward 30, where 50% of the population has been considered, and in ward 22 where 40% of the population has been considered. In South Dum Dum Municipality, the settlements near the STP are Pramod Nagar, West Rabindra Nagar and Bediapara, and includes wards 1, 3, 4 and 5. Similarly, 35% of the ward 1 population will be considered, 85% of ward 3, 30% of ward 4, and 15% of ward 5. Ward number 6 is a railway shed therefore there are no settlements observed in this area (**Table 4.17**).

Table 4.17: Settlements and Percentage of Respective Municipal Wards under Baseline Study

STP Location	Name of the Municipality	Name of the Settlement	Ward Number	% Considered for Baseline Study
Baranagar STP Location	Baranagar Municipality	Noaw Para & Satin Sen Nagar	18	90%
			17	70%
			15	50%
			1	50%
	Kamarhati Municipality	Adharsh Nagar, Two (2) Number Government Pally & Saratpally	18	40%
			35	40%
	South Dum Dum Municipality	Pramod Nagar, West Rabindra Nagar and Bediapara	1	35%
			3	85%
			4	30%
			5	15%
			6	Its mostly rail yard
	North Dumdum Municipality	Rabindra Nagar	22	40%
			30	50%

The settlements in the vicinity of the Baranagar STP, including the ward information are presented in **Figure 4.36** below.

Figure 4.36 Settlements in Vicinity of Baranagar 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 Baranagar and Kamarhati Municipalities. 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.

In Baranagar Municipality, the settlements along the sewer line alignment include ward numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33 and 34. In Kamarhati Municipality, the settlements along the sewer line alignment include ward numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 and 35. An analysis of the google earth map **(Figure 4.37)** 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 4.18**.

Table 4.18: Settlements and Percentage of Respective Municipal Wards near along Sewer Lines, under Baseline Study

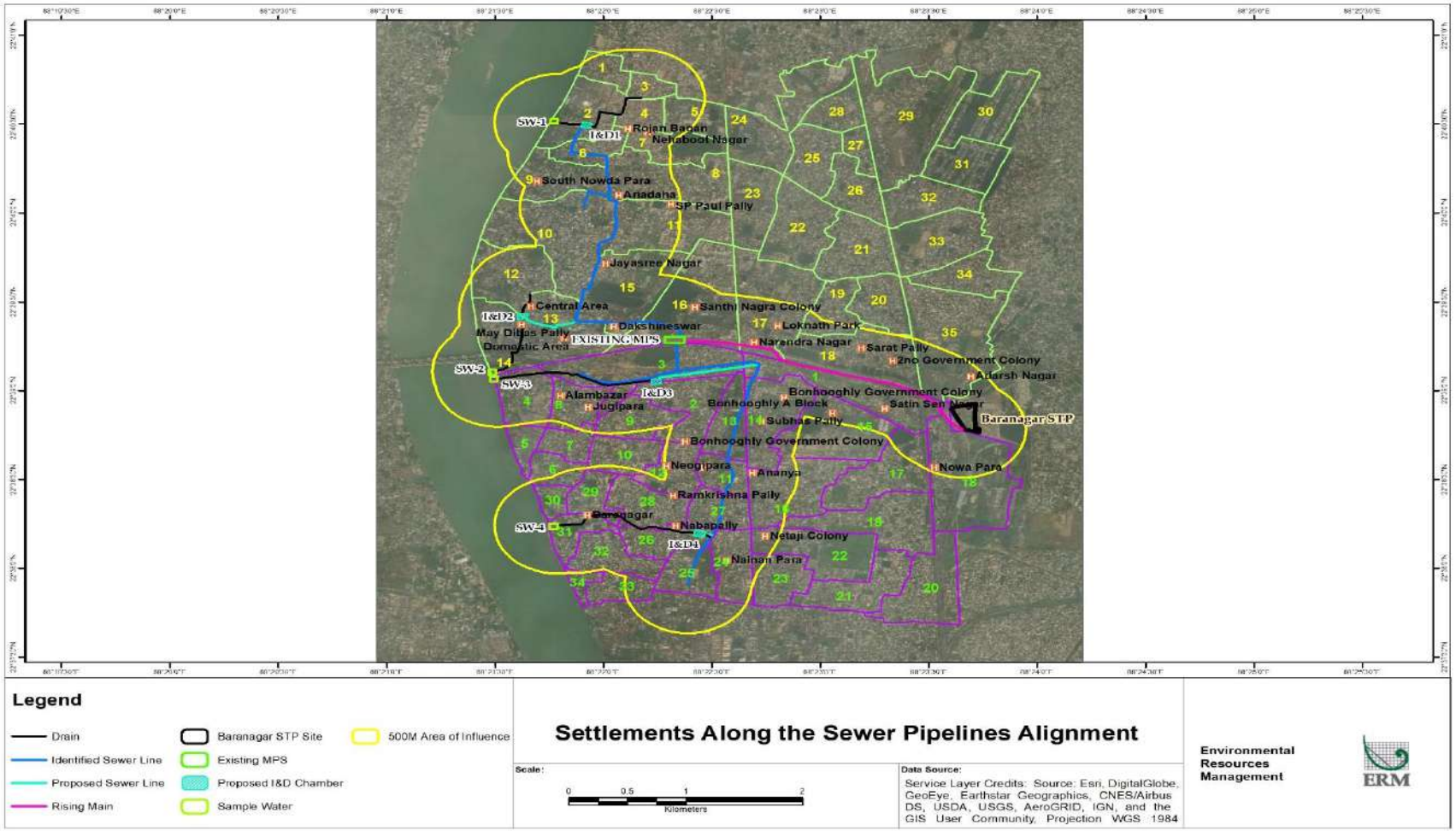
STP Location	Municipality	Ward Number	% Considered for Baseline Study
Baranagar STP Location	Baranagar	1	100%
	Baranagar	2	90%
	Baranagar	3	100%
	Baranagar	4	100%
	Baranagar	5	5%
	Baranagar	6	30%
	Baranagar	7	10%
	Baranagar	8	90%
	Baranagar	9	90%
	Baranagar	10	10%
	Baranagar	11	100%
	Baranagar	12	90%
	Baranagar	13	100%
	Baranagar	14	100%
	Baranagar	15	30%
	Baranagar	16	60%
	Baranagar	17	10%

STP Location	Municipality	Ward Number	% Considered for Baseline Study
	Baranagar	18	50%
	Baranagar	19	5%
	Baranagar	22	20%
	Baranagar	23	10%
	Baranagar	24	95%
	Baranagar	25	100%
	Baranagar	26	100%
	Baranagar	27	100%
	Baranagar	28	100%
	Baranagar	29	100%
	Baranagar	30	100%
	Baranagar	31	100%
	Baranagar	32	95%
	Baranagar	33	40%
	Baranagar	34	5%
	Kamarhati	1	90%
	Kamarhati	2	100%
	Kamarhati	3	100%
	Kamarhati	4	100%
	Kamarhati	5	50%
	Kamarhati	6	100%
	Kamarhati	7	70%
	Kamarhati	8	50%
	Kamarhati	9	80%
	Kamarhati	10	80%
	Kamarhati	11	60%
	Kamarhati	12	90%
	Kamarhati	13	100%
	Kamarhati	14	100%
	Kamarhati	15	90%
	Kamarhati	16	40%

STP Location	Municipality	Ward Number	% Considered for Baseline Study
	Kamarhati	17	40%
	Kamarhati	18	100%
	Kamarhati	19	30%
	Kamarhati	35	20%

The ward level data of the population along the sewer lines have been presented in Figure 4.37 below.

Figure 4.37 Settlements along Sewer Lines



4.4.3 Administrative Structure

The Baranagar STP and its linked facilities are dedicated for the sewerage system of Baranagar and Kamarhati Municipal areas. Hence, for the broad level contextual setting for the baseline conditions, only these two municipalities (Baranagar and Kamarhati) have been considered. However, for analysis of the baseline condition within the one kilometre radius of the STP facility, concern municipal wards under the respective municipalities (Baranagar, Kamarhati, South Dumdum and North Dumdum) have been considered.

4.4.3.1 North 24 Parganas District

North 24 Parganas district covers a total area of 4,094 sq. km, with Barasat Municipality being the district headquarters. The district's Northern and Eastern part shares an international boundary with Bangladesh, while the Western boundary is shared with Nadia, Hooghly, Howrah and Kolkata districts. Towards the South and South Western part, the district shares a boundary with South 24 Parganas district. The district comprises 27 Urban Local Bodies (ULBs) of which 27 are municipalities, 22 Panchayat Samities and 200 Gram Panchayats.

4.4.3.2 Baranagar Municipality

The administrative boundary of Baranagar Municipality was established in 1869 and the Baranagar Municipality was established in 1986. It is situated east of the Hooghly River and is close to Kolkata and also a part of the area is covered by Kolkata Metropolitan Development Authority (KMDA). Baranagar is located at 22.64°N 88.37°E. As per the District Census Handbook 2011, Baranagar municipality covered an area of 7.12 sq.km. Amongst the civic amenities, it had 160.23 km of roads and both open and closed drains. Baranagar is a major industrial centre for the manufacture of agricultural and industrial machinery, chemicals, castor oil, and matches; there are also numerous cotton-processing companies.

4.4.3.3 Kamarhati Municipality

The administrative boundary of Kamarhati Municipality was established in 1899. Towards the west, the municipality is bound by the Hooghly River; towards the north, it borders Panihati; towards the east, it borders North Dum Dum; and towards the South, it borders Baranagar Municipality. Kamarhati was previously a part of Baranagar Municipality. It is close to Kolkata and also a part of the area covered by Kolkata Metropolitan Development Authority (KMDA). Kamarhati is located at 22.67°N 88.37°E. As per the District Census Handbook 2011, Kamarhati municipality covered an area of 10.96 sq. km. amongst the civic amenities, it has 268.95 km of roads (260.80 km pucca, 6.15 km kucha), 456.17 km drains (422.67 km pucca, 33.5 km kucha).

4.4.4 Demographic Profile of the Study Area

4.4.4.1 North 24 Parganas District

As per the 2011 Census of India, the total population of North 24 Parganas district is 10,009,781 comprising of 2,348,683 households. Out of the population, 5,119,389 population are men and 4,890,392 are women. The total number of Schedule Caste (SC) population is 2,169,084, with 1,115,458 being men and 1,053,626 being women. The total number of Schedule Tribe (ST) population however is 264,597 with 134,179 men and 130,418 women.

4.4.4.2 Baranagar Municipality

As per the 2011 Census of India, Baranagar Municipality has a total population of 245,213 individuals residing in 63,387 households and constitutes approximately 2.4 percent of the total population of North Twenty Four Parganas district. Out of the total population, men constitute 126,187 while women

constitute 119,026. The population density of the municipality is 34,440 per square kilometre, which is much higher than the district average i.e. 2,445 per square kilometre (**Table 4.19**). The overall population of Baranagar has decreased over the 10 years as it was 250,768 as per the 2001 census, and 245,213 as per the 2011 census of India.

Table 4.19: Population Trends of Baranagar Municipality

Index	2011	2001
Total Households	63,387	55,250
Total Population	245,213	250,768
Population Density Per Sq. K.M	34,440	35,220
Sex Ratio	943	892
Average Annual Increase	-0.22%	1.15%
Average Household (HH) size	3.9	4.5

Source: Census of India 2011

4.4.4.3 Kamarhati Municipality

As per the 2011 Census of India, Kamarhati Municipality has a total population of 330,211 individuals residing in 70,107 households and constitutes approximately 2.4 percent of the total population of North 24 Parganas district. Out of the total population, men constitute 170,293 while women constitute 159,918 (Table 4.20). The population density of the municipality is 30,129 per square kilometre, which is much higher than the district average i.e. 2445 per square kilometre.

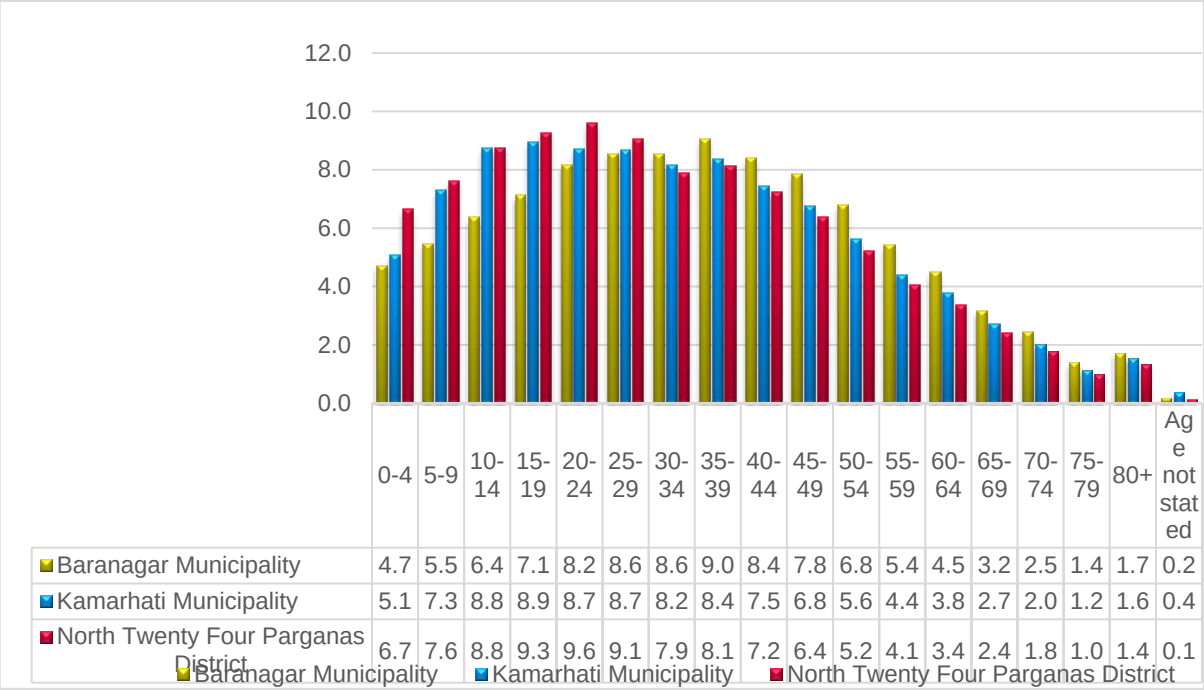
Table 4.20: Population Trends of Kamarhati Municipality

Index	2011	2001
Total Households	70,107	62,691
Total Population	33,0211	314,507
Population Density Per Sq. K.M	30,129	28696
Sex Ratio	939	866
Average Annual Increase	0.5%	1.78%
Average Household (HH) size	3.87	4.54

Source: Census of India 2011

Figure 4.38 below presents the age wise distribution among the population in Baranagar and Kamarhati Municipalities as well as the North 24 Parganas district. In Baranagar Municipality, the age category with the highest population is 35-39 years at 9%, while in Kamarhati Municipality, the age category with the highest population is 15-19 years at 8.9%. At the district level however, the age category with the highest population is 20-24 years of age.

Figure 4.38 Age Wise Distribution of Population



	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+	Age not stated
Baranagar Municipality	4.7	5.5	6.4	7.1	8.2	8.6	8.6	9.0	8.4	7.8	6.8	5.4	4.5	3.2	2.5	1.4	1.7	0.2
Kamarhati Municipality	5.1	7.3	8.8	8.9	8.7	8.7	8.2	8.4	7.5	6.8	5.6	4.4	3.8	2.7	2.0	1.2	1.6	0.4
North Twenty Four Parganas District	6.7	7.6	8.8	9.3	9.6	9.1	7.9	8.1	7.2	6.4	5.2	4.1	3.4	2.4	1.8	1.0	1.4	0.1

Source: Census of India 2011

4.4.4.4 Demographic Profile of Settlements near STP

The **Table 4.21** below presents 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 15,547 HHs and a population of 60,944 persons, collectively, within the defined radius of one km from the Barangar STP. Out of 60,944 persons, 51% (31,146) are male, and 49% (29,797) are female and the average HH size is 3.9. It is observed that ward number 3 of South Dum Dum Municipality, where Pramod Nagar, Bedia Para and West Radindra Nagar settlements are located have the highest population density, followed by ward number 18 in Baranagar Municipality.

Ward number 18 of Baranagar Municipality, where Naowpara settlement is located has approximately 2,044 HHs and a population of 8,214 persons. Ward number 1, where Satin Sen Nagar is located has approximately 1,887 HHs with a population of 7,257 persons, followed by ward number 17 with 1,793 HHs and a population of 6,714 persons. Ward number 15 of Baranagar Municipality has approximately 554 HHs with a population of 2,209 persons.

Ward number 35 of Kamarhati Municipality where Sarat Pally and 2 No. Government Pally settlements are located has approximately 938 HHs with a population of 4084 persons. However, Ward number 18 where Adharsh Nagar and Jatin Das Nagar are located, has 935 HHs with a population of 3,694 persons.

Ward number 30 of North Dum Dum Municipality where Rabindra Nagar settlement is located has 623 HHs and a population of 2415 persons, while ward number 22 has 1104 HHs and a population of 4254 HHs.

Ward number 3 of South Dum Dum Municipality, where Pramod Nagar, Bediapur and West Rabindra Nagar settlements area located have approximately 3,114 HHs and a population of 12,214 numbers. Additionally, ward number 4 has approximately 744 HHs with a population of 2816 while ward number 5 has 507 HH with a population of 1,952 persons.

Table 4.21: Demographic Data of Settlements around Baranagar 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	%
Baranagar	Satin Sen Nagar	1	1887	7257	3.8	3711	51	3546	49
		15	554	2209	4.0	1087	49	1122	51
	Noaw Para	17	1793	6714	3.7	3439	51	3275	49
		18	2044	8214	4.0	4201	51	4013	49
Kamarhati	Sarat Pally 2no Government Pally	18	938	4084	4.4	2067	51	2017	49
	Jatin Das Nagar Adharsh Nagar	35	935	3694	3.9	2012	54	1681	46
North Dum Dum	Rabindra Nagar	22	1104	4254	3.9	2173	51	2081	49
		30	623	2415	3.9	1200	50	1216	50
South Dum Dum	Matkol Naskar Para	1	1304	5121	3.9	2585	50	2536	50
	Bedia Para West Rabindra Nagar Pramodnagar	3	3114	12214	3.9	6276	51	5937	49
	Manoshipara	4	744	2816	3.8	1420	50	1396	50
		5	507	1952	3.8	975	50	977	50
Total			**15547**	**60944**	**47**	**31146**	**51**	**29797**	**49**

Source: Census of India 2011

4.4.4.5 Demographic Profile of Settlements along Sewer Lines

The Table 4.22 below presents the 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. An analysis of the percentage of ward area considered under study area and proportionally the percentage population of the respective municipal ward, the data indicates that there are approximately 71,153 HHs and a population of 312,993 persons, collectively, within the defined buffer zone. Out of 379,112 persons, 51.3% (160,635) are male, and 48.7% (152,358) are female and the average HH size is 4.4. It is observed that ward number 2 of Kamarhati Municipality is located has the highest population density with 18,942 persons, followed by ward number 4, also in Kamarhati Municipality, with 18,321 persons. It is observed that ward number 34 in Baranagar Municipality has the lowest population density within the buffer zone, with 185 persons, followed by ward number 5, also in Baranagar Municipality, with 308 persons.

Table 4.22: 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	%
Baranagar	1	3774	14513	3.8	7421	51.1	7092	48.9
Baranagar	2	934	3670	3.9	1812	49.4	1858	50.6
Baranagar	3	2639	10466	4.0	5358	51.2	5108	48.8
Baranagar	4	1715	6685	3.9	3557	53.2	3128	46.8
Baranagar	5	79	309	3.9	173	56.0	136	44.0
Baranagar	6	505	2438	4.8	1288	52.8	1150	47.2
Baranagar	7	142	615	4.3	330	53.7	285	46.3
Baranagar	8	1522	6107	4.0	3113	51.0	2994	49.0
Baranagar	9	2039	8128	4.0	4044	49.8	4084	50.2
Baranagar	10	137	541	4.0	267	49.4	274	50.6
Baranagar	11	1257	4584	3.6	2269	49.5	2315	50.5
Baranagar	12	1300	4879	3.8	2442	50.1	2437	49.9
Baranagar	13	2212	8295	3.8	4291	51.7	4004	48.3
Baranagar	14	1856	6878	3.7	3524	51.2	3354	48.8
Baranagar	15	332	1325	4.0	652	49.2	673	50.8
Baranagar	16	1725	6389	3.7	3161	49.5	3228	50.5
Baranagar	17	256	959	3.7	491	51.2	468	48.8
Baranagar	18	1136	4564	4.0	2334	51.1	2230	48.9
Baranagar	19	142	552	3.9	286	51.9	266	48.1
Baranagar	22	348	1310	3.8	661	50.5	649	49.5

Municipality	Ward No	Total HHs	Total Population	Average HH Size	Male	%	Female	%
Baranagar	23	187	782	4.2	422	53.9	361	46.1
Baranagar	24	1196	4436	3.7	2247	50.7	2189	49.3
Baranagar	25	1501	5814	3.9	2883	49.6	2931	50.4
Baranagar	26	1990	7406	3.7	3626	49.0	3780	51.0
Baranagar	27	1584	5723	3.6	2897	50.6	2826	49.4
Baranagar	28	1839	6735	3.7	3398	50.5	3337	49.5
Baranagar	29	1411	5134	3.6	2627	51.2	2507	48.8
Baranagar	30	1271	4944	3.9	2562	51.8	2382	48.2
Baranagar	31	1577	6033	3.8	3114	51.6	2919	48.4
Baranagar	32	1927	7127	3.7	3580	50.2	3547	49.8
Baranagar	33	579	2155	3.7	1099	51.0	1056	49.0
Baranagar	34	51	186	3.7	94	50.3	92	49.7
Kamarhati	1	1976	10493	5.3	5696	54.3	4797	45.7
Kamarhati	2	3036	18942	6.2	10030	53.0	8912	47.0
Kamarhati	3	2439	16067	6.6	8458	52.6	7609	47.4
Kamarhati	4	2815	18321	6.5	9674	52.8	8647	47.2
Kamarhati	5	909	6148	6.8	3196	52.0	2953	48.0
Kamarhati	6	1837	12488	6.8	6538	52.4	5950	47.6
Kamarhati	7	1133	73467	6.5	3830	52.1	3517	47.9
Kamarhati	8	1593	7581	4.8	3917	51.7	3664	48.3
Kamarhati	9	204	974	4.8	497	51.1	477	48.9

Municipality	Ward No	Total HHs	Total Population	Average HH Size	Male	%	Female	%
Kamarhati	10	2336	8589	3.7	4279	49.8	4310	50.2
Kamarhati	11	1902	7857	4.1	4074	51.9	3783	48.1
Kamarhati	12	1837	6948	3.8	3434	49.4	3514	50.6
Kamarhati	13	2088	8456	4.0	4198	49.6	4258	50.4
Kamarhati	14	1489	6180	4.2	3112	50.4	3068	49.6
Kamarhati	15	1607	6511	4.1	3280	50.4	3231	49.6
Kamarhati	16	732	3113	4.3	1586	51.0	1527	49.0
Kamarhati	17	895	3761	4.2	1896	50.4	1865	49.6
Kamarhati	18	2346	10211	4.4	5168	50.6	5043	49.4
Kamarhati	19	348	1476	4.2	743	50.4	732	49.6
Kamarhati	35	468	1847	3.9	1006	54.5	841	45.5
	Total	**71,153**	**312,993**	**4.4**	**160,635**	**51.3**	**152,358**	**48.7**

Source: Census of India 2011

4.4.5 Literacy Profile

4.4.5.1 North 24 Parganas District

As per the 2011 Census of India, the overall literacy rate of North 24 Parganas District is 76% with 79% being the male literacy rate and 73% being the female literacy rate. The male literacy rate is thus higher than the female literacy rate**.**

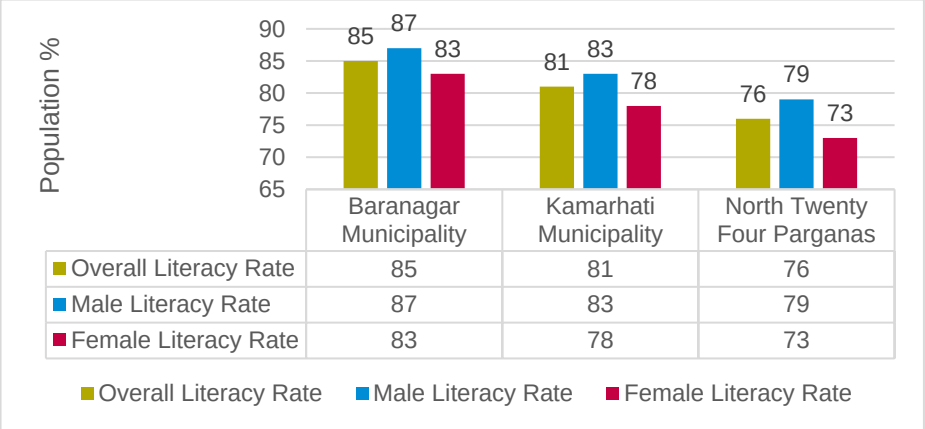
Out of the total literate population at the district level i.e. 7,608,693 numbers, 3% (238,691 numbers) are literate without any education level; 21% (1,637,963 numbers) have below primary level education; 20% (1,545,327 numbers) have completed middle level education; 11% (811,325 numbers) have completed secondary education; 10% (771,645 numbers) have completed higher secondary education; 0.4% (29,435 numbers) have completed technical education and 12% (945,363 numbers) are graduates. Approximately 0.4% have an education level that has not been classified. (**Table 4.23**).

4.4.5.2 Baranagar Municipality & Kamarhati Municipality

As per the 2011 Census of India, the overall literacy rate of Baranagar Municipality is 85% which is higher than Kamarhati Municipality's overall literacy rate of 81% and North Twenty Four Parganas district literacy rate of 76%. Moreover, the literacy rate of men at the Baranagar and Kamarhati

Municipalities are 87% and 83% respectively, which are higher than the district level of 79%. The literacy rate of women is 83 % at Baranagar Municipality and 78% at Kamarhati Municipality, which are also higher than the district level of 73% (**Figure** 4.39).

Figure 4.39 Literacy Profile of Population in Baranagar and Kamarhati Municipality



Source: Census of India 2011

Table 4.23: Education Level at Baranagar and Kamarhati Municipality and District Level

Location	Literate w/o educatio		Below Primary		Primary		Middle		Secondary		Higher Secondary		Technical/ Diploma		Graduate		Not Classified	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
North 24 Parganas District	238691	3	1599291	21	1637963	22	1545327	20	811325	11	771645	10	29435	0.4	945363	12	29653	0.4
Baranagar	9150	4	23122	11	29689	14	36628	18	35261	17	23045	11	1529	0.7	49711	24	644	0.3
Kamarhati	11397	4	34902	13	46796	18	48841	18	44051	16	27697	10	1978	0.7	50367	19	1238	0.5

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 82% (49,762 numbers), the male and female literacy rate being 85% (26,425 numbers) and 78% (23,337 numbers) respectively. Ward number 35 of Kamarhati where Jatin Das Nagar and Adharsh Nagar are located and ward number 30 of North Dum Dum Municipality where Radindra Nagar is located both have a literacy rate of 91%. It is observed that ward number 18 where Nowapara is located and ward number 1 where Satin Sen Nagar is located has the lowest literacy rate among the settlements i.e. 74% and 76% respectively (**Table 4.24**).

It is thus observed that the overall literacy rate of the settlements near the STP location i.e. 82%, is higher than the district average i.e. 76%. However, the literacy rate of the settlements near the STP location is lower than the literacy rate at Baranagar Municipality i.e. 85% and higher than the literacy rate of Kamarhati Municipality i.e. 81%.

Table 4.24: Literacy Profile of Settlements near STP

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	Female Literacy
Baranagar	Satin Sen Nagar	1	7257	3711	3546	5536	2970	2566	76	80	72
		15	2209	1087	1122	1838	939	900	83	86	80
	Nowa Para	17	6714	3439	3275	5557	2925	2632	83	85	80
		18	8214	4201	4013	6070	3326	2743	74	79	68
Kamarhati	Sarat Pally 2 no. Government Pally	18	4084	2067	2017	3559	1843	1716	87	89	85
	Jatin Das Nagar Adharsh Nagar	35	3694	2012	1681	3348	1875	1473	91	93	88
North Dum Dum	Rabindra Nagar	22	4254	2173	2081	3666	1924	1742	86	89	84
		30	2415	1200	1216	2204	1109	1095	91	92	90
South Dum Dum	Matkol Naskar Para	1	5121	2585	2536	4226	2221	2005	83	86	79
	Bedia Para West Rabindra Nagar Pramodnagar	3	12214	6276	5937	9625	5177	4447	79	82	75
	Manoshipara	4	2816	1420	1396	2475	1268	1207	88	89	86
		5	1952	975	977	1659	848	810	85	87	83
Total			**60943**	**31147**	**29797**	**49762**	**26425**	**23337**	**82**	**85**	**78**

Source: Census of India 2011

4.4.5.4 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 87% (253,120 numbers), the male and female literacy rate is 90% (133,713 numbers) and 84% (119,408 numbers) respectively. Ward number 12 and 32 of Baranagar Municipality have the highest literacy rate within the buffer zone at 97.8% and 97.1% respectively. However, wards number 2 and 6 of Kamarhati Municipality have the lowest literacy rate with the defined buffer zone at 75.9% and 75.1% respectively.

It is thus observed that the overall literacy rate of the settlements along the sewer lines i.e. 87% are higher than the average of the settlements within the 1 km radius i.e 82%, the district average i.e. 76%, Baranagar Municipality i.e. 85% as well as Kamarhati Municipality i.e. 81%.

Table 4.25: 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 %
Baranagar	1	3774	14513	7421	7092	11072	5940	5132	84.0	88.2	79.7
Baranagar	2	934.2	3669.3	1811.7	1857.6	3245	1616	1629	94.7	96.3	93.3
Baranagar	3	2639	10466	5358	5108	8248	4425	3823	85.1	89.4	80.5
Baranagar	4	1715	6685	3557	3128	5223	2868	2355	85.6	88.1	82.8
Baranagar	5	78.35	308.65	172.95	135.7	229	136	93	82.1	86.2	76.7
Baranagar	6	504.9	2437.8	1287.9	1149.9	1785	1030	755	81.0	87.7	73.4
Baranagar	7	141.5	614.5	329.8	284.7	450	253	197	80.4	84.0	76.3
Baranagar	8	1521.9	6107.4	3113.1	2994.3	5306	2768	2538	93.7	96.6	90.7
Baranagar	9	2038.5	8127.9	4043.7	4084.2	7271	3663	3608	95.3	96.5	94.1
Baranagar	10	136.7	540.6	267.2	273.4	446	233	213	88.0	92.9	83.2
Baranagar	11	1257	4584	2269	2315	4190	2103	2087	96.8	97.9	95.8
Baranagar	12	1300	4879	2442	2437	4500	2283	2217	97.8	98.8	96.8
Baranagar	13	2212	8295	4291	4004	7247	3821	3426	94.0	95.4	92.4
Baranagar	14	1856	6878	3524	3354	5978	3097	2881	93.5	94.4	92.6
Baranagar	15	332.4	1325.4	652.2	673.2	1103	563	540	89.7	93.3	86.1
Baranagar	16	1725	6389.4	3161.4	3228	5800	2887	2912	96.2	97.2	95.3
Baranagar	17	256.2	959.2	491.3	467.9	794	418	376	90.1	93.4	86.7
Baranagar	18	1135.5	4563.5	2334	2229.5	3372	1848	1524	81.7	86.8	76.2
Baranagar	19	140.65	551.45	286.2	265.25	474	250	224	92.8	94.3	91.2

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 %
Baranagar	22	348.4	1310.2	661.2	649	1178	597	582	96.0	96.7	95.3
Baranagar	23	187.4	782.2	421.6	360.6	715	390	325	96.5	97.5	95.2
Baranagar	24	1196.05	4435.55	2246.75	2188.8	4033	2066	1967	96.2	97.4	95.1
Baranagar	25	1501	5814	2883	2931	4896	2501	2395	89.9	93.1	86.8
Baranagar	26	1990	7406	3626	3780	6580	3269	3311	93.7	95.3	92.1
Baranagar	27	1584	5723	2897	2826	5261	2679	2582	96.7	97.5	95.8
Baranagar	28	1839	6735	3398	3337	5980	3079	2901	94.3	96.5	92.0
Baranagar	29	1411	5134	2627	2507	4495	2353	2142	91.8	93.9	89.7
Baranagar	30	1271	4944	2562	2382	4181	2245	1936	90.6	93.4	87.5
Baranagar	31	1577	6033	3114	2919	5130	2674	2456	90.4	91.4	89.3
Baranagar	32	1926.6	7126.9	3579.6	3547.3	6590	3320	3270	97.1	97.8	96.4
Baranagar	33	578.8	2154.8	1099.2	1055.6	1939	1008	931	95.6	97.5	93.5
Baranagar	34	50.15	185.25	93.25	92	167	85	82	94.4	95.5	93.3
Kamarhati	1	1976.4	10493.1	5696.1	4797	7358	4161	3197	77.8	81.2	73.9
Kamarhati	2	3036	18942	10030	8912	12636	7048	5588	75.1	79.0	70.7
Kamarhati	3	2439	16067	8458	7609	11044	6144	4900	76.6	80.5	72.3
Kamarhati	4	2815	18321	9674	8647	13345	7313	6032	80.3	83.1	77.2
Kamarhati	5	908.5	6148	3195.5	2952.5	4386	2356	2030	78.7	81.3	76.0
Kamarhati	6	1837	12488	6538	5950	8610	4765	3845	75.9	79.9	71.5
Kamarhati	7	1132.6	7346.5	3829.7	3516.8	5238	2872	2366	79.0	82.8	74.8

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 %
Kamarhati	8	1592.5	7581	3917	3664	6007	3223	2784	87.0	90.4	83.5
Kamarhati	9	203.9	973.7	497.4	476.3	806	421	385	89.5	91.6	87.3
Kamarhati	10	2336	8588.8	4278.4	4310.4	7420	3766	3654	92.0	94.5	89.7
Kamarhati	11	1902	7857	4074	3783	6435	3470	2965	89.0	92.5	85.3
Kamarhati	12	1836.9	6947.1	3433.5	3513.6	6040	3074	2966	92.0	94.7	89.4
Kamarhati	13	2088	8456	4198	4258	7585	3862	3723	94.5	96.7	92.3
Kamarhati	14	1489	6180	3112	3068	4916	2589	2327	86.2	90.0	82.3
Kamarhati	15	1606.5	6510.6	3279.6	3231	5515	2854	2661	90.3	92.8	87.8
Kamarhati	16	731.6	3113.2	1586.4	1526.8	2687	1406	1280	92.3	94.6	89.8
Kamarhati	17	893.6	3756.8	1891.6	1865.2	3332	1712	1620	93.9	95.7	92.1
Kamarhati	18	2346	10211	5168	5043	8898	4607	4291	93.2	95.7	90.7
Kamarhati	19	347.7	1475.7	743.4	732.3	1313	666	647	95.2	96.4	94.1
Kamarhati	35	467.6	1846.8	1006.2	840.6	1674	937	737	96.0	98.2	93.3
Total		**71145**	**312982.3**	**160628.85**	**152353.45**	**253120.5**	**133713**	**119408**	**87.6**	**90.1**	**84.8**

Source: Census of India 2011

4.4.6 Religious Composition

4.4.6.1 North 24 Parganas District

In the North 24 Parganas district, 73.46% (7,352,769 numbers) are Hindus, 25.82% (2,584,684 numbers) are Muslim, 0.09% (9394 numbers) are Sikh, 0.27% (26,933 numbers) are Christian, 0.06% (5,818 numbers) are Buddhist, 0.04% (4,452 numbers) are Jain and 0.26% (25,731 numbers) are listed as others.

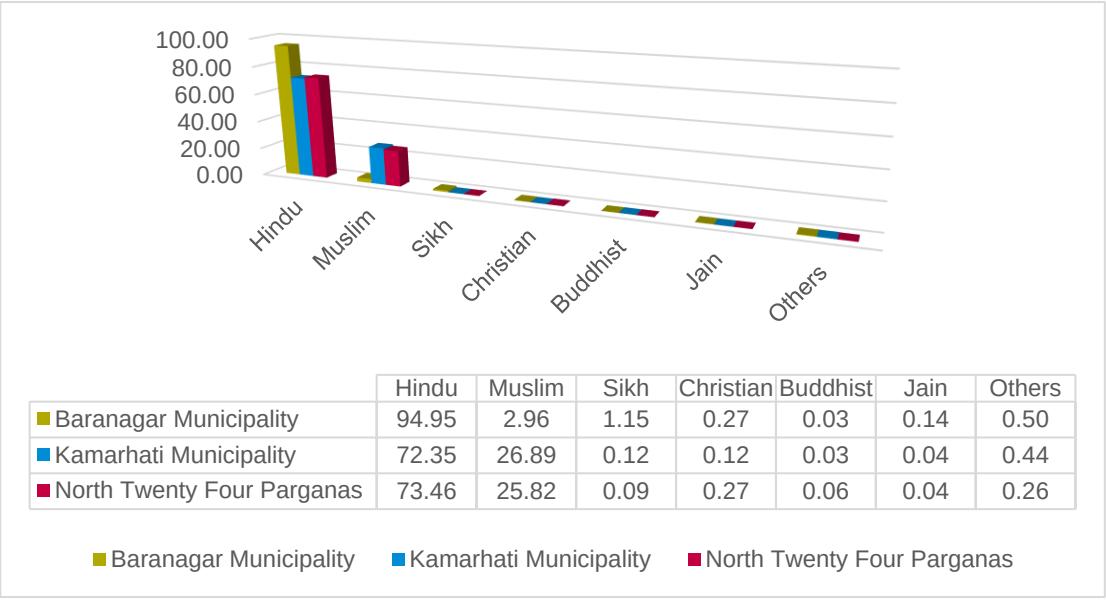
4.4.6.2 Baranagar and Kamarhati Municipality

As per the 2011 Census of India, the total Schedule Caste (SC) population in Baranagar Municipality is 12,723, out of which 6,615 are male and 6,108 are female. Total Scheduled Tribe (ST) population is 1,383 with 713 being men and 670 being women.

With regard to the religious composition in Baranagar Municipality, 94.95 % (232,839 numbers) of the population are Hindus, 2.96 % (7,269 numbers) are Muslims, 1.15% (2,810 numbers) are Sikhs, 0.27% (653 numbers) are Christian, 0.14% (345 numbers) are Jain, 0.03% (63 numbers) are Buddhists while 0.50% are listed as others (***Figure 4.40***).

In Kamarhati Municipality, 72.3% (238,902 numbers) of the population are Hindus, 26.9% (88,790 numbers) are Muslims, 0.12% (411 numbers) are Sikhs, 0.12% (411 numbers) are Christians, 0.03% (104) are Buddhist, 0.04% (138 numbers) are Jain, and 0.44% (1455 numbers) are classified as others.

Figure 4.40 Religious Composition



	Hindu	Muslim	Sikh	Christian	Buddhist	Jain	Others
Baranagar Municipality	94.95	2.96	1.15	0.27	0.03	0.14	0.50
Kamarhati Municipality	72.35	26.89	0.12	0.12	0.03	0.04	0.44
North Twenty Four Parganas	73.46	25.82	0.09	0.27	0.06	0.04	0.26

Source: Census of India 2011

4.4.7 Employment and Occupational Profile in the Study Area

4.4.7.1 North 24 Parganas District

As per the 2011 Census of India, main workers account for 31% (3,055,630 numbers) of the total population at North 24 Parganas District, where men comprise 86% (2,630,907 numbers) and women comprise 14% (424,723 numbers). Marginal workers account for 5% (515,994 numbers) of the total district population, with 61% (314,282 numbers) men and 39% (201,712 numbers) women. Non-

workers however account for 64% (6,438,157 numbers) of the total district population thereby constituting a majority, with 34% (2,174,200 numbers) men and 66% (4,263,957 numbers) women.

Moreover, out of a total of 3,571,624 workers at North 24 Parganas District, 8% (288,058 numbers) are cultivators out of which 7% (266,507 numbers) are men and 1% (21,551 numbers) are women. Moreover, 17% (599,039 numbers) are agricultural labourers, with 14% (509,401 numbers) men and 3% (89,638 numbers) women. 4% (155,762 numbers) are engaged in household industries, with 2% (81,434 numbers) men and 2% (74,328 numbers) women. Additionally, over 71% (2,528,765 numbers) are engaged in other activities, with 58% (2,945,189 numbers) men and 12% (440,918 numbers) women. It may be noted that since North 24 Parganas district mainly comprises of urban settlements, majority of the population are therefore engaged in commercial activities and in the service sector for their source of income.

4.4.7.2 Baranagar Municipality

As per the 2011 Census of India, main workers account for 34.7% of the population in Baranagar Municipality with 85,177 individuals. Out of this, 83.8% (71,385 numbers) are men and 16.2% (13,792 numbers) are women. Marginal workers account for 2.7% (6,628 numbers) of the population, with 56.6% (3,754 numbers) men and 43.4% (2,874 numbers) women. The non-workers account for 62.6% (153,408 numbers) of the population, with 33.3% (51,048 numbers) men and 66.7% (102,360 numbers) women. The data thus shows that women account for majority of the non-working population. The data is also presented in **Table 4.26** below.

Table 4.26: Employment in Baranagar Municipality

Type of Workers	Total	%	Men	%	Women	%
Main Workers	85,177	34.7	71,385	83.8	13,792	16.2
Marginal Workers	6,628	2.7	3,754	56.6	2,874	43.4
Non Workers	153,408	62.6	51,048	33.3	102,360	66.7
Total	**245,213**		**126,187**		**119,026**	

Source: Census of India 2011

It is observed that majority of the population at Baranagar Municipality are engaged in activities other than cultivation, agricultural labour and household industries. 0.45% (417 numbers) of the population are engaged as agricultural labourers, with 0.35% (319 numbers) being men and 0.11% (98 numbers) being women. Around 3.39% (3,112 numbers) of the population are engaged in household industries, with 2.54% (2,331 numbers) being men and 0.85% (781 numbers) being women. 95.81% (87,954 numbers) which constitutes majority of the population however are engaged in other activities, with 78.75% (72,229 numbers) being men and 17.05% (15,665 numbers) being women. Over 0.35% (322 numbers) of the population are engaged as cultivators, with 0.21% (190 numbers) being men and 0.14% (132 numbers) being women. The reason there are fewer individuals engaged in agricultural and household industries is because Baranagar is an urban settlement where most individuals are engaged in the service sector and commercial activities (**Table 4.27**).

Table 4.27: Sector Wise Employment in Baranagar Municipality

Type of Workers	Total	%	Men	%	Women	%
Cultivators	322	0.35	190	0.21	132	0.14
Agricultural Labourers	417	0.45	319	0.35	98	0.11
Household Industries	3,112	3.39	2,331	2.54	781	0.85
Other	87,954	95.81	72,299	78.75	15,655	17.05
	91,805		**75,139**		**16,666**	

Source: Census of India 2011

4.4.7.3 Kamarhati Municipality

As per the 2011 Census of India, main workers account for 29% (95,724 numbers) of the population in Kamarhati Municipality, out of which 85.3% (81,659 numbers) are men and 14.7% (14,065 numbers) are women. Marginal workers account for 3.8% (12,391 numbers) of the population, with 62.7% (7,775 numbers) being men and 37.3% (4,616 numbers) women. The non-workers account for 67.3% (222,096 numbers) of the population, with 36.4% (80,859 numbers) men and 63.6% (141,237 numbers) women. The data thus shows that women account for majority of the non-working population. The data is also presented in **Table 4.28** below.

Table 4.28: Employment in Kamarhati Municipality

Type of Workers	Total	%	Men	%	Women	%
Main Workers	95,724	29	81,659	85.3	14,065	14.7
Marginal Workers	12,391	3.8	7,775	62.7	4,616.0	37.3
Non Workers	222,096	67.3	80,859	36.4	141,237	63.6
Total	**330,211**		**170,293**		**159,918**	

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 Over 0.8% (834 numbers) of the population are engaged as cultivators, with 0.4% (439 numbers) being men and 0.4% (395 numbers) being women. 0.8% (841 numbers) of the population are engaged as agricultural labourers, with 0.5% (580 numbers) being men and 0.2% (261 numbers) being women. Around 3.4% (3,653 numbers) of the population are engaged in household industries, with 2% (2,119 numbers) being men and 1.4% (1,534 numbers) being women. 95.1% (102,787 numbers) which constitutes majority of the population however are engaged in other activities, with 79.8% (86,296 numbers) being men and 15.3% (16,491 numbers) being women. The reason there are fewer individuals engaged in agricultural and household industries is because Kamarhati is an urban settlement where most individuals are engaged in the service sector and commercial activities. **Table 4.29** below presents the sector wise employment data for Kamarhati Municipality.

Table 4.29: Sector Wise Employment in Kamarhati Municipality

Type of Workers	Total	%	Men	%	Women	%
Cultivators	834	0.8	439	0.4	395	0.4
Agricultural Labourers	841	0.8	580	0.5	261	0.2
Household Industries	3,653	3.4	2,119	2.0	1,534	1.4
Other	102,787	95.1	86,296	79.8	16,491	15.3
	108,115		**89,434**		**18,681**	

Source: Census of India 2011

4.4.7.4 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 60,943 persons, approximately 39% (23,467 numbers) are participating in the workforce. Approximately 91% (21344) are main workers and approximately 9% (2123) are marginal workers. It is observed that ward 18 of Baranagar Municipality where Nowapara settlement is situated, has the highest WPR at 44%, while ward number 30 in North Dum Dum where Rabindra Nagar is situated, and ward number 18 in Kamarhati municipality where Sarat Pally and 2no Government Pally are situated, have the lowest WPR at 34%.

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 Ratio of Settlements near STP

Municipality	Settlements/Paras	Ward No	WPR%	Total Population	Total Workers	Main Workers	Main Workers %	Marginal Workers	Marginal Workers %
Baranagar	Satin Sen Nagar	1	41	7257	2954	2537	86	417	14
		15	36	2209	790	735	93	55	7
	Nowa Para	17	36	6714	2426	2113	87	314	13
		18	44	8214	3600	3379	94	221	6
Kamarhati	Sarat Pally 2no Government Pally	18	34	4084	1376	1241	90	135	10
	Jatin Das Nagar Adharsh Nagar	35	40	3694	1470	1193	81	277	19
North Dum Dum	Rabindra Nagar	22	35	4254	1489	1315	88	174	12
		30	34	2415	821	751	91	70	9
South Dum Dum	Matkol Naskar Para	1	37	5121	1895	1803	95	92	5
	Bedia Para West Rabindra Nagar Pramodnagar	3	40	12214	4893	4581	94	312	6
	Manoshipara	4	36	2816	1025	994	97	31	3
		5	37	1952	729	704	97	26	3
Total			**39**	**60943**	**23467**	**21344**	**91**	**2123**	**9**

Source: Census of India 2011

An analysis of the data reveals that majority of the populations at Baranagar and Kamarhati Municipalities 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.

Baranagar Municipality however, has a higher number of main workers (34.7%) than Kamarhati Municipality (29%) as well as the district level (31%). Kamarhati Municipality however, has a higher number of marginal workers (3.8%) than Baranagar Municipality (2.7%) but has a lower number than the district level (5%). Kamarhati Municipality also has a higher number of non-working population (67.3%), as compared to Baranagar Municipality (62.6%). The district level of non-working population is 64%.
Moreover, over 39% of the population in the settlements near the STP location are participating in the workforce where 91% are main workers and only 9% are marginal workers.

4.4.7.5 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 312,982 persons with the defined buffer zone, approximately 33% (105,391 numbers) are participating in the workforce. Approximately 90% (105,391 numbers) are main workers and approximately 9% (9587) are marginal workers. It is observed that ward 18 of Baranagar Municipality where Nowapara settlement is situated, has the highest WPR at 44%, while wards number 5 and 3 at Kamarhati Municipality have the lowest WPR within the defined radius at 24%. As the study area is an urban settlement, the numbers of persons engaged in agricultural and household industries are negligible.

Table 4.31: Work Participation Ratio of Settlements along Sewer Line

Municipality	Ward No	WPR%	Total Population	Total Workers	Main Workers	Main Workers %	Marginal Workers	Marginal Workers %
Baranagar	1	40.7	14513	5908	5074	86	834	14
Baranagar	2	34.3	3669.3	1258.2	1190.7	95	68	5
Baranagar	3	37.6	10466	3936	3596	91	340	9
Baranagar	4	39.2	6685	2620	2455	94	165	6
Baranagar	5	38.3	308.65	118.1	110.4	93	8	7
Baranagar	6	36.0	2437.8	878.1	812.4	93	66	7
Baranagar	7	34.9	614.5	214.3	201.9	94	12	6
Baranagar	8	36.2	6107.4	2210.4	1875.6	85	335	15
Baranagar	9	34.6	8127.9	2812.5	2744.1	98	68	2
Baranagar	10	36.6	540.6	198.1	174.4	88	24	12
Baranagar	11	35.8	4584	1639	1605	98	34	2
Baranagar	12	35.8	4879	1747	1680	96	67	4
Baranagar	13	38.6	8295	3200	3110	97	90	3
Baranagar	14	36.5	6878	2508	2418	96	90	4
Baranagar	15	35.7	1325.4	473.7	441	93	33	7
Baranagar	16	33.1	6389.4	2118	2002.2	95	116	5
Baranagar	17	36.1	959.2	346.6	301.8	87	45	13
Baranagar	18	43.8	4563.5	2000	1877	94	123	6
Baranagar	19	37.7	551.45	207.65	187.95	91	20	9
Baranagar	22	35.9	1310.2	470.8	437	93	34	7
Baranagar	23	36.8	782.2	288.1	278.3	97	10	3
Baranagar	24	37.5	4435.55	1661.55	1527.6	92	134	8
Baranagar	25	38.0	5814	2207	2030	92	177	8
Baranagar	26	35.4	7406	2620	2483	95	137	5
Baranagar	27	35.2	5723	2012	1993	99	19	1

Municipality	Ward No	WPR%	Total Population	Total Workers	Main Workers	Main Workers %	Marginal Workers	Marginal Workers %
Baranagar	28	35.0	6735	2355	2274	97	81	3
Baranagar	29	35.2	5134	1806	1597	88	209	12
Baranagar	30	35.2	4944	1738	1679	97	59	3
Baranagar	31	43.7	6033	2634	2209	84	425	16
Baranagar	32	35.2	7126.9	2511.8	2454.8	98	57	2
Baranagar	33	39.3	2154.8	847.6	816	96	32	4
Baranagar	34	41.1	185.25	76.05	61.45	81	15	19
Kamarhati	1	34.2	10493.1	3593.7	3210.3	89	383	11
Kamarhati	2	27.3	18942	5170	4521	87	649	13
Kamarhati	3	26.3	16067	4218	3569	85	649	15
Kamarhati	4	25.0	18321	4572	4220	92	352	8
Kamarhati	5	23.5	6148	1447.5	1308	90	140	10
Kamarhati	6	24.8	12488	3092	2241	72	851	28
Kamarhati	7	24.0	7346.5	1761.9	1509.9	86	252	14
Kamarhati	8	33.7	7581	2553	2359.5	92	194	8
Kamarhati	9	34.8	973.7	339.3	313	92	26	8
Kamarhati	10	37.5	8588.8	3224.8	2837.6	88	387	12
Kamarhati	11	36.3	7857	2848.8	2574	90	275	10
Kamarhati	12	33.4	6947.1	2320.2	2133.9	92	186	8
Kamarhati	13	32.2	8456	2723	2580	95	143	5
Kamarhati	14	38.6	6180	2383	2130	89	253	11
Kamarhati	15	37.2	6510.6	2420.1	2285.1	94	135	6
Kamarhati	16	36.6	3113.2	1140	1003.6	88	136	12
Kamarhati	17	33.2	3756.8	1248.8	1158.4	93	90	7
Kamarhati	18	33.7	10211	3439	3102	90	337	10
Kamarhati	19	36.5	1475.7	539.1	453.3	84	86	16
Kamarhati	35	39.8	1846.8	735.2	596.6	81	139	19
			312982.3	**105390.95**	**95803.8**	**90.9**	**9587**	**9.1**

Source: Census of India 2011

4.4.8 Housing, Sanitation & Drinking Water Access

4.4.8.1 North 24 Parganas District

As per the 2011 Census of India, over 70.6% (1,609,014 numbers) HHs in North 24 Parganas District are permanent, 22.95% (524,184 numbers) HHs are semi- permanent, 6.03% (137,760 numbers) HHs are temporary structures. Moreover, approximately 11.66% (266,295 numbers) HHs have closed

drainage systems, 38.43% (877,582 numbers) HHs have open drainage systems while 49.91% (1,139,690 numbers) have no drainage systems.

As per the Census of India 2011, out of 2,348,683 HHs, 32.3% (732,482 numbers) HHs have access to tap water from a treated source, 6.56% (149,788 numbers) have access to tap water from an untreated source, 0.27% (6,186 numbers) HHs have drinking water access from a covered well, while 0.18% (4,214 numbers) HHs have access to uncovered wells. Additionally, 40.2% (918,092 numbers) HHs have access to handpumps, 19.15% (437,410 numbers) HHs have access to tubewells and/or boreholes, 0.06% (1,344) HHs have access to springs and 0.13% (2,907 numbers) HHs have access to rivers and/or canals. Over 0.26% (5,907) HHs have access to tanks, ponds and/or lakes, while 0.89% (20,237) HHs have access to other sources for their drinking water.

4.4.8.2 Baranagar Municipality

As per the 2011 Census of India, over 92.1% of the housing structures in Baranagar Municipality are permanent, 6.7% are semi-permanent, 0.5% are temporary, 0.1% are serviceable, 0.5% are non-servicable structures and 0.6% are not classified. The households in Baranagar municipality have both open and closed systems of drainage. Moreover, there are 15,847 households with septic tanks while the toilets in 7,924 households have been listed as others.

Out of 62,209 HHs in Baranagar Municipality, 91.4% (56,881 numbers) have drinking water access through taps from a treated source, while 2% (1,230 numbers) HHs have access to tap water from an untreated source. 0.4% (253 numbers) HHs have access to covered wells while 1% (317 numbers) HHs have access to un-covered wells. Moreover, 1% (491 numbers) HHs have access to hand pumps while 3% (1,891 numbers) HHs have access to tube wells/ boreholes. Over 0.1% (81 numbers) HHs have access to springs for their drinking water source and over 0.2% (113 numbers) HHs have access to rivers and canals for their drinking water sources. Over 1% (332 numbers) HHs have access to tanks/ponds and lakes for their drinking water source and 1% (620 numbers) HHs have access to other sources of water.

4.4.8.3 Kamarhati Municipality

As per the 2011 Census of India, over 90.6% of the housing structures in Kamarhati Municipality are permanent, 8.3% are semi-permanent, 0.5% are temporary, 0.2% are serviceable, 0.3% are non-serviceable and 0.6% are unclassified. The households in Kamarhati municipality have both open and closed systems of drainage. Moreover, there are 17,527 HHs with septic tanks while the toilets in 8,764 HHs have been listed as others.

Out of 62,773 HHs in Kamarhati Municipality, 93.7% (56,819 numbers) have drinking water access through taps from a treated source, while 2.5% (1567 numbers) HHs have access to tap water from an untreated source. 0.2% (154 numbers) HHs have access to covered wells while 0.4% (281 numbers) HHs have access to un-covered wells. Moreover, 0.3% (216 numbers) HHs have access to hand pumps while 1.4% (890 numbers) HHs have access to tube wells/ boreholes. Over 0.3% (213 numbers) HHs have access to springs for their drinking water source and over 0.2% (120 numbers) HHs have access to rivers and canals for their drinking water sources. Over 0.2% (139 numbers) HHs have access to tanks/ponds and lakes for their drinking water source and 0.6% (374 numbers) HHs have access to other sources of water. ***Table 4.32*** below presents the drinking water access for both Baranagar and Kamarhati Municipalities.

Table 4.32: 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
Baranagar	62,209	56,881	91.4	1230	2	253	0.4	317	1	491	1	1,891	3	81	0.1	113	0.2	332	1	620	1
Kamarhati	62,773	58,819	93.7	1567	2.5	154	0.2	281	0.4	216	0.3	890	1.4	213	0.3	120	0.2	139	0.2	374	0.6

Source: Census of India 2011

It is observed that majority of the housing structures at both Baranagar and Kamarhati Municipalities are permanent structures at 92.1% and 90.6% respectively, while only 70.6% of the housing structures at the district level are permanent structures.
Additionally, majority of the HHs at Baranagar and Kamarhati Municipalities have access to drinking water through taps from a treated source, at 91.4% and 93.7% respectively. However, at the district level, only 32.3% of the HHs have access to tap water from a treated source and over 40.2% HHs utilise handpumps, for their drinking water source.

4.4.9 Educational Facilities

4.4.9.1 Baranagar Municipality

As per the 2011 Census of India, Baranagar Municipality has 49 government primary schools, 33 government middle schools, 30 government secondary schools and 3 private secondary schools. The municipality also has 1 government Commerce College as well as 1 government arts, science and Commerce College, 1 government management institute and 1 government special school for disabled children.

4.4.9.2 Kamarhati Municipality

In Kamarhati Municipality, there are 97 Government Private Schools, 20 Government Secondary Schools, 19 private secondary schools, 21 government senior secondary schools, 2 government art science and commerce degree colleges, 2 private art science and commerce degree colleges, 1 government medical college.

4.4.9.3 Educational Facilities near STP Area

Is is observed that in Adharsh Nagar, ward number 35, there is a school, the Derozio Mission High School as well as a polytechnic institute, the Rama Mission Shilpapitha, which has appximately 700 students

4.4.10 Health Facilities

4.4.10.1 Baranagar Municipality

With regard to access to health institutions, the Baranagar Municipality has 1 hospital, 10 dispensaries/ health centres, 1 Family Welfare Centre, 1 Maternity and Child Welfare Centre, as well as 1 Maternity Home.

4.4.10.2 Kamarhati Municipality

Kamarhati Municipality has 4 hospitals, 3 dispensaries/ health centres, 1 Family Welfare Centre, 2 Maternity and Child Welfare Centre, as well as 1 Maternity Home.

4.4.11 Financial Institutions & Transportation

As per the 2011 Census of India, Baranagar Municipality has 20 nationalised banks, 5 commercial banks and 3 cooperative societies. Kamarhati has 13 nationalised banks.

4.4.12 Cultural and Historical Heritage

Baranagar is an ancient locality on the Eastern Side of the River Ganges and was originally a Portuguese settlement. It later became an important Dutch trading station and eventually ceded to the British in 1795. Baranagar is also associated with many great personalities such as Sree Ramkrishna Paramhansa, Swami Vivekananda and Rabindra Nath Tagore, among others. Additionally, the first Indian Statistical Institute was also established here, along with the Indian Ministry of Defence's famous gun shell factory. It was also the centre for extensive jute trade, where gunny bags were manufactured. The Dakshineshwar Temple is a Hindu temple founded in 1855 and located in Kamarhati Municipality, close to the banks of the Hooghly river. 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 Location

The potential areas 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, in Adharsh Nagar, ward number 35, there is a school, the Derozio Mission High School as well as a polytechnic institute, the Rama Mission Shilpapitha, which has approximately 700 students attending.

In the vicinity of the STP, there is a local market in Pramod Nagar, i.e. the Pramod Nagar market, situated near the Pramod Nagar auto stand.

The site assessments also revealed that there are overcrowded areas in the vicinity of the project site. Reportedly, there are approximately 25 HHs in the congested and compact area near Matkol Naskapara. At Pramod Nagar Market area, there are three congested areas, one with approximately 40 HHs, one with approximately 35 HHs and a sweeper's colony with approximately 26 HHs. Another congested area identified is in Indira Nagar, situated in ward 1 of Baranagar Municipality (***Figure 4.41***).

The study team were not able to examine if these congested locations are notified slums areas. Since there are no proposed renovation and upgradation works along these identified sensitive locations, the potential social impacts are negligable. 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 4.41 Potential Areas of Sensitivity near STP Location

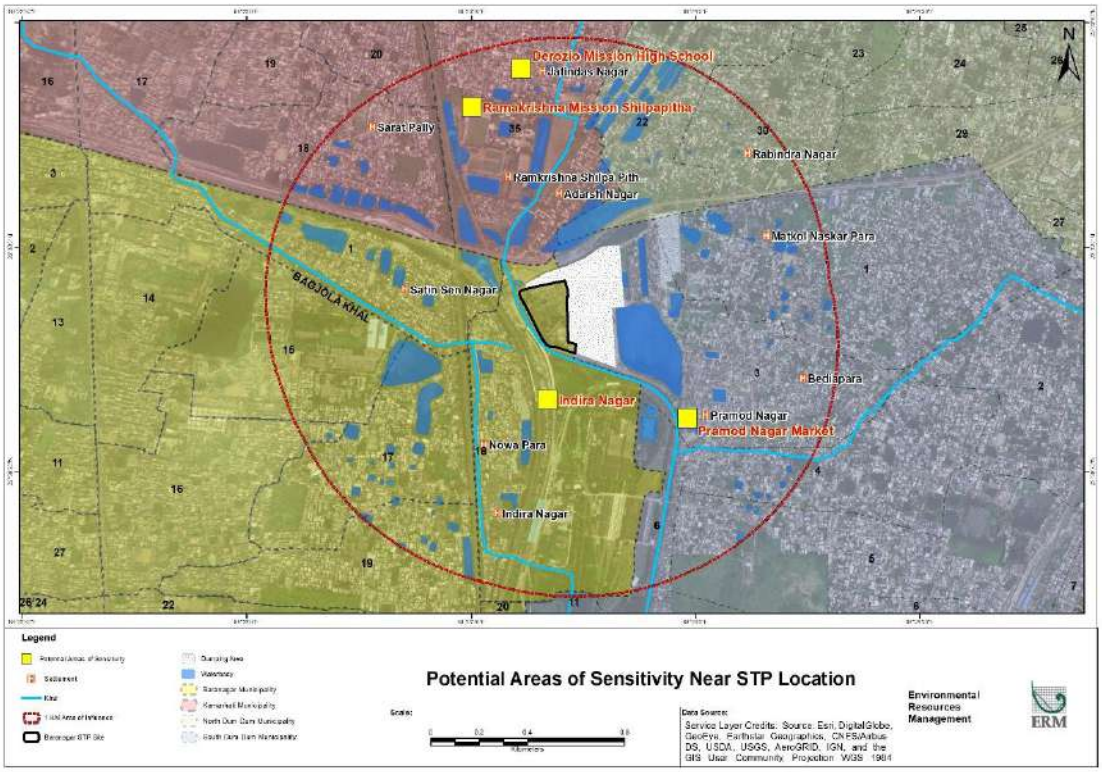
Congested area in Matkol, Naska Para, Pramod Nagar

Congested area near Pramod Nagar Market

Congested area near Pramod Nagar Market

Congested area near Pramod Nagar Market

Figure 4.42 Potential Areas of Sensitivity near STP Location



4.4.14 Potential Areas of Sensitivities along Sewer Lines

The potential areas of sensitivities along the sewer lines have also been identified, which include congested settlements. The laying of the sewer pipelines may potentially cause impacts such as access disruption and temporary income loss to receptors situated along the alignment of the pipes.

The 34B private bus terminal, a local market, and a daily morning market are located along the Gopal Lal Tagore road may potentially be affected by access disruption during the proposed pipeline works. Consultations revealed that there are approximately 25-30 bus parked at the bus terminal. Additionally, the replacement of gravity pipeline from the main pumping station from Dunlop to I&D structure number 2 in Anna Kali Devi Road may cause access disruption to the parking area of the e-rickshaws (toto) stand and cycle stand where approximately 40 to 50 drivers, are using the space for parking their rickshaws.

Moreover, at the daily market, there are approximately 30 vendors situated at GL Tagore Road, along the alignment where the gravity sewer line will be laid, therefore there is potential for temporary income loss for these vendors. Additionally, the replacement of the gravity sewer lines will take place at RN Tagare lane where approximately 23 squatter shops are situated. The laying of the new rising mains will be conducted from the MPS to the STP which will pass through Northern Park Road, where 2 shops and 1 temple are found near the MPS and 30 shops are located near the Additionally, the proposed work for replacement of sewer line may potentially impact the main entrance of the Ramakrishna Mission Ashrama School. A detailed analysis of these impacts are highlighted in Chapter 5, sections 5.5 and sub-sections 5.5.1 and 5.5.2.

Figure 4.43 Potential Areas of Sensitivities along Sewer Lines

Congested Area at Cycle Stand near I&D 2 Dakshineshwar Bus Stand and RKPD Road

Ramakrishna Mission Ashram School

34 B Bus Terminus along Gopal Lal Tagore Road, along Gravity Sewer Lane

Vendors at Morning Market, Gopal Lal Tagore Lane

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 which includes 25 households across the project footprint 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 4.44*** below.

The locations of the surveys and number of Project Affected Households (PAHs) among the surveyed HHs are presented in ***Table 4.34*** below. Six surveyed HHs are situated near I&D 1 structure at Hanuman Jute Mill Road, out of which one is a project affected household (PAH). Five surveyed HHs are situated near I&D 2 structure out of which three are PAHs. One surveyed HH which is also a PAH is situated near I&D 4 structure at Golighat. Two surveyed HHs are situated near the Main Pumping Station at Dunlop, Kamarhati; five surveyed HHs are situated near the rising main along Northern Park road, and three surveyed HHs are situated near Gopal Lal Tagore Road. Two surveyed HHs are situated in Neogi Para and one HH is situated near Bagjola Khal. Therefore out of the 25 surveyed HHs, six are PAHs.

The locations and number of participants in the stakeholder consultations are presented in Table 4.33 below. The stakeholder consultations were attended by 118 households.

Table 4.33: Locations of Surveyed Population

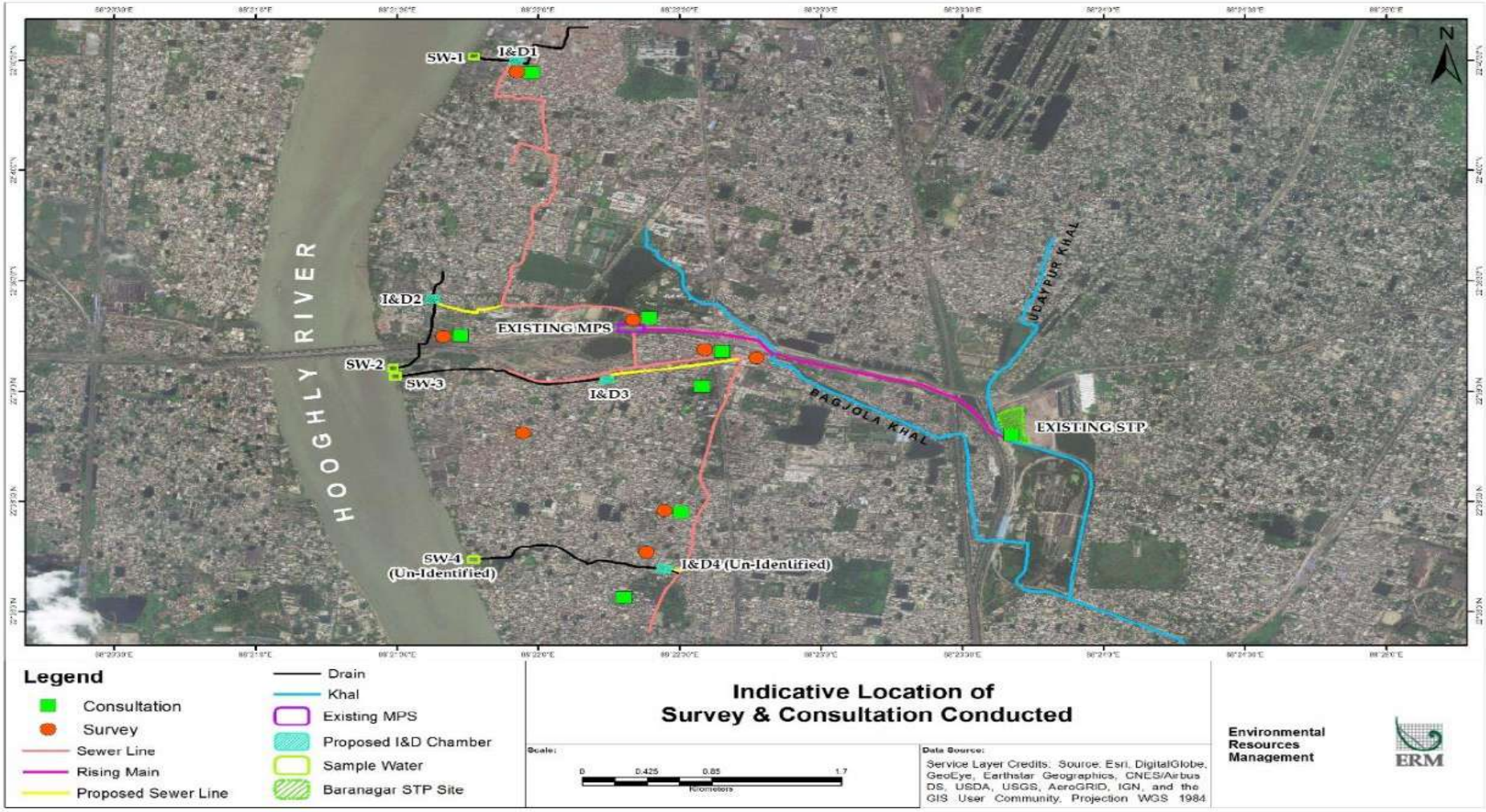
Component	Location	HHs Surveyed	Project Affected Households (PAH)
I & D 1	Hanuman Jute Mill	6	1
I&D 2	Tantipara (3) RKP Deb Road (2)	5	3
I&D 4	Goli Ghat	1	1
MPS	Dunlop, Kamarhati	2	-
Rising Main	Northern Park Road	5	-
Gravity Sewer Line	Gopal Lal Tagore Road	3	-
-	Neogi Para	2	-
-	Bagjola Khal	1	1
	Total	**25**	**6**

Table 4.34: Details of Stakeholder Consultations Conducted

Stakeholder Group	Location	Date	Number of Participants
Existing STP workers **(**contractual**)**	Baranagar STP	31st May 2019, 21st July 2019	4
Existing MPS contractual workers	Karmahati MPS	27th July 2019	5
Vendors at morning market	GL Tagore Road	24th August 2019	5
Teachers at Baba Sitaram Vidyapith Shiv Mandir High School and SPS Upper Primary High School	I&D 1, Hanuman Jute Mill Road	3rd August 2019	12
Baba Sitaram Vidyapith temple	I&D 1, Hanuman Jute Mill Road	3rd August 2019	1
Bus Operators at 34 B Bus Stand	34 B Bus Stand at GL Tagore Road	24th August 2019	2
Electric Rickshaw Drivers	Near Dakshineshwar Temple and Bus Stand	24th August, 2019	3
KMDA Officials	Unnayan Bhavan, Salt Lake	24th June 2019	8
Joint consultation with Existing Workers at Barangar STP and MPS, along with KMDA, VA Tech Wabag and ERM	Baranagar –Kamarhati MPS	16th September 2019	31
Information Disclosure Meeting with the officials of Baranagar Municipality and Ward Councilor to disclose about the KMDA project on the upgradation of the STP and sewerage system at Baranagar and Kamarhati Municipality	Baranagar Municipality Office	13th November 2019	8

Stakeholder Group	Location	Date	Number of Participants
Information Disclosure Meeting with the local community and affected person communities where the sewer pipeline replacement work would be undertaken and at I&D locations	RKPD Road, Baranagar Municipality	23th November 2019	11
Broad Community Support Consultation with the Affected person	G.L.Tagore Road, Baranagar	21st January 2020	26
Consultation with the local community residing in Railway Colony, RKPD Road	RKPD Road, Baranagar Municipality	18th February, 2020	5
Consultation with the local community residing near MPS	Baranagar –Kamarhati MPS	18th February, 2020	2
		Total	**118**

Figure 4.44 Locations for Primary Survey and Consultations Conducted



4.5.1 Family Size, Social Categorisation and Religion

The total 25 HHs surveyed constitutes a total population of 91, out of which 58% (53 numbers) are males and 42% (38 numbers) are females. **Table 4.35** below presents the family details and the social categorization of the HHs surveyed. The average family size of the 25 HHs is 3.6. 28 % (7 numbers) HHs belong to the Scheduled Caste category and 72% (18 numbers) HHs belong to the General category. None of the HHs belong to the Scheduled Tribe (ST) and Other Backward Classes (OBC) category.

Table 4.35: Family Details and Social Categorization

Location	Total HHs	Average Family Size	Social Categorization			
			Gen	%	SC	%
Baranagar	25	3.6	18	72%	7	28%

Source: ERM socio-economic survey

Table 4.36 below presents the religious affiliation of the households considered under the primary survey; 92% (23 numbers) of the surveyed HHs are Hindu while only 8% (2 numbers) HHs are Muslim.

Table 4.36: Religious Affiliation of the Surveyed Households

Location	Hindu		Muslim		Total
	No.	%	No.	%	
Baranagar	23	92%	2	8%	25

Source: ERM socio-economic survey

4.5.2 Age and Sex Composition

Out of the 91 persons, over 58% (53 numbers) are male and 42% (38 numbers) are female. The age category with the highest frequency is between ages 19 to 60 i.e. 75% (68 numbers), followed by age 60 and above i.e. 11% (10 numbers). 5% (5 numbers) are below the age of 6 and 7% (6 numbers) are between ages 7 and 14.**Table 4.37** below highlights the sex composition while **Table 4.38** below highlights the age composition.

Table 4.37: Sex Composition of the Surveyed Persons

Location	Male		Female		Total
	No.	%	No.	%	
Baranagar	53	58%	38	42%	91

Source: ERM socio-economic survey

Table 4.38: Age Composition of the Surveyed Persons

Location	<=6		07 to 14		15-18		19-60		>60		Total Persons
	No.	%	No.	%	No.	%	No.	%	No.	%	
Baranagar	5	5%	5	5%	2	2%	67	74%	12	13%	91

Source: ERM socio-economic survey

4.5.3 Education Profile

Over 19% (17 numbers) of the surveyed population are illiterate, while 23% (21 numbers) have completed their primary education. Moreover, 22% (20 numbers) have completed their secondary

education and 31% (28 numbers) have completed their higher education. Around 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. 23%, as compared to the district level (22%), as well as at Baranagar Municipality (14%) and Kamarhati Municipality (18%). Moreover, over 22% of the surveyed population have completed their secondary education, which is higher than the district level (11%) as well as at Baranagar Municipality (17%), and Kamarhati Municipality (16%). Over 31% of the surveyed population have completed their higher education, which includes graduates. However, over 35% of the population at Baranagar Municipality and 29% of the population in Kamarhati Municipality have completed their higher education which includes higher secondary and graduate education.

Table 4.39 below presents the literacy profile of the surveyed population.

Table 4.39: Education Profile of the Surveyed Persons

Location	Illiterate		Primary Education		Secondary		Higher		Not School Going Age		Total Persons
	No.	%	No.	%	No.	%	No.	%	No.	%	
Baranagar	17	19%	21	23%	20	22%	28	31%	5	5%	91

Source: ERM socio-economic survey

4.5.4 Occupational Profile

The table (**Table 4.40**) below presents the occupational patterns. Out of 91 surveyed population, 28 individuals are presently working. Over 50% (14 numbers) of the surveyed population are shop owners out of which 13 are male and 1 is female. The shops include clothing shops, a cosmetics shop and a meat shop. 18% (5 numbers) are engaged in daily labour, out of which one is female and 4 are male. 14% (4 numbers) are running tea stalls and all are male. 11% (3 number) is engaged in private service, out of which 1 is female and 2 are male. 7% (2 numbers) are engaged in other activities which include working as driver who is a male, and as a female domestic worker. In addition, two tea stall owners are also engaged in daily labour as their secondary occupation. As per the household survey conducted as part of the SIA, out of the 28 surveyed population, approximately 2 shops will be potentially impacted on account of the project activities.

Table 4.40: Occupational Patterns

Location	Daily Labour		Food & Tea Stall		Shop Owner		Private Service		Other		Total Persons
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	
Baranagar	1	4	0	4	1	13	1	2	1	1	28
Total	5		4		14		3		2		
%	18%		14%		50%		11%		7%		

Source: ERM socio-economic survey

4.5.5 Workforce Participation

The working age is categorised between ages 19 and 60 and the table below presents the workforce participation of the working age population. Out of 91 surveyed individuals, 68 individuals are of working age i.e. between ages 19 and 60, and 23 indivduals 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 six 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 91, is 28 individuals, as reported in **Table 4.40** above.

Out of those 68 individuals of working age (between ages 19 and 60), 32% (22 numbers) are presently working and 68% (46 numbers) are presently not working. Out of the 22 working population, 82% (18 numbers) are male and only 18% (4 numbers) are female. However, out of the 46 individuals (18 males and 28 females) who are of working age (between ages 19 and 60) are presently not engaged in work.

Therefore, the majority of women from the surveyed population are not participating in the workforce. 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 4.41: Workforce Participation

Location	Yes- Total Working Population						No- Total non-working Population						Total Working Population
	Female		Male		Total		Female		Male		Total		
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Baranagar	4	18%	18	82%	22	32%	28	61%	18	39%	46	68%	68

Source: ERM socio-economic survey

4.5.6 Income Distribution Pattern

The monthly family incomes of the HHs are represented below. Out of the surveyed HHs, 76% (19 numbers) have an income between Rs. 5,000 and 10,000, 12% (3 numbers) have an income between Rs.10,001 and 20,000, 4% (1 number) has an income between Rs. 30,001 and above. Rs.100,000 is the highest income among the surveyed population. The **Table 4.42** below presents the monthly family incomes of the surveyed HHs. None of the surveyed HHs fall within the BPL category. [39]

Table 4.42: Monthly Income

Location	Rs. 5000-10000		Rs. 10001-Rs. 20000		Rs.20001-30000		Rs.30001 and above		Total HHs
	No.	%	No.	%	No.	%	No.	%	
Baranagar	19	76%	3	12%	1	4%	2	8%	25

Source: ERM socio-economic survey

4.5.7 Drinking Water & Electricity Access

All the HHs source their drinking water from tap water, supplied by the municipality and table below presents the drinking water access. 32% (8 numbers) have access to their own source of drinking water (individual connection) while 68% (17 numbers) share their drinking water source with other HHs (**Table 4.43**).

The survey also revealed that all of the 25 HHs have access to an electricity connection.

Table 4.43: Drinking Water Ownership

Location	Owned by the HH	Shared Source	Total HHs

[39] 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.

	No.	%	No.	%	
Baranagar	8	32%	17	68%	25

Source: ERM socio-economic survey

4.5.8 Sanitation

Table 4.44 below highlights the sanitation arrangement of the HHs; over 40% (10 numbers) of the HHs have septic tanks, 20% (5 numbers) have a sanitary water sealed toilet, 8% (2 numbers) have a sanitary non-water sealed toilet, 24%(6 numbers) utilise a public toilet and 8% (2 numbers) still practice open defecation.

Table 4.44: Sanitation Arrangement

Location	Open Defecation		Sanitary-Non Water Sealed		Sanitary Water Sealed		Septic Tank		Public Toilet		Total HHs
	No.	%	No.	%	No.	%	No.	%	No.	%	
Baranagar	2	8	2	8	5	20	10	40	6	24	25

Source: ERM socio-economic survey

4.5.9 Health

4.5.9.1 Access to Health Care Facilities

An analysis of the access to health care facilities reveals that 76 %(19 numbers) HHs access government hospitals while 16 %(4 numbers) indicated that they have access to private hospitals. 8% (2 numbers) indicated that they have access to both government and private hospitals (**Table 4.45**).

Table 4.45: Access to Health Care Facilities

Location	Private Hospital		Govt. Hospital		Both		Total HHs
	No.	%	No.	%	No.	%	
Baranagar	4	16	19	76	2	8	25

Source: ERM socio-economic survey

4.5.9.2 Problems with Chronic Health & Vector Borne Diseases

Only one HH indicated having a chronic health problem i.e. Thyroid. The rest of the HHs did not indicate having any chronic health problems (**Table 4.46**). None of the HHs indicated having faced any water and air borne diseases.

Table 4.46: Chronic Problems Faced

Location	Yes		No		Total HHs
	No.	%	No.	%	
Baranagar	1	4	24	96	25

Source: ERM socio-economic survey

4.5.10 Water Logging

Over 8% (2 numbers) of the HHs indicated waterlogging as a problem in their locality, while 92% (23 numbers) have no problems with waterlogging, which is presented in **Table 4.47** below. The two HHs that face waterlogging in their locality are both situated near I & D structure 2 location, near the Dakshineshwar Bus Stand. Consultation with the local community residing in railway colony near to RKPD road revealed that the residents have been facing waterlogging in the area during rainy season. The major reason being that the manholes located in the junction of the road stretches in RKPD is small in size and the water flow during rainy season is low, mainly because of clogging of the associated sewage pipeline. Thus water from the manholes overflows and causes water logged in the low areas around the neighbourhood of the railway colony of Dakhineshwar station. The situation worsen since the neighbourhood have no propoer drainage facilities, thus causes health problem such as Malaria and Dengue.

Table 4.47: Water Logging Problems

Location	Yes		No		Total HHs
	No.	%	No.	%	
Baranagar	2	8	23	92	25

Source: ERM socio-economic survey

4.5.11 Odour Emnating from STP Operations

Normal STP operation is an open to air phenomenon. Since the Baranagar STP is currently not functioning, any malodour felt in the site and immediate surrounding, cannot be correlated with the STP operations. Malodour can also be caused by malfunctioning of sewerage facilities such as sewer pipelines, I&D structures and pumping stations. For example, the accumulation or leakage of sewage within the sewerage network can cause spillage, which can in turn lead to malodour in an environment. Additionally, as highlighted in section 4.2.6.2 above, the Baranagar solid waste dumpyard adjacent to the STP, is also a source of odour in the immediate surrounding.

An analysis of the primary socio-economic survey conducted on the HHs situated along the sewer pipelines indicated that 12% (3 numbers) HHs reported as having experienced malodour in their surrounding, while 88% (22 numbers) did not report any such instance. One HH is situated near I & D 1 structure and two HHs are situated near the Baranagar Main Pumping Station (MPS) (**Table 4.49**).

Table 4.48: Odour during STP Operations

Location	Yes		No		Total HHs
	No.	%	No.	%	
Baranagar	3	12	22	88	25

Source: ERM socio-economic survey

4.5.12 Gender & Vulnerability

In the Baranagar project area, out of the 25 HHs, only one is a woman-headed HH located near I&D 1 structure location in Kamarhati, consisting of three members and having an approximate monthly income is Rs. 5000. The primary survey revealed that none of the HHs have any members who are living with any form of disability. [40]

[40] 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

Over 19% (17 numbers) of the surveyed population are illiterate out of which 10% (9 numbers) are women and 9% (8 numbers) are men. Over 23% (21 numbers) have completed their primary education out of which 11% (10 numbers) are women and 12% (11 numbers) are men. Only 22% (20 numbers) have completed their secondary education, with 8% (7 numbers) women and 14 % (13 numbers) men. Over 31% (28 numbers) have completed their higher education out of which 12% (11 numbers) are women and 19% (17 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 Baranagar STP and associated facilities reveal that all the workers are male workers. Therefore women are entirely unrepresented in the workforce.

Table 4.49: Gender Disaggregated Literacy Profile of Study

Location	Gender	Illiterate		Primary Education		Secondary		Higher		Not School Going		Total Persons
		No.	%	No.	%	No.	%	No.	%	No.	%	
Baranagar	Women	9	10%	10	11%	7	8%	11	12%	1	1%	38
	Men	8	9%	11	12%	13	14%	17	19%	4	4%	53
Overall		**17**	**19%**	**21**	**23%**	**20**	**22%**	**28**	**31%**	**5**	**5%**	**91**

4.6 Existing Manpower at Baranagar STP

This section presents the details of the existing manpower at the Baranagar STP and the Baranagar-Kamarhati MPS. Presently, there are two O&M agencies engaged at the Baranagar STP and Baranagar- Kamarhati MPS. M/s Kakinara Engineer's Workers Co-operative Society Ltd is engaged at the Baranagar STP and has a total of twenty (20) workers, while M/s Sunny Enterprise is engaged at the Baranagar-Kamarhati MPS and has a total of eleven (11) workers.

The STP and MPS facilities have been operational since 1996. The contractor M/s. Sunny Enterprise has been engaged as an O&M contractor at the Baranagar- Kamarhati MPS since 1996. However, the O&M agency at Baranagar STP has changed multiple times since 1996. From 1996 to 2011, the O&M contractor engaged was M/s. Neo Parisrutan Pvt. Ltd. and from 2011 to 2012, the O&M contractor engaged was M/s Roy Enterprise. M/s Kakinara Engineer's Workers Co-operative Society Ltd. has been engaged at the STP since 2012 and its contract was renewed again in 2016. The details of the O&M agencies engaged are presented in **Table 4.50** below.

Table 4.50: O&M Agencies at Baranagar STP & MPS

Baranagar STP	Time Period
M/s. Neo Parisutan Pvt. Ltd.	1996 to 2011
M/s. Roy Enterprise	2011 to 2012

consider factors such as gender, age, ethnicity, culture, literacy, sickness, physical or mental disability, poverty or economic disadvantage, and dependence on unique natural resources.

M/s. Kakinari Engineers Co-operative Society	2012 to 2016 2016 to Present
Baranagar – Kamarhati MPS	**Time Period**
M/s. Sunny Enterprise	1996 to Present

Source: Stakeholder Consultation with Workers on 16th 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[41], 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 one (1) worker Ms. Jiban Rudra who has been engaged at Baranagar-Kamarhati MPS was not included in the list, as he had recently joined the workforce. Another individual, Mr. Bishu Dholui had passed away during the month of August 2019, following which a new worker Mr. Babun Mondal had joined the MPS in his place. Additionally, one (1) individual Mr. Alok Adhikary, who is the Secretary of the Kakinara Engineers Co-operative Society, was incorrectly listed as a worker. Therefore there are a total of thirty-one (31) workers presently engaged at the Baranagar STP and Baranagar-Kamarhati MPS. The details of the existing workers and contractors are presented in **Table 4.51** below.

Table 4.51: Details of Existing Workers and Contractors

Project Facility	Location	Contractor	Manpower Involvement	Designation
Baranagar STP	Matkol, Baranagar	M/s Kakinara Engineer's Workers Co-operative Society Ltd.	20	Operators
Baranagar-Kamarhati MPS	Deshpran Shasmal road of Kamarhathi Municipality	M/s. Sunny Enterprise	11	Operators
Total			**31**	

Source: KMDA (List of Existing Manpower) & Stakeholder Consultation with Workers on 16th of September, 2019

As per the circular from the Labour Commissioner, Government of West Bengal, the minimum wage rate for workers employed in a manufacturing activity[42] 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.

As per the list made available by KMDA, it is highlighted that the workers at the MPS are earning Rs. 10,122 per month and the workers at the STP are earning Rs. 8,080 per month. Therefore as per the revised wage rate of the Government of West Bengal, the wages of the existing workers engaged in the STP facility are found to be below the minimum wage rate[43].

It is also mentioned that the workers are enrolled in the Employee Provident Fund (EPF) and Employee State Insurance (ESI) schemes, which was also confirmed during the site assessments and consultations. It was reported that no appointment letter has been issued to the workers the monthly

[41] Stakeholder Consultation with Workers of Baranagar STP and Baranagar-Kamarhati MPS on 16th of September, 2019

[42] As per the section 34 (m) factory means any premises whereon ten or more workers are working, or were working on any day of the preceding twelve months, and in any part of which a manufacturing process is being carried on with the aid of power. Section 34 k (ii) of the Factory Act, manufacturing process refer to pumping oil, water, sewage or any other substance

[43] 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.

payment of wages are disbursed through online bank transfer, and wage slips are provided to them. The site assessments and stakeholder consultations conducted with the workers further established that the workers have been working at the sites for over 25 years; this information was not represented in the KMDA list. The workers are employed 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 and Safety (H&S) and they were not utilizing any Personal Protective Equipment (PPE).

The stakeholder consultation with the workers, O&M agency M/s Kakinara Engineer's Workers Co-operative Society, indicated that in the event of early termination of the contract by KDMA, they will abide by the condition of "premature cessation of contract" under their O&M contract, whereby they will be expected to close their activities within three working days. O&M agency M/s Kakinara Engineer's Workers Co-operative Society also specified that they will clear all their dues related to wages, ESI, PF, gratuity (as applicable) and further stated that they will not have any legal liability towards the existing contractual workers, as per their contract. Representative from KMDA, an Assistant Engineer, also affirmed that there is no legal liability stipulated in the O&M contract agreement, with the various O&M agencies regarding the engagement of skilled or unskilled workers. KMDA representative however indicated that while formulating any O&M contract agreement with the different agencies for the STP and linked infrastructure, as Principal Employer, their first priority will be towards re-engaging the existing workers, into the new O&M agencies wherever feasible, out of humanitarian grounds.

4.6.1 *Contract Agreement between KMDA and Contractor*

The agreements between KMDA and O&M agencies M/s Kakinara Engineers' Cooperative Society Ltd and M/s Sunny Enterprise have been shared with ERM. This section is thus a summary of the contract agreements. Based on the review of the contracting arrangement between KMDA and the respective manpower supply contracting agencies, it is observed that KMDA has assigned the compliance liability against all applicable labour regulations which include:

- Minimum Wages Act, 1948;
- Workmen's Compensation Act, 1923;
- Employees State Insurance Act, 1948;
- Employees Provident Fund and Miscellaneous Provisions Act, 1952;
- Contract Labour (Regulation and Abolition) Act, 1970;
- Payment of Bonus Act, 1965;
- Payment of Wages Act, 1932;
- Payment of Gratuity Act, 1972;
- Employee Liability Act, 1938;
- Industrial Dispute Act, 1947;
- Maternity Benefit Act, 1961

The agreement also specfies that this is applicable to the rules, orders and notifications issued under those enactments as well as all other Acts/Rules/Regulations at present or applicable in the future.

In the event there is non-compliance and/ or violations on behalf of the contractors, in terms of provision of the amenities as mandated in the various Labour Laws, the Contractors, KMDA and the principal employers become liable for the acts of omission and commission by the contractors.

The agreement also specifies that in the event of any violation of the various Labour Laws, the contractors should ensure that the KMDA is duly indemnified against all losses, damages, cost, charges, penalties, suits or proceedings which the KMDA may be subjected to (Clause 1).

The agreement further mandates the contractors to maintain proper attendance records of their workers, pay the Employee State Insurance (ESI) and Provident Fund (PF) contributions of both the employer and employee within the statutory period to the respective authorities, without any default. Additionally, it is also specified in the agreement that the Contractor should pay the wages of the workers which should not be below the minimum rate of wages and should also be paid on time. (Clause 2).

It is also specified that in order to ensure compliance, the contractor should allow the KMDA authorities to examine the registers, returns as well as provide them with a copy of the pay sheet for ascertaining the exact payment of wages, ESI and PF contribution, including other statutory payments made (Clause 4).

4.6.1.1 Compliance of Contractor Obligations

The agreement specifies that in the event KMDA observes non-compliance on behalf of the contractor, with regard to payment of wages, payment of PF and ESI contributions, minimum wages, payment of bonuses etc., the KMDA is authorized to withhold the payment to the contractors, until all obligations are met (Clause 5).

Additionally, the agreement specifies that the KMDA is authorized to recover any dues which include interest damages payable by the contractor to the labourers employed by them as well as amounts on account of P.F and ESI contribution damages. This also includes interest on losses, damages, costs, charges, expenses and penalties or dues in any other contracts with KMDA, including the security money. (Clause 6)

The agreement further specifies that in the event of non-compliance on the provisions of the Employees State Insurance Act, Employees Provident Fund and Miscellaneous Provisions Act, Minimum Wages Act, Payment of Bonus Act and other Acts with rules, regulations and notifications, the contractor should adequately compensate KMDA against all losses, damages or claims suffered by KMDA, either directly or indirectly. Additionally, KMDA is authorized to deduct from any amounts payable to the contractors, as a consequence of any claim demand, cost interest charges made by the statutory authorities appointed under those Acts (Clause 8).

4.6.1.2 Other Conditions of Contract

The ‘General Rules and Directions for the Guidance of Contractors’ document of the KMDA has further laid down certain conditions of contract in relation to labour. It is specified that in the event KMDA is obliged to pay compensation to a workman employed by the contractor, under the provisions of Workmen’s Compensation Act, 1923, KMDA will recover from the contractor the amount of the compensation paid through deduction from the security deposit or any sum due by the KMDA 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 contract agreement also specifies a section on the premature cessation of contract, whereby KMDA may prematurely terminate the contract of the O&M agency by giving a minimum of three (3) 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 Baranagar. 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:

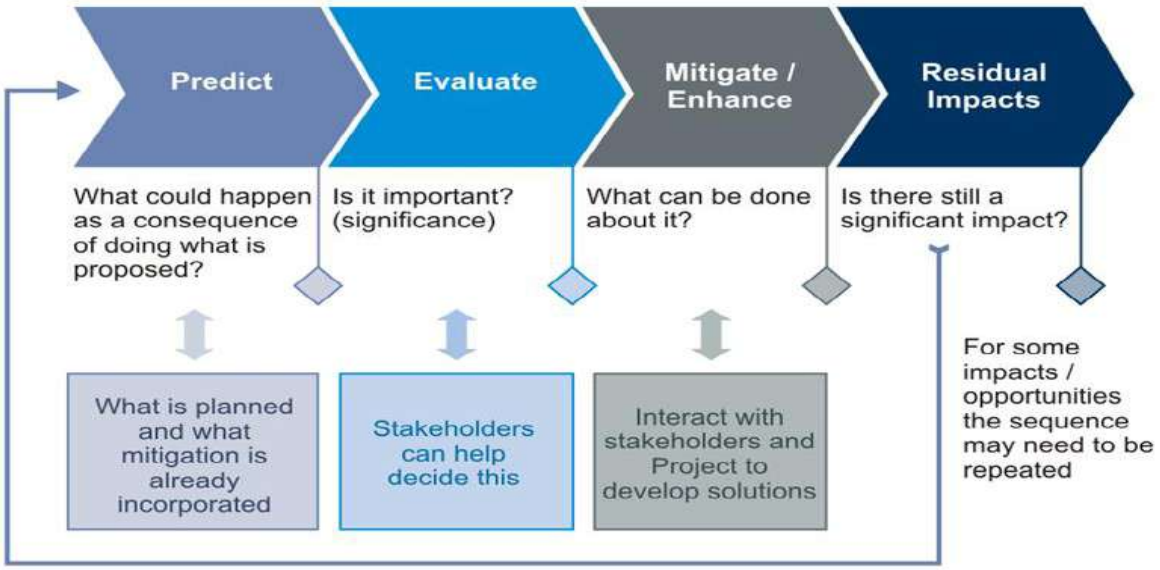
- Project site information (*as outlined in **Section 2***)**;**
- Baseline information (*as outlined in **Section 4***).

5.2 Impact Assessment Methodology and Approach

The identification of likely impacts during decommissioning, 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 associated activities;
- **Impact evaluation**: to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource/receptor;
- **Mitigation and enhancement**: to identify appropriate and justified measures to mitigate negative impacts and enhance positive impacts;
- **Residual impact evaluation**: to evaluate the significance of impacts assuming effective implementation of mitigation and enhancement measures.

Figure 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 associated 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	■ Project site and the entire study area i.e. beyond Project influence area.	National

Impact Elements	Criteria	Ranking
of impact due to a project and related activities	■ 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
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. 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 associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

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 associated Project components remain in conformance with applicable standards; and b) mitigation measures are effectively addressing impacts and compensatory measures and offsets are reducing effects to the extent predicted.

Environmental Management Plan summarises all actions (including mitigation/enhancement and compensatory measures) which the Project Proponent has committed to executing with respect to environmental/social/ health performance for the Project, is also included as part of the 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) associated with the Project have been considered with respect to their potential to interact with environmental and social resources or receptors. In addition to the project components like 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 Baranagar 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. De-Commissioning Phase																								
Land preparation (cleaning and grading)	■		■	■		■					■					■			■					■
De-watering from existing structure (clarifiers, Sludge digester, etc.)	■		■				■									■			■					
On-Site removal and storage of sludge/silt form existing structures	■				■											■			■					■
Off-Site disposal of removed sludge/silt	■		■		■		■									■			■					■
Mobilization and operation of earthmoving equipment				■	■											■			■					■
Dismantling of existing electro-mechanical equipment					■											■			■					■
Demolition of existing concrete structure (primary settling tank, sludge digester, biogas holder, etc.)	■		■	■	■	■	■									■			■					■
Operation of DG sets (standby)				■	■											■			■					

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
Use of water for fugitive dust suppression during decommissioning activities			■	■		■	■			■						■			■						
On-Site storage of demolition waste			■	■		■	■									■			■						■
Off-Site disposal of demolition waste			■	■		■	■				■					■			■						■
II. Construction Phase																									
Mobilization and Operation of earthmoving equipment				■	■						■					■			■			■			■
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					■											■			■						■
Installation of electro-mechanical equipment																■			■						■

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
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	■					■					■					■									■
Off-Site disposal 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
Dismantling of Electro-Mechanical equipment at linked facilities (MPS, I&D 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)			■	■			■				■					■									■
III. 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				■												■									■
Hazardous and Non-Hazardous			■			■										■									■

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
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 Baranagar 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 associated to above mention have been assessed and respective mitigation measures have be analysed further in this section.

5.4.1 Visual and Aesthetics

De-Commissioning and Construction Phase

Visual and Aesthetics

The proposed facility will be developed by clearing the structures of existing STP viz., aeration tank, primary clarifiers sludge digesters etc. During this phase multiple activities will be undertaken within the STP complex starting mobilization of construction and demolition equipment, de-commissioning of existing STP structures followed by demolition of the structures. 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 are generally 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 or the structure. Since the site has unique location advantage which results in low or negligible impact on surrounding receptors. As per the ***Figure 5.3*** , line of vision for residents of Satin Sen Nagar(115 m, West) is blocked by already developed green belt on west boundary, which is backed by overhead metro railway construction starting from Nowapara station which is at an height ~5-8 m. If we consider the residents of Adarsh Nagar (150 m, north) are separated by Belghoria Expressway at a height ~5-8 meter blocking the line of vision. For resident of Promod Nagar(270m, East), Baranagar dumpyard is the immediate feature blocking the line of vision due to its huge size (~20 m) and area (~20 acres). Lastly on southern direction there is under-construction metro rail yard having its own green belt as well as presence of natural full grown trees beyond the boundary. The only visual and aesthetic impact which is envisaged during this project may arise due transportation construction and demolition waste through trucks, tippers and dumpers. Thus overall impact for this phase Minor.

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

Figure 5.3 Local Site Setting

Figure 5.4 Present Scenario of Baranagar STP Location

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

- All the construction and demolition 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	**Potential Impact on Visual Aesthetics during Decommissioning 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. Though the line of vision for receptors on all four side are blocked due to existing external and internal

structures (as discussed in de-commissioning and construction phase), still Baranagar dumpyard will be a standout for all the receptors within the area of influence due to its magnitude of operation.

Figure 5.5 View of Baranagar Dumping Ground from STP complex

5.4.2 Ambient Air Quality and Odour

As discussed in the baseline section, the area in the immediate vicinity of the STP site has a local level issue with regard to fugitive emissions from uncontrolled open burning of municipal solid waste ocuuring in the adjacent Baranagar waste dumping ground. Such landfill fires are common in open garbage dumps, where no inert daily or intermediate cover which results in air intrusion provides the oxygen required for increased biological activity decomposition, in the process creating substantial heat and causing the wastes in the landfills to spontaneously combust. Such surface fires are quite commonly noticed in improperly managed garbage dumps across this part of the country. Emissions from such open burning of wastes are known to comprise of particulate matter (PM) and a variery of combustion products including carbon monoxide, oxides of sulphur and nitrogen, hydrogen sulphide, volatile organics and potentially dioxin and furan in trace quantities. Other sources of air pollution in the area include vehicular emissions from the highway, fugitive emissions from construction sites and point sources emissions from SME industries in the area. As a result, the potential air quality impacts that may be caused by different phases of the project would be considered in light of the incremental deterioration that they may cause to the air quality in relation to existing baseline. In addition, assessment of potential odour related impacts from the operation of the STP would also be covered in this section.

De-Commissioning and Construction Phase

During this phase major source of emissions would be fugitive dust emissions from demolition of concrete structures, storage and handling of construction and demolition 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 dumpyard along the eastern boundary which is spread across ~22 acres with a height ~20 m generating fugitive emissions due the surface fires. On southern boundary, the metro railway yard construction work and on western boundary overhead Metro railway corridor construction resulting in fugitive emissions from these sources. Comparing the nature of operation and duration of these sources of fugitive emissions within the influence area of STP, the magnitude of fugitive emissions from construction and demolition phase of STP impacting the receptor will be minor in nature adding up to the baseline condition (***refer section 4.2.7***).

Another set of activities affecting ambient air quality is vehicular emissions due to movement of trucks carrying construction material, mobilization of construction and demolition equipment. Estimated movement of trucks per day for delivering construction material and removal of construction waste ~10 PUC/day. The site has Belghoria expressway on northern side based on traffic monitoring (***refer section 4.2.13***) which high flow of vehicle and exhaust emission within the area STP is high.

All actives during construction and demolition phase will be carried using connection from electricity grid and portable DG sets 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 due construction and demolition phase will have negligible impact on the air quality of the surrounding and radial spread is will not be more than ~200-250 m which less compared to distance of immediate receptor from STP site.

Embedded Control Measures: The following measures have been incorporated as a part of the project costruction plans-

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

Anticipated impact scenarios mentioned above will be short-term and will exist during de-commissioning and 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.

Mitigation Measures:

The proposed mitigation measures are as follows:

- The construction materials and demolition 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 demolition 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 and decommissioning 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.

Impact Significance	**Air Quality Impact during decommissioning and 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

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[44] 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[45].

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

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

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

Table 5.5: Emission Charecteristics from the Proposed Plant

Source of stack	No. of stack	Stack Height (m)	Stack Internal Diameter (m)	Gas exit velocity (m/s)	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***) will not result in minor alteration in the existing baseline conditions and is unlikely to contribute to any exceedance of NAAQS (NOx – 40 µg/m^3; CO – 2 mg/m^3; VOC as Benzene – 5 µg/m^3) levels or WHO Ambient Air Quality Guidelines [NOx – 40 µg/m^3; CO – no mention; VOC – no mention]. 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 GLC Values

Pollutants	24 Hourly Maximum GLC (µg/m^3)	Distance from Source	Direction
Source – emission from stack attached to Biogas Engine			
NOx	1.62	260	West
CO	3.63	260	West
VOC	2.61	260	West
Source – emission from flare stack			
NOx	1.06	360	West
CO	0.10	260	West
VOC	0.06	360	West

Overall incremental impact on the ambient air quality due to the STP operation, taking into account exisiting air quality and neighbourhood sources causing air pollution, can be considered of ***Minor*** significance.

Figure 5.6 NOx Isopleths of stack connected to Engine

(24 Hourly Maximum Ground Level Concentrations)

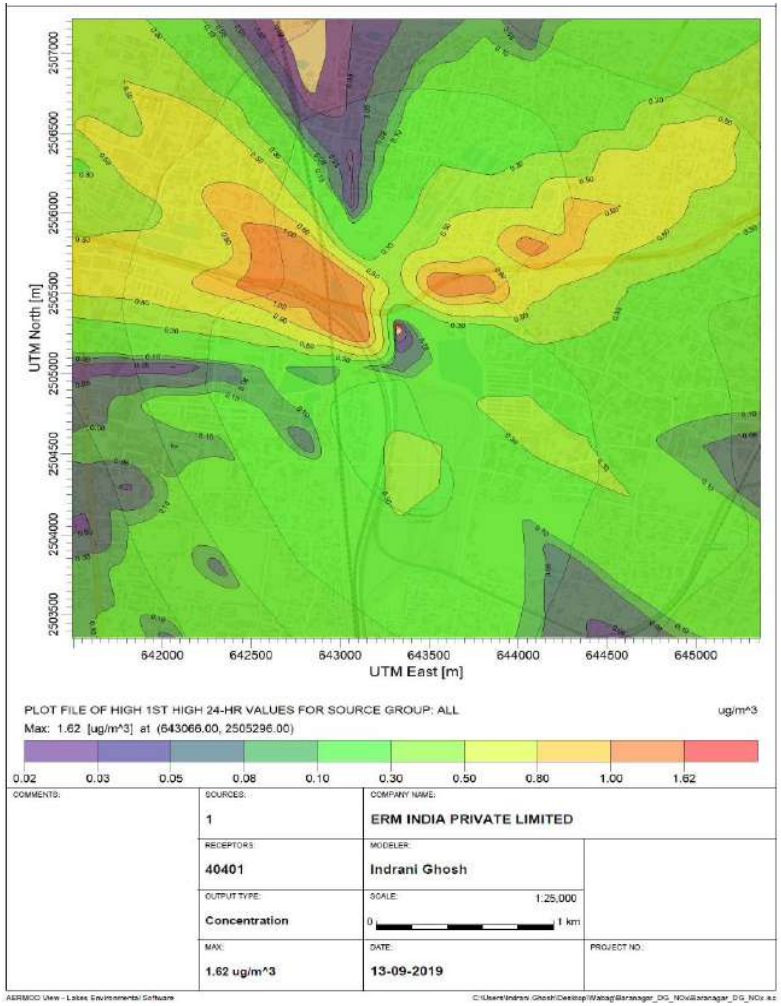


Figure 5.7 CO Isopleths of stack connected to Engine

(24 Hourly Maximum Ground Level Concentrations)

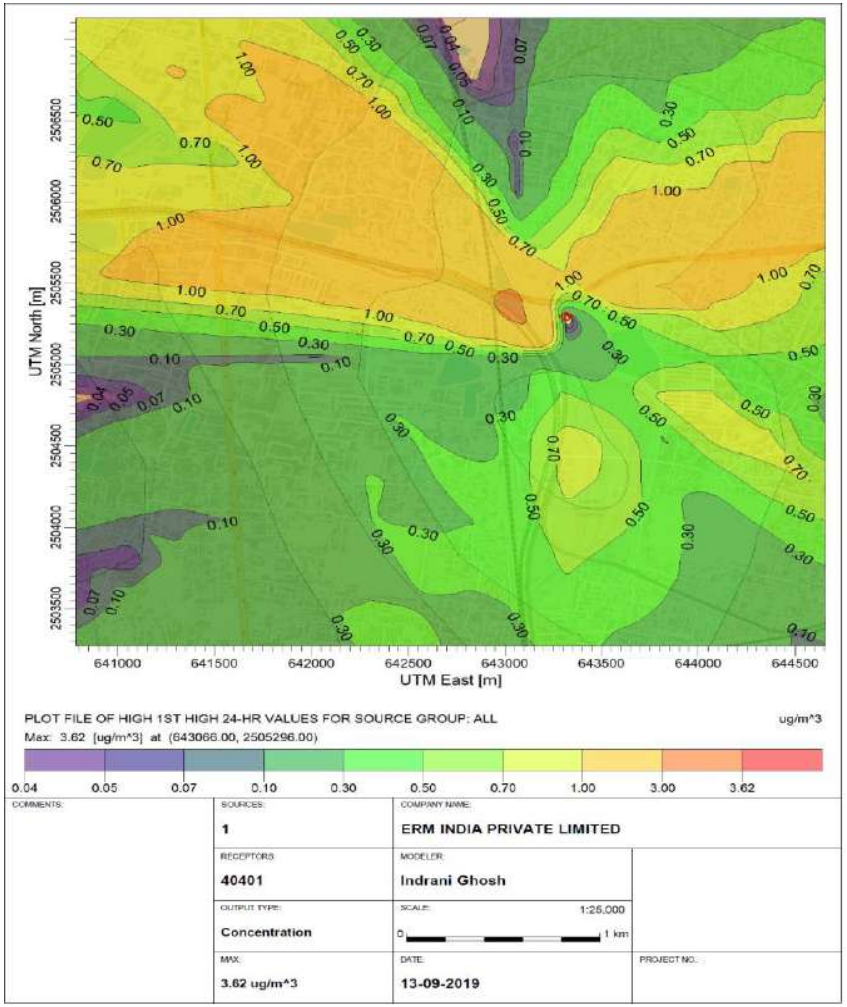


Figure 5.8 VOC Isopleths of stack connected to Engine

(24 Hourly Maximum Ground Level Concentrations)

Figure 5.9 NOx Isopleths of flare stack

(24 Hourly Maximum Ground Level Concentrations)

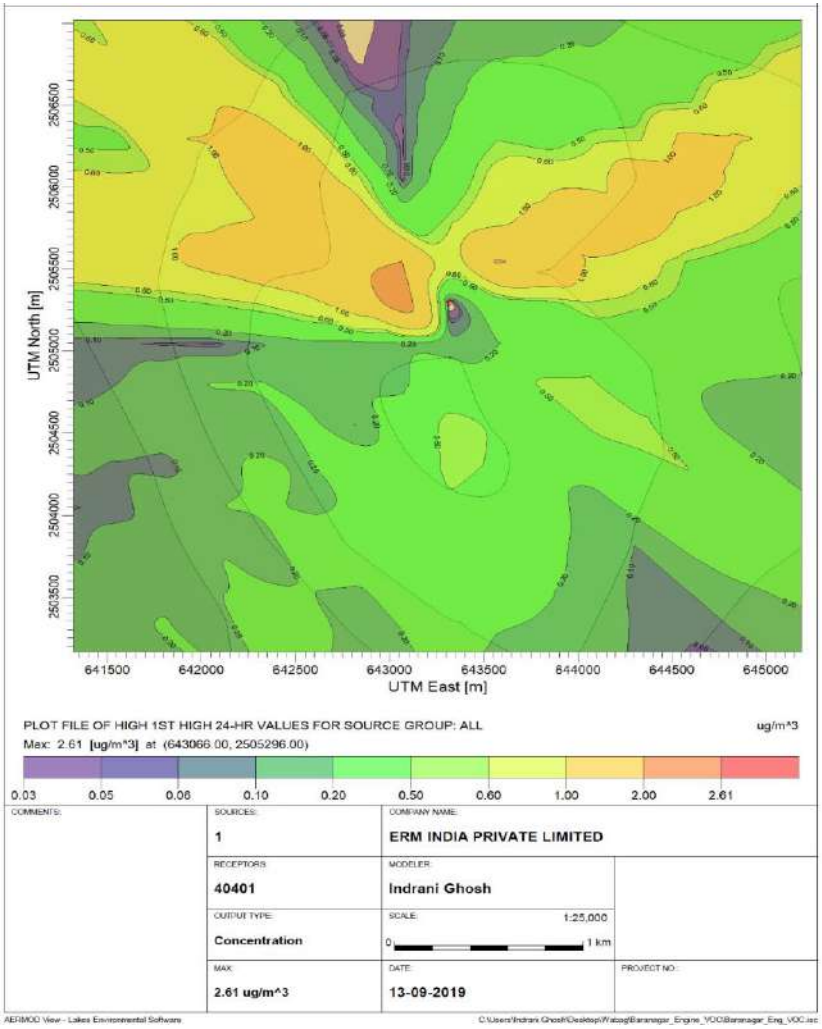


Figure 5.10 NOx Isopleths of stack connected to Engine

(24 Hourly Maximum Ground Level Concentrations)

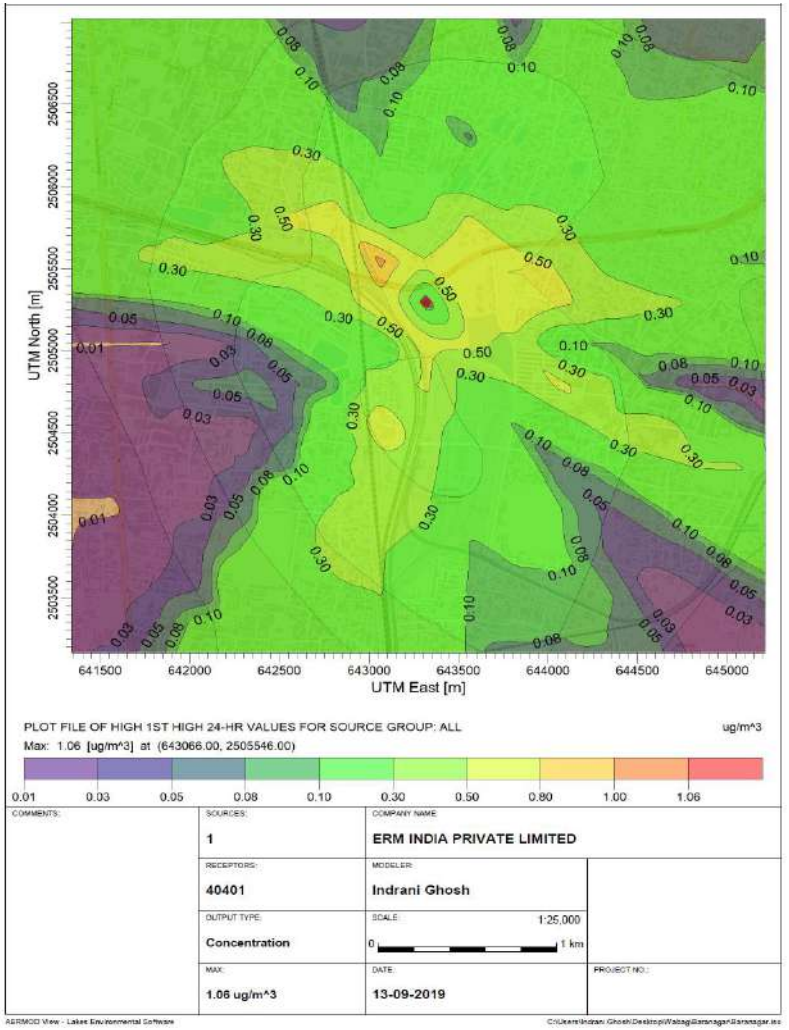


Figure 5.11 CO Isopleths of stack connected to Engine

(24 Hourly Maximum Ground Level Concentrations)

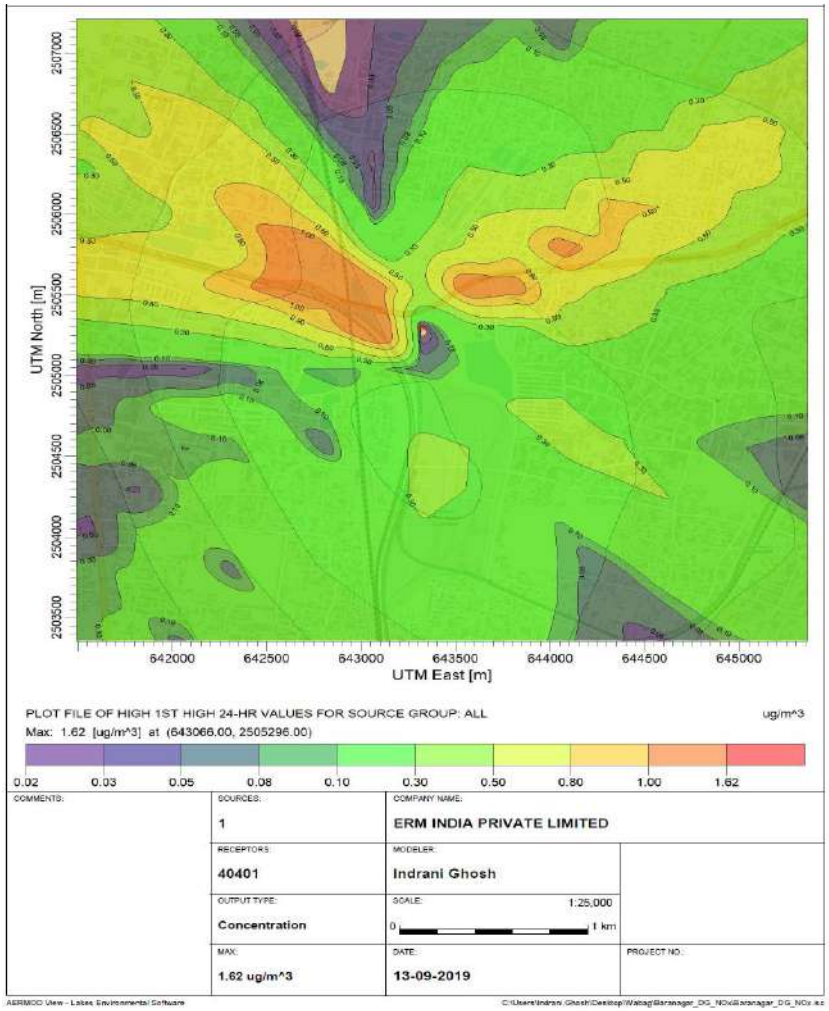


Figure 5.12 CO Isopleths of flare stack

(24 Hourly Maximum Ground Level Concentrations)

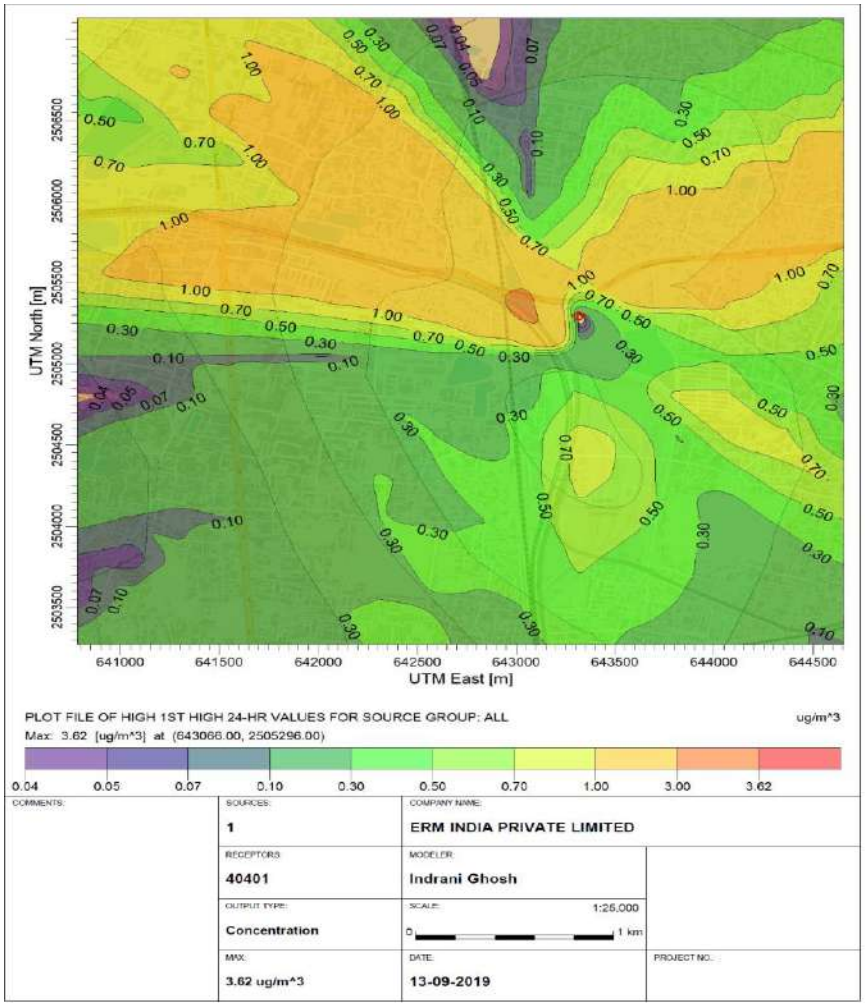
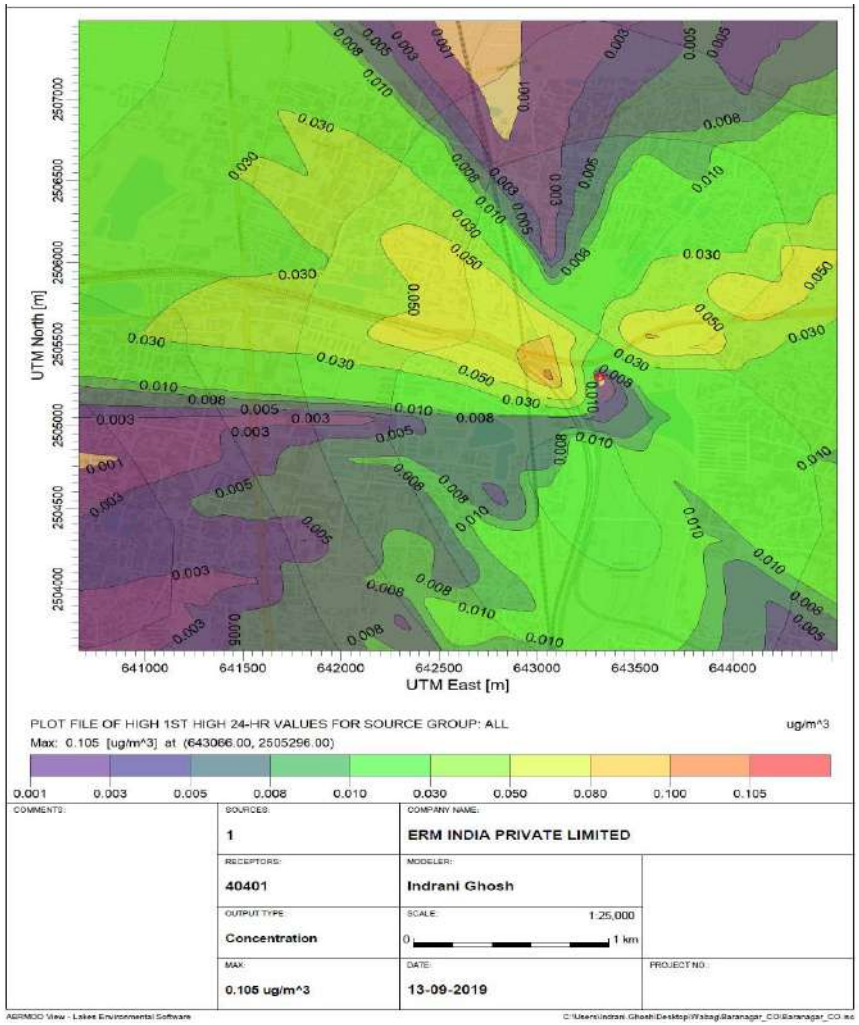
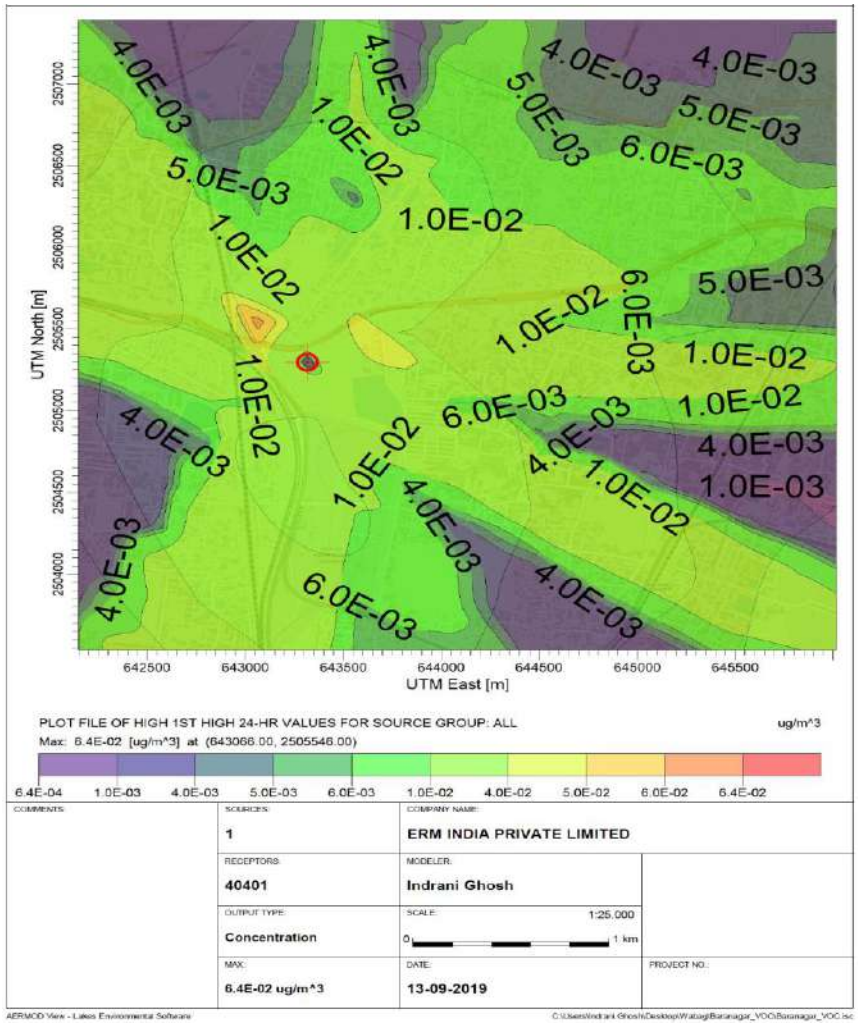


Figure 5.13 VOC Isopleths of flare stack

(24 Hourly Maximum Ground Level Concentrations)


UTM North [m]
UTM East [m]
PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: ALL
ug/m^3
Max: 0.105 [ug/m^3] at (643066.00, 2505296.00)
0.001 0.003 0.005 0.008 0.010 0.030 0.050 0.080 0.100 0.105
COMMENTS:
SOURCES: 1
COMPANY NAME: ERM INDIA PRIVATE LIMITED
RECEPTORS: 40401
MODELER: Indrani Ghosh
OUTPUT TYPE: Concentration
SCALE: 1:25,000
MAX: 0.105 ug/m^3
DATE: 13-09-2019
PROJECT NO.:
AERMOD View - Lakes Environmental Software


UTM North [m]
UTM East [m]
PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: ALL
ug/m^3
Max: 6.4E-02 [ug/m^3] at (643066.00, 2505546.00)
6.4E-04 1.0E-03 4.0E-03 5.0E-03 6.0E-03 1.0E-02 4.0E-02 5.0E-02 6.0E-02 6.4E-02
COMMENTS:
SOURCES: 1
COMPANY NAME: ERM INDIA PRIVATE LIMITED
RECEPTORS: 40401
MODELER: Indrani Ghosh
OUTPUT TYPE: Concentration
SCALE: 1:25,000
MAX: 6.4E-02 ug/m^3
DATE: 13-09-2019
PROJECT NO.:
AERMOD View - Lakes Environmental Software

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 decompistion 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 sulfur and nitrogen content. Other byproducts of such decomposition process may comprise of highly odourous componds like mercaptans, organic sulfur 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 primary clarifier, secondary clarifier, aerated grit separator, activated sludge treatment section, digestor feed pump and digested sludge pump[46];

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 uncharacterised 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
Aeration Grit Chamber	86.54	20000	5.56	480.81
Digester Feed Sump	8.03	35000	9.72	78.15
Digested Sludge Sump	11.33	16000	4.44	50.38

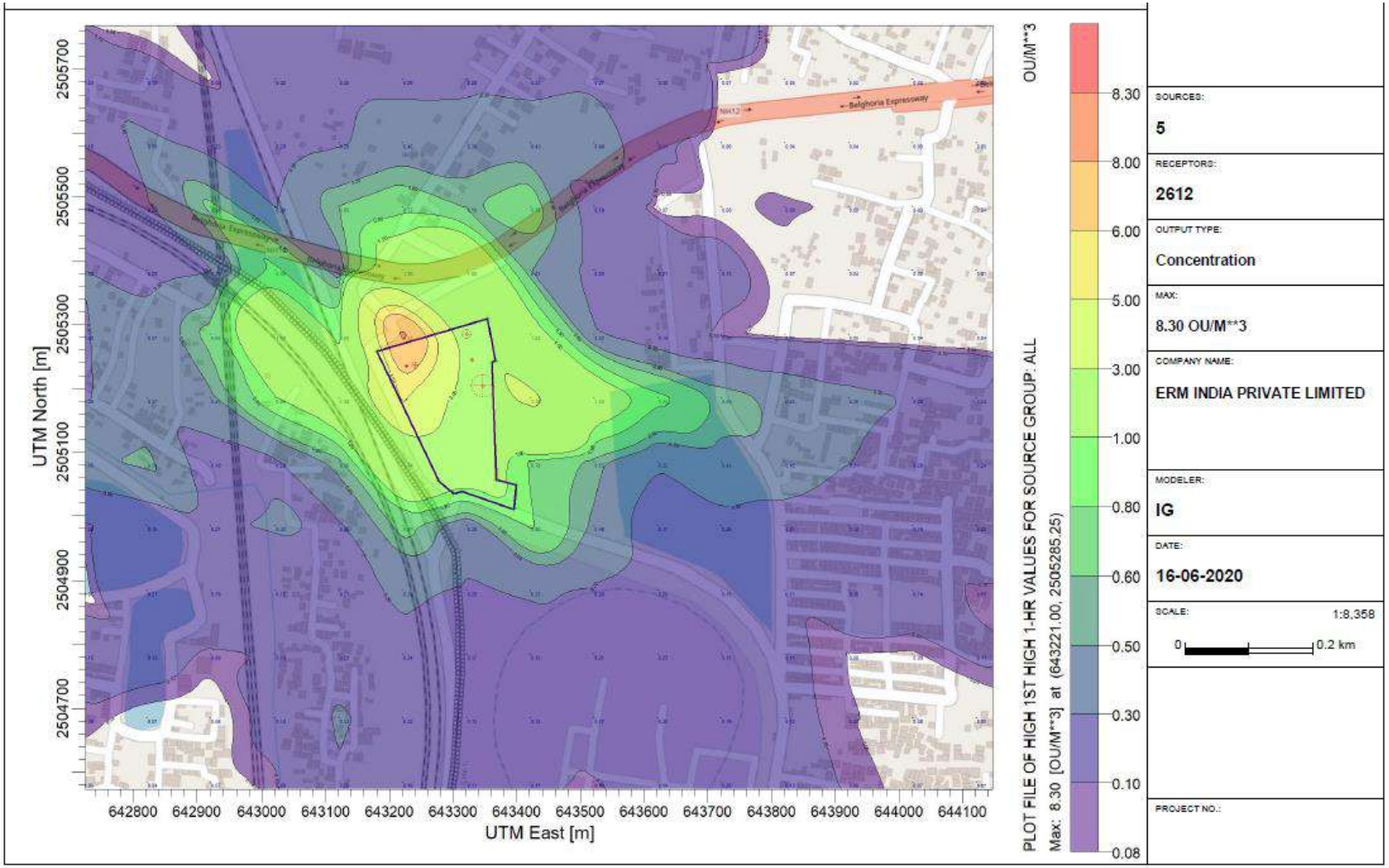
- One season's meteorological data has been complied based on near site secondary data available and used for the use in the predictive modelling exercise. Given that the terrain is flat, and the proposed buildings and structures are not very high, no terrain data or building wake effects have been considered in the model run.

[46] [1] Gostelow, P., Parsons, S., Stuetz, R. (2001). Odour measurements for sewage treatment works. Water Research, 35(3), 579–597.
[2] http://www.epa.ie/licences/lic_eDMS/090151b28023d02f.pdf

- 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 odour emissions.

Figure 5.14 Odour Concentration Contours around the Cource of Emissions



The dispersion of odour concentrations based on emissions from source of origin shows that the highest concentrations 28.31 OU/m^3 at a point located within 50 m from the source. At the point where the nearest receptors (~250 m) are present as also the infrastructure corridors (railway line and highway), the odour concentrations fall to values in the range of 1.00 OU/m^3 or lesser. In addition, the sensitivity of the site and its immediate vicinity can be considered to be relatively low because of prevailing high odour levels caused by the Baranagar waste dump and the Udaypur canal as also low population density in the immediate surroundings with no residential area within 500 m of the site. 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. It is also anticipated that the odour from the STP will be masked sufficiently by the existing larger odour sources (garbage dump and Udaypur canal) and no incremental adverse odour impacts will be caused by the operation of the STP. However, 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 from grit screen of I&D structures, along the roadside. Duration of temporary storage may be up to 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

As discussed in the baseline section, 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 in the Baranagar dumping grounds and 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 mdoelling:

$SPL_{(R2)} = SPL_{(R1)} – 20 \log R2/R1 – Ae - Aabs;$

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)
i. Construction Phase			
Wheeled loader	80	Concrete Mixer	84
Tracked loader	82	Batching Plant	78
Dozer	81	Pneumatic Drill	95
Excavator	85	Compressor	70
Dumper	89	Diesel Generator set	75
Grader	83	Hand-held pneumatic rock drill	90
Pneumatic breaker	86	Water pump	77
Compressor	87	Hand-held electric circular saw	82
Pneumatic spade	87	Club Hammer	79
Road roller	80		
Auger	90		
ii. Operation Phase			
Hydraulic pump	81	Mixing Pit Pump	81
Digester Loading Pump	81	Air Blower	80
Biogas engine	90	DG Set	75

It is to be noted that the landuse of 500 m around source has been considered for this noise dispersion modelling exercise. The total area has been divided into four quadrants based on the landuse. Features which are relevant from the noise propagation point of view in the four quadrants have been described below:

- North - There is a concrete boundary wall of 1.5 m at a distance of approximately 90 m. There is a flyover with a solid foundation that has a height ranging between 5-10 m and width of 18 m and runs approximately 120 m away from the source along the northern boundary. The residential area of Adarsh Nagar lies at an approximate distance of 350 m;
- East -There is an open landfill which is 5-7 m in height located approximately 200 m away from source. Residential area of Pramod Nagar lies within 260 m from source;
- South – There is an expanse of fallow land, land fill area, vegetated land and water body within 500 m. There is no residential area within 500 m;
- West – There is a concrete boundary wall of 1.5 m at a distance of 90 m, two layers of vegetation of approximately 6 m and 12 m width separated by a railway corridor of 16 m and residential area of Satin Sen Nagar between approximately 200 m and 500 m;

The results of the noise modelling exercise from the source both during construction and operation phase has been shown in **Figure 5.15** and **Figure 5.16** 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 and other pumps and equipments is estimated 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 phases is provided below:

Table 5.9: Total noise levels at receptor locations

Monitored Locations	Baseline Noise Level (dBA)	Predicted Sound Pressure Level (dB)	Cumulative Noise Level (dB)	Daytime Noise Standard (dBA)	Nighttime Noise Standard (dBA)
Construction Phase					
Baranagar Site West Dumping Site - N1	63.9	86.0	86.0	55	45
Adarsha Nagar - N2	61.0	57.2	62.5	55	45
Pramod Nagar - N3	62.3	43.7	62.5	55	45
Baranagar Site - N4	61.7	77.0	77.1	55	45
Operation Phase (Day time)					
Baranagar Site West Dumping Site - N1	63.9	80.4	80.5	55	45
Adarsha Nagar - N2	61.0	52.6	61.7	55	45
Pramod Nagar - N3	62.3	37.1	62.3	55	45
Baranagar Site - N4	61.7	52.1	62.2	55	45
Operation Phase (Night time)					
Baranagar Site West Dumping Site - N1	54.4	80.4	80.4	55	45
Adarsha Nagar - N2	48.3	52.6	54.0	55	45
Pramod Nagar - N3	52.4	37.1	52.6	55	45
Baranagar Site - N4	52.3	52.1	55.2	55	45

Figure 5.15 Predicted incremental Noise Pressure Levels during Construction Phase

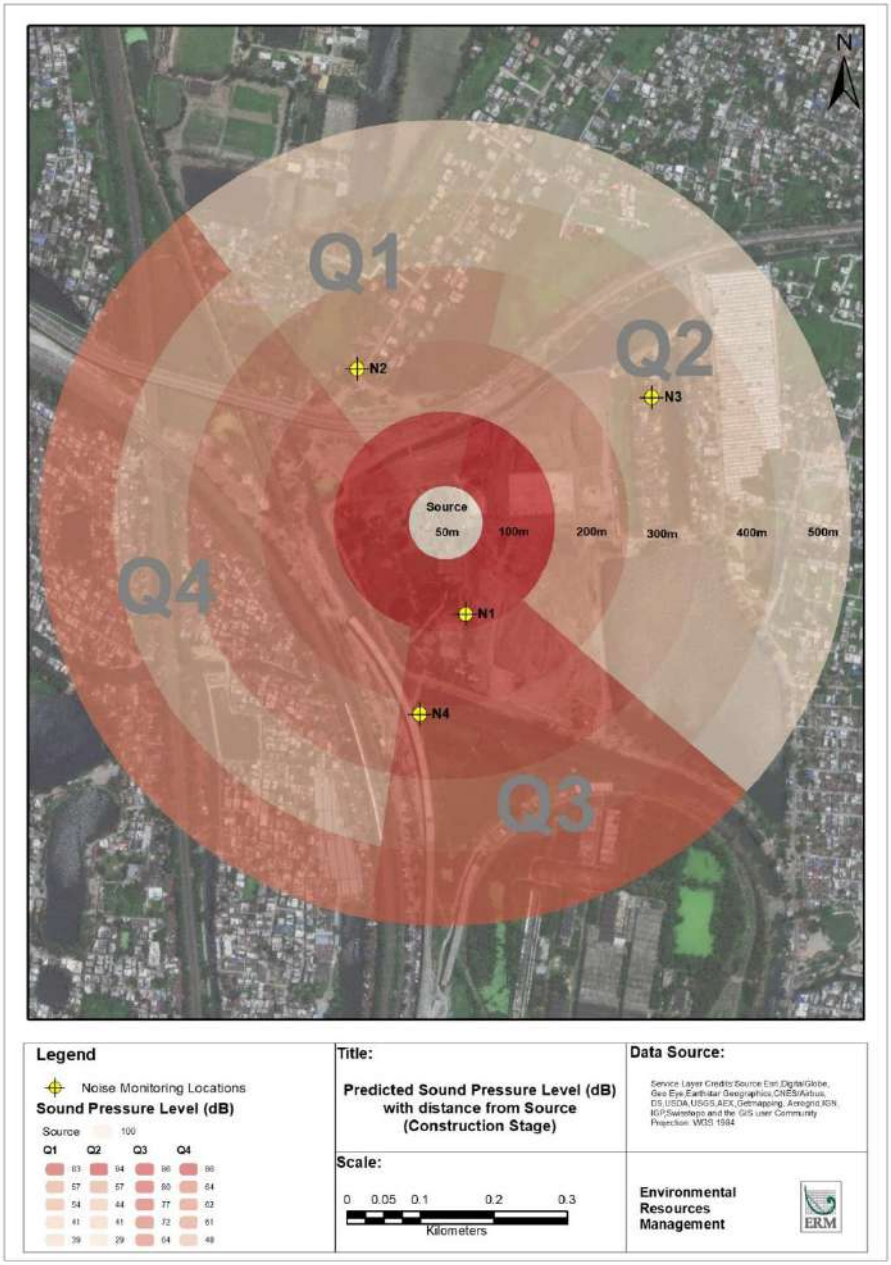
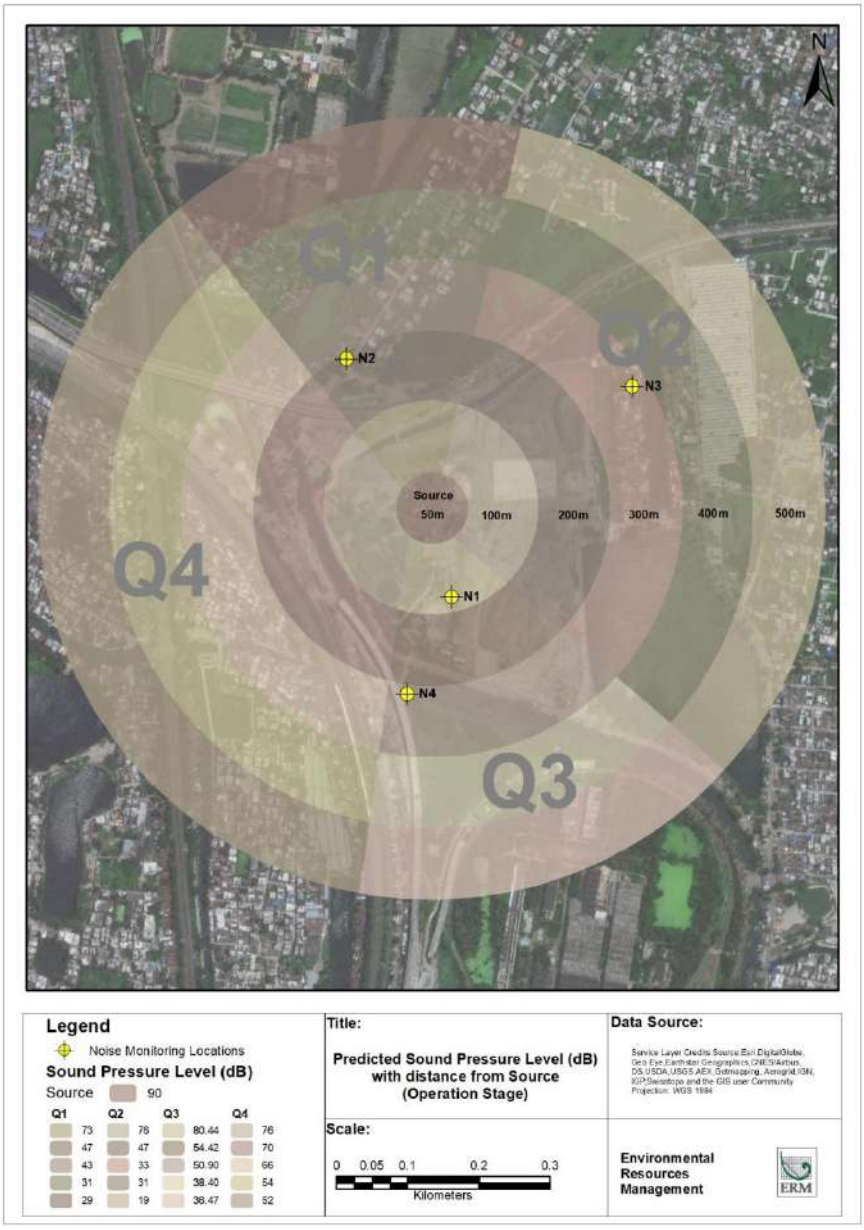


Figure 5.16 Predicted incremental Noise Pressure Levels during Operations Phase



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 N2 (Adarsha Nagar) and N3 (Pramod Nagar) more than 1.5 dB during construction phase at day time. Similarly, in the operation phase, the cumulative noise level at N2 and N3 will not increase more than 0.7 dB at day time.

The monitoring location of N1 is located within the Site itself. Since, the cumulative noise level is more than 85 dB during construction stage, as best practise the workers must be provided with personal protective equipment such as ear muffs to reduce exposure to high noise level. The monitoring location of N4 lies within 20 m of the metro corridor connecting Noapara with Airport. There are no residential area at this location. Hence, impact due to incremental noise during construction and operation phase from the proposed project will not significantly impact this area.

Construction will not be undertaken at night time, hence predicted noise level at night time during construction phase has not been calculated. As shown in the Section 4.2.7, the equivalent noise level

at nightime exceeds the stipulated night time standard by CPCB. During operation phase, the cumulative noise level at N2 and N3 will not increase more than 2 dB. Hence, will not be source of annoyance for receptors at monitored locations at night time.

Generation of noise due to pipeline laying: The proposed pipeline network will pass through dense urban localities. Vehicles such as excavators, dumpers and graders will be employed. The cumulative noise will be approximately 85 dB. This noise level is above the baseline noise level. However, the activities will be staggered and the vehicles will not work in tandem, hence the noise generated will be lower than estimated. Moreover, the area is populated, hence the construction noise will potentially blend with the surrounding baseline noise levels. Further, construction activities will not be undertaken at nighttime hence, will not be a source of annouyance for neighbouring community.

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:

- No construction work to be taken up in night-time;
- Switching off unnecessary or idle equipments;
- Fitting of noise mufflers to mobile equipments; and
- Preventive maintenance of equipment to minimize noise emissions.

Impact Significance	**Impact due noise generation during De-commissioning and 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 **Moderate**			
Impact Magnitude (With Mitigations)	Negligible	Small	Medium	Large
Impact Significance (With Mitigations) i.e. Residual Impact	Significance of impact is considered **Minor.**			

Operation 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 ~250m and noise generated from either source will be within 45-55 dB and have negligible 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;

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 ***Minor***			
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.***

5.4.4 Drainage Impacts

During project life-cycle potential scenarios impacting the surrounding drainage system are, firstly, dewatering of existing structures through electrically operated pumps and pipes discharging, secondly, storm water from dumpyard entering into STP complex through gaps along the shared boundary along, thirdly, 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 adjacent Udaypur canal due to natural slope ***(refer section 4.2.9)***. As discussed in baseline (***refer section 4.2.9***) the carrying capacity of Udaypur canal is 652.61 MLD. Hence we infer that excess load of 60 MLD from STP operation will not have any impact on the drainage of the surrounding or will affect the load bearing capacities of the Bagjola canal system. The potential impact scenarios as discussed above will also have negligible impact on the drainage due to buffer carrying capacity of ~590 MLD.

Mitigation Measure:

- Site to design and develop an appropriate 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 drainage during construction phase is assessed as ***Negligible.***

5.4.5 Surface Water Quality

De-Commissioning and Construction Phase

No adverse impact on surface water quality is envisaged as routine discharge into surface water is proposed during de-commissioning and construction phase and all proposed phase activities will happen within the STP complex as result the there is no interaction with surface water resource. However, a one time discharge of wastewater that is presently stored within the existing STP structures is expected to occur. As the STP is non-functional over two years, the stored waste water is can be anticipated to have got diluted, but with the possibility of having some sedimented organic material in the bottom layers. It is unlikely that the stored waste water would have high pollution potential and in all likelihood would be discharged through a one-time pumping arrangement into the Udaypur Canal.

Impact Source: Contamination of surface water bodies during the construction phase is possible in the following cases:

- Discharge of water stored in existing STP structures;
- 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:

- Monitor quality of water stored in exisiting STP structures before planning a draining and discharge into Udaypur Canal;
- 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 recieving water stream of Udaipur and subsequently Bagjola Canal 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 Kulti Gong and Hooghly rivers to the east and west respectively. The Udaypur canal, 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 Bagjola canal system has also been observed to be having similar conditions with the average observed BOD concentration in the range of 20 – 26 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 recieving surface water environment.

The facility has a flat topography ***(refer 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 in draining of storm water during heavy rains or monsoon season causing local level spillover in the Udaipur and Bagjola canal, in the immediate vicinity of the STP facility ***(refer 4.2.9).***

Quantitaive 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 canal in vicinity to STP discharge point is 26 mg/l or 26 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 Canal peak flow (m^3/Hr)	:10848
B.	STP discharge Peak Flow (m^3/Hr)	:2500
C.	Highest BOD load in drainage Canal (kg/m^3)	:26 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

Total BOD (Kg/Hr) = **BOD Concentration (Kg/m^3)** X **Flow Rate (m^3/Hr)**

E.	Total BOD load in Drainage Canal (Kg/Hr)	:282.048
F.	Total BOD load in STP treated water discharge (Kg/Hr)	:50

Formulae used for calculating Cumulative BOD load from STP on drainage Canal

$$\text{Cumulative BOD Load (mg/L)} = \frac{E+F}{A+B}$$

Result

As per formulae stated above the cumulative BOD load on the adjacent drainage canal due the peak BOD load discharge from STP operation is 24.88 mg/L. Hence, there will be a minor improvement in water quality of drainage canal in vicinity to STP discharge point, as there is an estimated reduction of 1.12 mg/L in BOD concentration in drainage canal 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 with certainty the impact of STP treated water discharge in the ultimate receiving body i.e. Bidyadhari river, as GSPPL and KMDA has no control over the upstream and downstream discharge from the local drainage basin into the Udaipur and Bagjola drainage canals.

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.

Note:

- The immediate sewage water canals has been considered as the receiving water body and not the rivers further downstream (Bhagirathi, Bidyadhari). Since there are several other sewage water outlet sources both upstream and downstream to the proposed STP discharge points from the surrounding urban/sub-urban areas;
- With the above rationale, assessing ecological sensitivity of the downstream river and relevant biodiversity of lower Gangetic Delta will not be reasonable to qualify or interpret any impact due to the proposed project, considering the treated water discharge from the proposed project STPs will be of better quality than those recieving sewage water canals which are finally discharge into the downstream river.

5.4.6 Ground Water Quality

There will be no groundwater extraction during project life-cycle, as per site observation, there exist a borewell along the eastern boundary which is used for drinking and domestic purpose presently. All water during construction and demolition phase 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 GSPPL. Hence there will no adverse impact on any local ground water resource. Potential for contamination of ground water during construction phase would be minor due to oil and grease spillage, during maintenance of construction machinery, de-watering of existing STP structures, repair of pumps and compressors during operational phase. As discussed in section 4.2.10 of this report, the depth of shallow aquifers in the study area varies from 60-80 m, the top of the shallow aquifer is characterized by aquitard formation composed of

several slity clay layers which will act as a barrier and limit permeability of any contaminants. The aquitard formation is overlain by alluvial soil with very limited permiablity (vertical and horizontal). The aquitard is underlain by alluvial clay deposit.

The proposed STP structural design will not permit any percolation to the soil. The accidendental discharge from the STP if occurred will restricted to the upper soil as the geology of the area would allow for limited percolation into soil and underlying groundwater aquifers. So, there is minimal likelihood of contamination of groundwater due to STP operation at the shallow aquifer level occurring at depth of 60-80 m.The chance of contamination of aquitard due to presence of Baranagar dumpyard will be confined to limited within or around the dumpyard site due low permeability of the aquitard. A detailed Phase II Environmental Site Assessment (ESA) study is proposed for the project site area to understand the exiting level of soil and groundwater contamination and there sources.

5.4.7 Soil Quality

De-Commissioning and Construction Phase

Potential impact activity during this phase, firstly dewatering of existing STP structures (~1000KL). The existing structures viz., collection chamber, primary settle tank, final settling tank and sludge thicker will be dewatered before the dismantling the structures. Retained water in the existing STP structures will be pumped and discharged into adjacent Udaypur canal ***(refer Section 2.4.2)*** through dewatering pumps. Major leakage from this dewatering arrangement in not envisaged as the operational integrity will be maintained. Chances of mixing of de-watered wastewater with leachate generated from Baranagar dumpyard is also not envisaged as the operational integrity of pumps will be maintained and knowing the soil charactericts of the proposed project location ***(refer Section 4.2.4).*** Scale of impact on soil quality is estimated to be low to medium. Chances receptors (i.e. near by residential areas, scholls etc.) getting impacted is negligible based on two major reasons firstly the STP site is bounded on all four sides, secondly distance of receptors from the source. Next activity during this phase that is temporary storage of sludge from existing structures within STP site till they are disposed to designated landfill area assigned by KMDA. As per control measures ***(refer Section 2.8)*** there will separate lined storage area for the sludge extracted from existing facility, hence the scale of impact will low and as stated earlier all these activities will happen within the STP complex interaction with immediate receptor apart from construction worker labour within the boundary is negligible. Two more impact scenario envisaged are firstly wastewater generated during suppression of fugitive emission during this phase and chances of oil spills and oil/grease mixed cotton waste not properly disposed after maintenance/repairing activities of construction and demolition equipment, during this phase ***(refer Section 2.8).***

Demolition 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. have minor chances to 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.

In context of quantification of storage, handling and disposal of Construction & Demolition (C&D) wastes as well as liquid wastes (lubricants/hydraulic oils etc) that are envisaged to be generated from the proposed project, GSPPL will develop and implement a detailed Waste Management Plan. The said Waste Management plan will be developed after a detailed quanitification study of structures that is envisaged to be demolished and constructed.

The primary monitoring results of soil quality results shows that there was no contamination of heavy metals and other soil contaminants in the nearby residential area ***(Refer Section 4.2.4).*** Any impacts from above mentioned activity will be reversible in nature and will not 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:

- De-watering from existing STP structures is to be performed preferably using a pumping arrangement and discharged into the Udaypur canal, after testing the quality of water;
- Any contaminated soil, sludge or slurry that will generated from the existing STP structures will be stored on a paved surface or in a temporary pit with HDPE lining to avoid any contamination of soil or groundwater at site and halued away to a disposal site agreed upon with the KMDA;
- Manage spills of contaminants on soil using standard engineering practices and secondary contamination kits;
- Impervious storage area, especially for e-waste, fuel & lubricant, chemical, hazardous waste etc.
- Construction and demolition concrete waste will be utilized for filling of site;
- 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 De-Commissioning and 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 back-up DG set or HSD/LDO used for initial ignition of gas engine) maintenance activity & lubricant (for gears, motors and air compressor unit) from storage facility or from transport vehicles. Such spilled chemicals, fuels may get absorbed in the soil soil, which may adversely impact the soil quality 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. Sludge from sludge digester will be de-watered by centrifuge and then collected in closed movable container attached to tractor trolley. Sludge from bio-gas scrubber will be recirculated to the sludge digester sump.Hence, there is no

storage of bio-solids with the facility. 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 Operation 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

The STP site is connected through two major roads i.e. A.K Mukherjee on the southern boundary and Belghoria Expressway along northern boundary ***(refer Section 2.3)***. To understand the baseline condition and traffic influx, baseline monitoring was undertaken on Belghoria Expressway which would be predominantly used during the de-commissioning and 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 demolition waste and transportation of plant machineries will be using the Belghoria expressway and arterial site access road. It is noted during site visit, that arterial road from Belghoria expressway approaching the municipal solid waste dump site and cross a culvert over the tributaries of Udaipur canal will be used throughout construction and de-commissioning phase. Based on the baseline traffic survey conducted (***Refer Section 4.2.13***). The average peak hourly traffic on this route was 3.93 PCU/Hr (up) and 8.19PCU/hr (down) number of vehicles per hour and maximum traffic load was 19 PCU per hour. 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 demolition and construction phase, may not cause perceptible changes in the existing scenario as this road is mostly not used 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 not cause major changes. Receptors on northern, eastern and southern boundaries will not be affected. Receptors western boundary i.e. residents of Satin Sen Nagar 115 m away will also be not affected as this road is not major

connectivity for them. Use of vehicles more than 35-ton capacity may damage the road and culvert 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 is expected to happen 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.

Mitigation Measures:

- 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.

Impact Significance	**Impact on 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 **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 residual impact disturbance/ discomfort to local people due to increase of traffic is assessed to be ***Negligible.***

5.4.9 Community, Health and Safety

Experience shows that because of its nature and scale, project like Baranagar 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 de-commissioning and 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 Spread of Infectious Diseases

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.

Additionally, solid waste dumpyards can potentially be a breeding ground for pathogenic microorganisms and vectors of diseases, such as rodents, birds, pigs, mosquitos, flies and other pests. These vectors can cause diseases such as typhoid fever, dengue, malaria, as well as skin and respiratory infections. Potential vectors such as pigs and birds were observed at the Baranagar dumpyard, which may thus spread infectious diseases in the surrounding neighbourhood.
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,
- 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

De-Commissioning and Construction Phase

Impact Source:

- Demolition activities for existing STP structures;
- 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 will be mainly construction and demolition 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 decommissioning and 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.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 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 De-Commissioning and 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 **Annexure J.**

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 Operation 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 ***Negligible.***

5.5 Social Impacts

5.5.1 Access Disruption

5.5.1.1 Construction Phase

Source of Impact:

STP Facility

The new Baranagar STP will be constructed on existing STP land owned by KMDA. This has no additional land requirement and thus, do not possess any land acquisition related impacts.

Sewer Pipelines

The proposed project will entail temporary access disruption during excavation work, removal of debris and piling up of mud earth along the roadside for replacement of 8.5 km gravity sewer line and replacement of new rising mains of 2.7 km from Baranagar-Kamarhati MPS to the STP. The moving of large construction machinery and vehicular movement for transportation of construction materials will also likely to cause some access disruption I the immediate vicinity of the project..

Impact Assessment:

The proposed project will entail heavy access disruption during the laying of new gravity sewer lines, rising main and replacement of sewer line. As observed during site visit, the alignment of the existing sewer line transverse through congested market and residential areas. Though the alignment of the gravity sewer lines are located in the middle of the road, however, there will be access disruption for shops and nearby residential structures located near the RoW of the alignment. The diameter of the sewer pipeline ranges from 200 mm to 1000 mm, of which nearly 51% of the sewers are of size between 200 mm and 700 mm. The width of the affected road stretches is between 6 ft to 12 ft.

The potential receptors that will be impacted due to access disruption are the 34B private bus terminal, local market in RKPD Road, and daily morning market located along the Gopal Lal Tagore road. Consultations with the Bus operator in 34B bus stand reveals that approximately 25-30 buses are parked in the area at night after the end of entire day trip. The buses starts operating from 6am in the morning to 11pm at night from the terminal.

Consultations with the morning market vendors along G.L Tagore Road revealed that the market timings are from 6 am to 1:30 pm and the vendors are situated on both sides of the road mainly selling meat, fish and vegetable. Since the road is a congested area, the proposed laying of the sewer pipelines may temporarily impact business of these vendors. The vendors proposed that the project work should take place at night.

The proposed work for replacement of sewer line may potentially impact the main entrance of the Ramakrishna Mission Ashrama School. Moreover, the replacement of gravity pipeline from the main pumping station from Dunlop to Interception & Diversion structure number 2 in Anna Kali Devi Road will also affect the parking area of Toto (e-rickshaw) stand and cycle stand. Consultation with the drivers and stand user reveal that the toto and cycle stand have been using the space for parking for the last 4 years and the parking space belongs to the municipal corporation. Currently, 40 to 50 drivers approximately, are using the space for parking their Toto's. The stand operates daily from 7am to 11 am in the morning and 4pm to 9pm in the evening s observed during site visit, the replacement of the rising main from MPS to STP in Mathkol will entails access disruption for one temple and two shopd located outside the MPS.

As reported by the project concessionaire, the number of days for the construction will be carried out in stretches (excavation-replacement-backfilling)of minimum of 25m stretch will take 3 days. Therefore the estimated time period that will cause access disruption for the local communities and commuters along these stretches is estimated to be 3 days. Moreover, as reported by the project concessionaire the design of the sewers will be laid based on the depth of existing sewer line which is approximately

1.5-2mtr depth. 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 laid 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 (2.5 LHS and 2.5 RHS) Figure 6.20 provides an overview of the potential impacts.

Table 5.10: Access disruption Road Details

Project Activity	Location of the Impacts	Road Width	Receptors	Photos
Laying of Gravity Sewer Line (*Diameter of the pipe may vary from 300 to 900 mm. Closer to the MPS the dia. of the pipes are more and gradually reduces, depending on the road width.*)	Gopal Lal Tagore Road	18-20 ft.	■ 34 Bus Terminal, ■ Access way to Ramkrishna School in Baranagar, ■ Road Side vendors	 34 B Bus Terminus along Gopal Lal Tagore Road, along Gravity Sewer Lane  Vendors at Morning Market, Gopal Lal Tagore Lane

Project Activity	Location of the Impacts	Road Width	Receptors	Photos
Replacement of sewer line	RN Tagore Road	12-16 ft.	Rickshaw and Cycle stand located along the roadside	 Congested Area at Cycle Stand near I&D 2 Dakshineshwar Bus Stand
Installation of Rising Main	B.N Mukherjee Road	6-8 ft.	■ Shops located near the ROW of the project footprint ■ Access way to Super Market ■ Temple located near the MPS	 Two Shops and temple outside Main Pumping Station

Project Activity	Location of the Impacts	Road Width	Receptors	Photos
	Northern Park Road	10 ft.		 Market along Northern Park Road

Source: Observation during Joint Site Visit Dated 13th August, 2019

Embedded control measures:

- For minimizing 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 pedestrains.
- In road stretches such as narrow streets, crowded market place where the used of machines is not feasible, the work will be carry out manually. The concessionare will put in place necessary precautions such as bracing / shoring in the trench will be provided for excavated trenches.
- The concessionaire will carry out replacement of sewer lines in stretches. In one each day, the maximum stretch at one location for the construction work which include trench excavation & replacement will be 25-25 Mtr. Thefore the total duration of all stages (Excavation, Laying & Back filling) of sewer line replacement work in one day will be 10-12 working Hours. The construction work will be carried out during off-business hours from 1:00pm to next day morning 6:00am.
- A Traffic Safety Management Plan will be put in place for contractor to comply during construction carry out work on the road in a manner creating least interference to the flow traffic while consistent with the satisfactory execution. Some of the measure to ease traffic congestion includes (a) 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; (b)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. Safe access with proper barricade to be provided for accessing the temple. A temple management plan if necessary may be prepared for managing and avoiding any potential impacts during construction.
- 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 existing government roads; the trunk sewer pipelines will be laid within the RoW of existing roads.

a. Laying of 2.18 km gravity sewer line in Gopal Lal Tagore road and
b. Replacement of 2.1 km gravity sewer line from MPS to STP along the R.N tagore road and
c. Laying of new raising main 2.7 km from MPS in Dunlop, Kamarhati Municipality to STP in Matkol under South Dum Dum Municipality.

Impact Assessment:

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 (sewer line) will face some disturbance in operating their business 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 3 days.).

a. Replacement of Gravity Sewer Line:

The proposed project for laying of 140mm dia. to 700mm sewer line will pass through congested and narrow road along the Gopal L Tagore road stretches, heavily congested areas and few local markets. Roadside vendors/shops and one local market and one local market in ward 13 and 14 were observed along the road stretches where the sewer pipeline traverses. Consultation with the market vendors reveals that the vendors regularly uses the shoulder of the road stretches for selling Vegetables Fish and meat. The vendors were the residents from Das para and Neogi para. There are approximately 16 vendors along the roadside. They operate their businesses early in the morning till afternoon. They reported their daily income ranging from INR 200 to INR 500. Thus laying of the

gravity sewer line will cause temporary closure of business causing temporary income loss for the roadside vendors. As per the discussion with the site representatives of GSPPL, the proposed work will not cause any permanent closure of the identified shops.

Replacement of Gravity Truck Sewer Line:

For replacement of pipeline, the existing sewer network as observed during site visit will trigger temporary income loss for 15 squatter shops along the R.N Tagore road during excavation of 1.5m to 2 m trench for replacement of existing sewer line. These shops were mostly makeshift and kutcha structures operating on a daily basis from 9.30 AM to 10 P.M. The average income of these impacted business entity ranges from INR 5000 to INR 8000.Though, the existing alignment of the pipelines are reported to be located in the middle of the road, however during excavation and replacement work it is anticipated that the roadside vendors will face temporary income loss.

Laying of New Rising Main:

During the joint visit, it has been reported that a new rising main will be laid for transferring the sewage flow from the Main Pumping Station (MPS) to the STP in Matkol. The new rising main will be laid at a depth of 1m. The alignment of the rising main will pass through congested areas in Northern Park road (road width 10ft) and B.N Mukherjee Road (road width 6-8 ft.). During the site visit, it has been observed that 2 shops and 1 temple near the MPS in Dunlop will be impacted.

Table 5.11: Number of Affected Entities

Sl. No.	Sewer Pipeline Location	Tentative No. of Affected Entities
1.	Laying of Gravity Sewer Line along the Gopal L Tagore road stretches	16 vendors
2.	Replacement of Pipelines Gravity Truck Sewer Line along the R.N Tagore road	15 squatter shops
3.	Laying of New Rising Mains MPS to STP – the pipeline is proposed to pass through Northern Park road (road width 10ft) and B.N Mukherjee Road (road width 6-8 ft.)	2 shops and 1 temple near the MPS

Embedded control measures:

- For minimizing the durations and extend of the impacts, the concessionaire will carry out excavation through machine (backhoe excavator). Additionally during excavation works, safety measures such 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 pedestrains.
- In road stretches such as narrow streets, crowded market place where the used of machines is not feasible, the work will also be supplemented manually. The concessionare will put in place necessary precautions such as bracing / shoring in the trench will be provided for excavated trenches.
- The concessionaire will carry out replacement of sewer lines in stretches. In each day, the maximum stretch at one location for the construction work which include trench excavation & replacement will be 25 Mtr. Therefore the total duration of all stages (Excavation, Laying & Back filling)of sewer line replacement work in one day will be 10-12 working Hours and the total number of days is maximum 3 days. The construction work will be carried out during off-business hours from 1:00pm to next day morning 6:00 am.

Mitigation Measure

- 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 Concessionaire 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 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.
- 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.

Figure 5.17 Impacts Identified Due to Replacement of New Rising Main

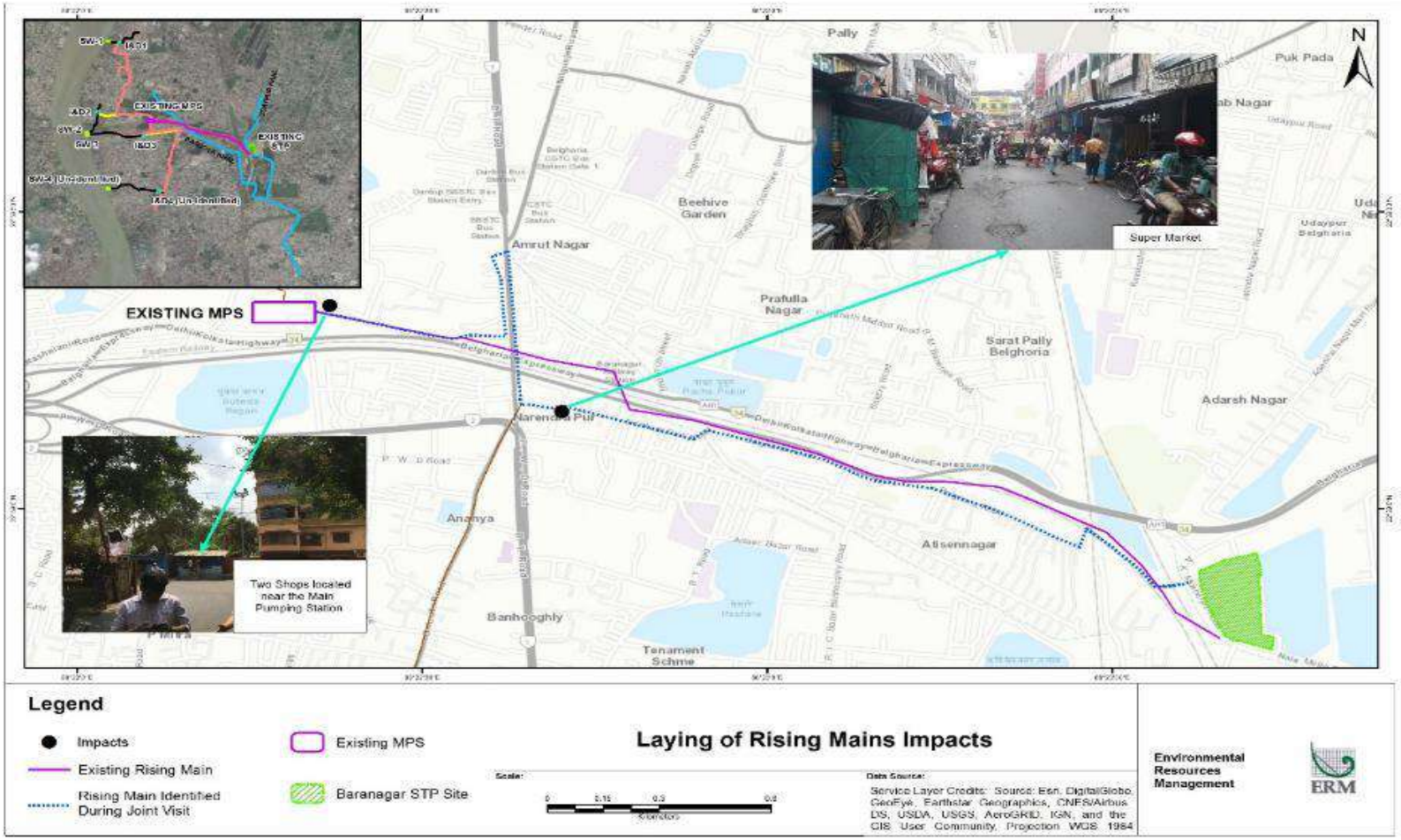


Figure 5.18 Impacts Identified Due Replacement of Gravity Sewer Line

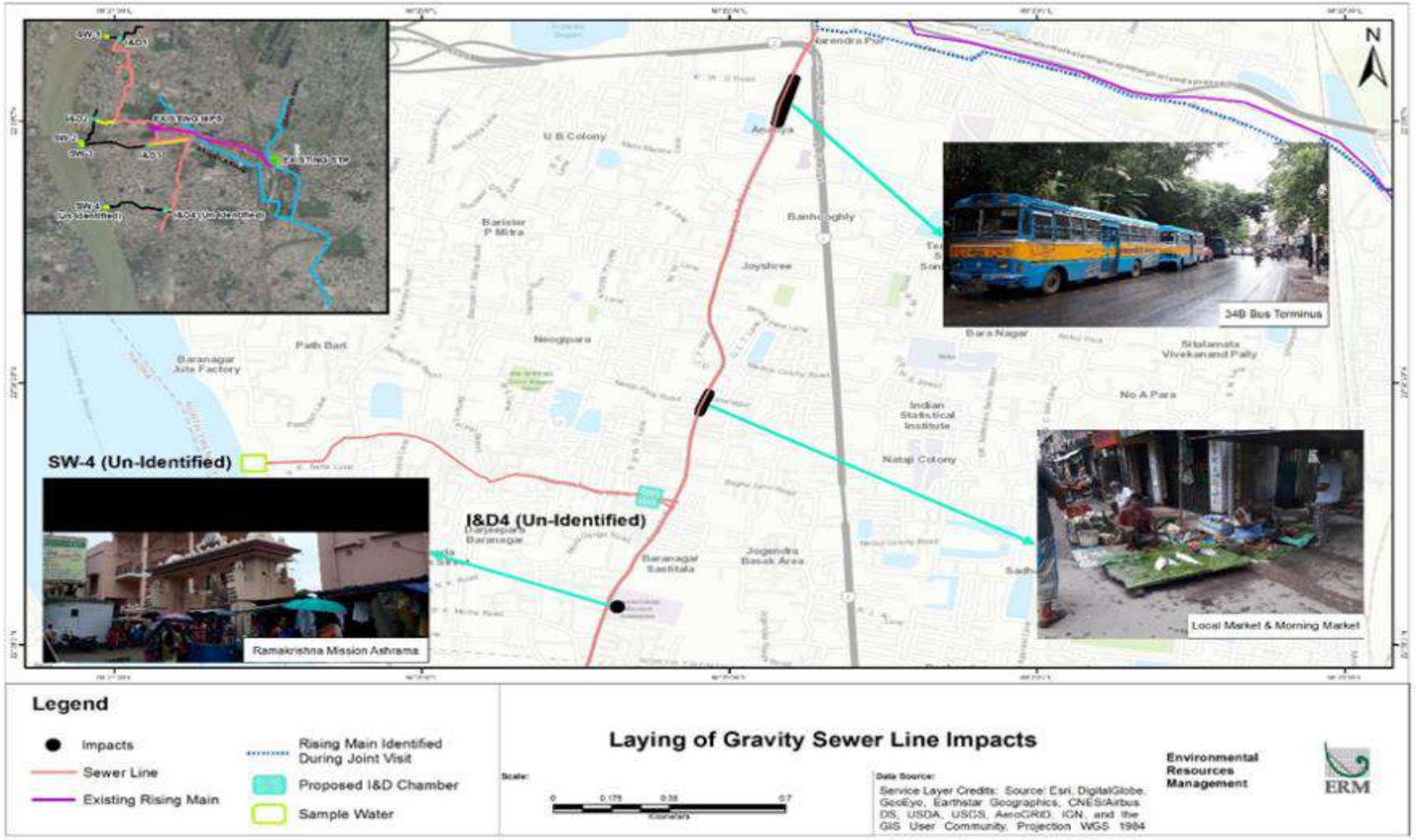
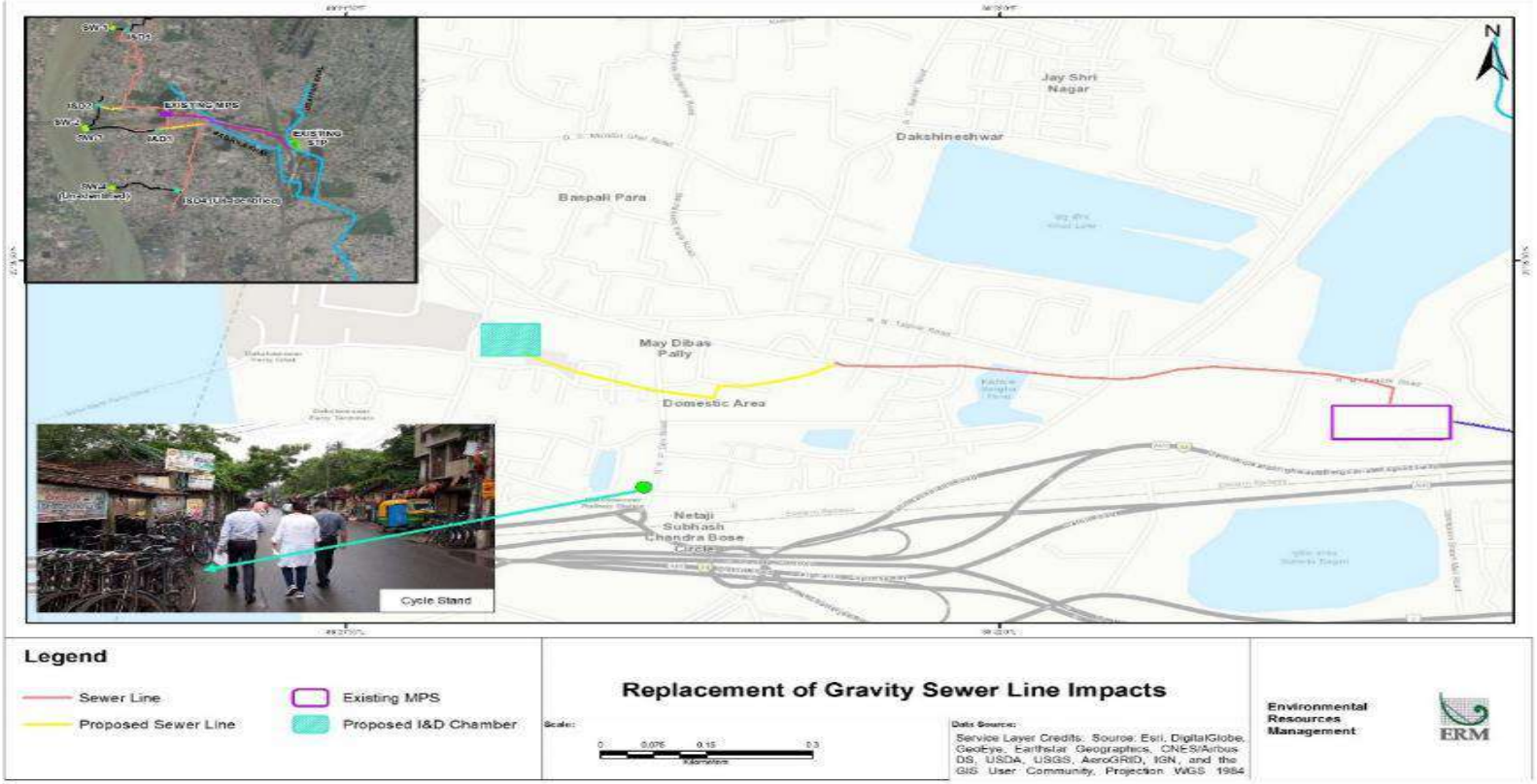


Figure 5.19 Impacts Identified Due to Replacement of Gravity Sewer Line



5.5.3 Influx of Labour and Conflict with Local people

Construction Phase

During 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, and the influx of labour may potentially led 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 take place especially during excavation and replacement work of the pipelines. The construction of the STP will be within closed premises and the labour camp will be within the site.

As this impact is restricted to the construction phase, measures such as proper orientation to workers on gender and culture 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
- 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.
- 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 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. The contractor should also refer to the Gender Action Plan for engaging women workers.

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-locals47. As a result, labour camp will be required during the different construction period. Mobile camps will be required to set up at every location during construction work. As observed, during site visit, the alignment of the existing sewer line for the proposed work passes through congested areas, thus haphazard establishment of

[47] Non-local in this context is defined as an intra state migrant who are non residence of 24th Parganas, but are resident of West Bengal belonging to other district.

the camp will aggravate the congestion. 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.

5.5.5 Gender Impacts

Secondary data on employment ability shows that 34.7 percent of the total population under Baranagar Municipality are main workforce and 2.7 percent are marginal workforce (refer Table 4.27), out of which only 16.2 percent are female main workers and 43.4 percent are female marginal workers. Also, the primary socio-economic survey undertaken in Baranagar project location indicate at 18 percent female work participation (refer Table 4.42). 0.85 percent women are involved into household industries in Baranagar Municipality. This indicates that the overall women's participation as work force is less in this area. Furthermore, women's participation into civil construction work is limited to unskilled workers for carrying construction materials. Hence, it is assessed that in the first year of the construction work when maximum number of unskilled workforce will majorly be required for civil construction work, there will less women workforce participation. Therefore, as civil construction work will take place at Baranagar 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. A review of the documentation reveals that Wabag's HR processes has a Prevention of Sexual Harassament (POSH) Policy.

Apart from an improved sewerage system for the local inhabitants, the project can potentially bring about more economic opportunities for women, especially those residing in the project affected area.

Detailed methods of engagement for women in the project area are presented in the Gender Action Plan (GAP) developed for the Project.

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, surpervisory and managerial roles.
- 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 programmes and tranings 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

5.5.6 Loss of Employment of Existing Workers

At present there are 31 contractual workers employed at the Baranagar STP as well as the MPS, under the man-power supply contractors M/s Kakinara Engineer's Workers Co-operative Society and M/s Sunny Enterprise, respectively.

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; 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 Consessionaire. In the second Review Meeting of the progress of achievement of conditions precedent by the stakeholders of Howrah, Bally and Baranagar and Kamarhati STP Project s 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 Consessionaire 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 Consessionaire held a meeting with the Chief Executive Officer, KMDA on 27th November, 2019, following which the Concessionaire (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***. 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 analyzed.
- 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 back pay 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 Consessionaire, then the impact would be reduced. Failing to which the Labour Management Plan would be effective.
- A monitoring plan 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 to monitor the reploymnet of workers to other facility.
- It may be considered to provide the 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 de-commissioning of existing facility and building a new 60 MLD 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. ■ Well settleable sludge flocks.	■ Extensive piping and valves/gates required. ■ Higher maintenance skill required

Technology	Merits	Demerits
	■ 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	
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, to avoid physical displacement.

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, consultations will be undertake and mitigation measures will be adopted 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 Baranagar 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.

7.2 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** below:

Table 7.1: List of Key Stakeholders

	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.

	Stakeholder Group	Description
Primary Stakeholders		
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	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)
5	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.
6	Project Workforce	■ 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.
Secondary Stakeholders		
7	National Mission for Clean Ganga (NMCG) &	■ NMCG is the governing authority for the Project.
8	Project Financing Agencies/Institutions	■ This stakeholder group includes International Finance Corporation (IFC) that is evaluating a potential investment opportunity into the Project.
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. Baranagar Municipality and Kamarhati Municipality. ■ This group is responsible for the development of their respective urban areas.
11	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)

7.3 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 in **Table 7.2** below:

Table 7.2: Stakeholder Impact Matrix

		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 following section (**Table 7.3)** provides brief profiles of the various stakeholders in the project as discussed in the previous sub section along with their degree of influence.

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. ■ Commercial structures include kiosks and vendors operating their businesses at G.L Tagore road, R.N Tagore road and Northern Park road, who will potentially impacted by project operations.	■ 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 center of the road will be proposed for laying of the pipelines. ■ In addition, the Project Affected Persons (PAPs) may potentially be engaged as local resources during the construction phase of the project, in the form of construction laborers, mason workers and drivers, etc. ■ In addition, this stakeholder group can also provide goods	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
				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 congestion and access disruption, caused by the Project activities.	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 laborers, 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.	Medium	Minor
Religious Institutions	■ This stakeholder group includes a temple located in the RoW and/or in proximity to the Project area.	■ The proposed laying of the rising main from the Main Pumping Station (MPS) may potentially cause temporary access disruption for the local community/ devotees, to a	Small	■ The Project's impact 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.	Low	Negligible

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
		temple situated outside the MPS.				
Project Workforce	■ 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.	■ The Project will engage manpower for the civil construction work during the construction phase comprising of approximately 100-150 workers. ■ 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 ensured through a Labor Management Plan (LMP).	Low	Minor
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

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
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 Resettlement Action Plan (RAP). ■ This group may also play an important role in the formation of public opinion towards 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/Institutions	■ 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 Project's financial feasibility.	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.		■ 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
Urban Local Bodies/ Municipality	■ This stakeholder group refers to the jurisdiction under which the STP and its linked facilities are located in i.e. Baranagar Municipality and Kamarhati Municipality. ■ This group is responsible for the development of their respective urban areas.	■ The impact of of the project on this stakeholder group will be in the case of potential for social disruption between the local inhabitants and the workforce ■ The impacts on the environment such as noise, air and water pollution cause during the construction and operation stage	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

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
				■ This group thus has the ability to influence the perception of the community in regards to the project and its activities.		

7.4 Stakeholder Consultation

7.4.1 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 instutitutes. 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 partcipants 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.

7.4.2 Stakeholder Consultation during Previous ESIA Conducted by IPE Global

As per the ESAMP conducted by IPE Global, a stakeholder consultation was conducted in the form of a Focus Group Discussion with the municipal councillors, on December 2015. The objective of the meeting was to understand the nature of pollution in the town, the main points of Ganga river pollution, the mportance and need for STP project in the town, the consequences resulting in construction and operation of the STP project, the mitigation measures that can be taken to reduce and altogether stop such consequences, the level of awareness among the community, and the means for raising the awareness level of the community.

The consultation with the coucillors revealed that they were aware of the pollution levels of the river Ganga and attributed it to the dumping of solid waste, the jute mill, immersion of idols, burning ghats, slums, khatals as markets. They also indicated the outfall points where both sewage and storm water falls into the river. They however believed that the people are generally not aware of the sanitation project as well as the STP sewerage network, under the Ganga Action Plan (GAP). They even suggested methods for addressing this lack of awareness such as public announcments, door to door leaflet distribution, awareness camps, outreach programmes through ward committee members, SHGs and local clubs.

The councillors pointed out some of the issues associated with rehabilitation and renovation of the STP which include accumulation of soil heaps on the roadside, generation of dust from the soil heaps, formation of water pools in the STP site, run-off of silt and sullage from the construction site, odour during operation of STP, traffic congestion. The however suggested mitigation measures which include covering of the soil heaps, water sprinkling, scheduling of work in manner that does not affect important roads, as well as coordination between the implementing agency, contractor and municipality on work plan and progress.

7.4.3 Stakeholder Consultation during ESIA Process

Consultations have been conducted with stakeholders of the Baranagar STP project which include the existing contractual workers at the STP and associated 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 L***.

Table 7.4: Details of Stakeholder Consultation

Sl. No	Stakeholder Group	Details of Consultation
	Baranagar STP	
1.	**Existing STP Contractual Workers** *Location:* Baranagar STP *Date:* 31st of May, 2019 and 21st of July, 2019	■ The consultations with the existing contractual workers at Baranagar STP revealed that there are approximately 20 workers who work for 8 hours with three shifts throughout the day. ■ It was revealed that all workers are all local workers. ■ 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). ■ Out of the 20 workers, only 2 workers were residing in the STP premises. ■ As the STP premises does not presently have a proper barricade, certain livestock were observed within the premises which were coming from the neighbouring dumping site. During the rainy season, water from the neighbouring dumping site also seeps into the STP premises. ■ For their drinking water, the workers revealed that they sometimes utilize the water pump in the premises but they mostly purchase the drinking water. ■ The workers indicated that they earn an approximate monthly income of INR 8000 and all have Personal Provident Fund (PPF) accounts. ■ The consultation revealed that the workers are aware of the Project.
2.	**Existing MPS Contractual Workers** *Location:* Baranagar MPS *Date:* 27th of July, 2019	■ A consultation was conducted with the existing contractual workers at the Baranagar Main Pumping Station (MPS). ■ During the consultation, the workers indicated that they are aware of the Project. ■ The consultation revealed that there are over 12 staff working at the MPS and they are employed by the contractor Sunny Enterprise. ■ They presently work in shifts i.e. morning, day, night and the general shift. ■ They indicated that since the pipelines from Baranagar and Kamarhati municipalities are damaged, the untreated waste water is discharged into the Bagjola Khal, next to B.T. Road.

Sl. No	Stakeholder Group	Details of Consultation
3.	**Vendors at Morning Market** *Location:* G.L Tagore Road *Date:* 24th of August, 2019	■ A consultation was conducted with the vendors at the morning market on G.L Tagore road which is located along the stretch for the proposed laying of the gravity sewer line. ■ The consultation revealed that the market timings are from 6 am to 1:30 pm and the vendors who mainly sell meat, fish and vegetables, occupy both sides of the road. ■ Their approximate daily income is Rs. 200-500. ■ The vendors were not previously aware about the project but however suggested that since the road is a very congested area, the project work should take place at night.
4.	**Teachers at Baba Sitaram Vidyapith Shiv Mandir High School & SPS Upper Primary Hindi School** *Location*: Near I&D 1, Hanuman Jute Mill Road	■ A consultation was conducted with the headmaster and teachers at Baba Sitaram Vidyapith Shiv Mandir High School as well as SPS Upper Primary Hindi School, which is located near I & D 1. The school is a co-educational government aided secondary school with an enrollment of over 730 students. ■ The school timings are between 10:30 am to 4:30 pm on weekdays and 10:30 am to 2 pm on Saturday. ■ The teachers indicated that they were not aware of the proposed project but are ready to cooperate during the construction of the I&D 1 sewer which will take place opposite the school. ■ They suggested that to avoid any congestion and traffic disruption, the work should be carried out during a holiday such as Sunday. ■ Moreover, since there is a temple within the same premises, construction work during the evening should be avoided. ■ The teachers also mentioned that during the rainy season, the school premises experiences waterlogging. ■ They also highlighted occurance of odour problems during the functioning of the STP. ■ They thus view the project as having a positive impact on the locality.
5.	**Bus Operators** *Location:* 34B Bus Stand at GL Tagore Road *Date:* 24th of August, 2019	■ A consultation was conducted with private bus operators at the 34 B Bus Stand which is situated on the G.L Tagore Road. ■ The consultation revealed that the bus operators were not aware of the project. ■ Out of 40 buses, 20-30 buses are presently in running condition and the bus timings are from 6 am to 11 pm, with the peak hours of operation being 8 am to 11 am, as well as 5pm to 9pm. ■ According to the bus operators, other buses such as Bus no. 43 also utilize the road. ■ The bus operators are however willing to cooperate during the pipeline laying work. ■ They requested to be intimated before the project work so that can rearrange and shift the buses to another nearby location. They further suggested that the work should take place after the Durga Puja, as it will be a busy period.
6.	**Electric Rickshaw Drivers**	■ A consultation was conducted with the electric rickshaw drivers operating near the I & D sewer 2 location i.e. Dakshineshwar Bus Stand The rickshaw stand is also located near the Dakshineshwar Temple.

Sl. No	Stakeholder Group	Details of Consultation
	Location: Dakshineshwar Temple and Bus Stand *Date:* 24th of August, 2019	■ The peak hours of operation are from 7am to 11am and 4pm to 9pm. ■ The consultation revealed that the drivers were not aware of the project but they are however now willing to cooperate as they expect the project to bring about positive outcomes. ■ They however highlighted that Dakshineshwar Temple is visited by thousands of worshippers each year, and thus suggested that it would be ideal if the project work can take place during the night.
7.	**Consultation with KMDA Officials, Wabag** *Location:* Unnayan Bhavan	■ It was discussed that due to the new O&M contract with GSPPL, more than 200 workers may be affected by KMDA discontinuing contracts with various contractors, associations and cooperatives who are currently operating and maintaining some of the operational components of the STP, MPS, LS and others in Baranagar, Bally and Arupara STPs. ■ It was requested that KMDA look into the terms of contract of between KMDA and with these with various contractors, associations and cooperatives and see what is required in terms of workers compensation under national regulations. KMDA was also requested to inform Wabag and ERM about their strategy to manage the existing workers
8.	**Joint Consultation between Existing Workers at Baranagar STP and Lifting Stations and KMDA, VA Tech Wabag & ERM** *Location*: Baranagar Main Pumping Station *Date:* 16th of September 2019	■ The meeting began with a discussion between representatives of KMDA, Kakinara Engineers Co-operative Society (told to be representing M/s. Sunny Enterprise as well), VA Tech Wabag as well as ERM India Pvt. Ltd, to understand the existing contractual arrangement between KMDA and the two agencies, M/s. Sunny Enterprise and M/s. Kakinara Engineers Co-operative Society. ■ It was established that the commissioning and O&M for the STP and the MPS begun in 1996. ■ Discussions has established different time period for the O&M agencies engaged by KMDA at the Baranagar STP and Baranagar-Kamarhati MPS since 1996. ■ Points clarified by M/s. Kakinara Engineers Co-operative Society was contracted on price bid basis during 2012 at the first phase with annual extension of the contract tenure and subsequently during 2016 in second phase (with annual extension cycle) and the existing contract tenure is valid till 31st December 2019. ■ It has been clarified by the representative of M/s. Kakinara Engineers Co-operative Society that the O&M contractual arrangement with KMDA is not governed by the man-power guarantee (i.e. how many skilled/ un-skilled workers needs to be engaged) rather governs by the O&M job guarantee. The existing workers remained engaged at the STP and MPS locations, whereas different O&M agencies were engaged by KMDA at different phases based on tendering process. While formalizing of the O&M contracting process by KMDA, the existing workers were re-engaged by the O&M agency purely based on informal advice by KMDA considering context of the livelihood of the workers. During the contracting process of the O&M agency, wages of the workers were also re-adjusted by the O&M agency in presence of worker's representatives, KMDA as well as political party representatives.

Sl. No	Stakeholder Group	Details of Consultation
		■ When asked about the context, in the event of premature cessation of the the contract, representatives from the contracting agency indicated that, they will abide by the "Pre-mature Ceasation of Contract" condition under their O&M contract and will close their activity within maximum three working days and will be liable to clear all dues related wage, PF/ESI, gratuity (as applicable) and the contractor agency will not have any other legal liability towards the existing contractual workers, as per their contract. ■ Mr. Mithun Barua, Assistant Engineer representing KMDA has also seconded the fact that although there is no formal condition(s) or legal liability stipulated under the O&M contract agreements related to the engagement of skilled or unskilled workers, however while formulating any O&M contract agreement with the different agencies for the STP or associated infrastructure (pumping stations), KMDA provides first priority towards re-engagement of the existing workers by the new O&M agencies out of humanitarian grounds as Principal Employer and it will seek to do so, wherever feasible. He has also mentioned that any decision on the re-engagement of the existing workers can be discussed and clarified with the higher authorities in KMDA. ■ Representative from ERM has briefed the existing workers present during the meeting on the objective and importance of the project under Namami Gange Mission and National Mission for Clean Ganga (NMCG) constituted under Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India. ■ Representative from VA Tech Wabag has explained their involvement context based on PPP based HAM for the demolition and construction of the Baranagar STP, renovation of the pumping stations, repairing, desilting and laying new pipelines under the project's 24 month construction and subsequent O&M phase of 15 years teherafter. ■ Representative from VA Tech Wabag has also clarified that there will be no operations of the existing sewerage treatment and handling infrastructure as well as no requirement of existing worker enagagement during the 24 months construction phase which is yet to start. They have also clarified that the new STP will have modernised operation procedures based on SCADA and less dependency on the man-power. ■ Furthermore, the names mentioned in the list of workers shared by KMDA (hereinafter stated as "KMDA list") were verified against the names of the workers present during the consultation or confirmed by the co-workers. 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 folllwoing facts: ■ Name of Mr. Jiban Rudra who is engaged at Baranagar-Kamarhati MPS for last 15 years (as confirmed by his co-wrokers) was not included in the KMDA list. This fact is cross checked against the site attendance list and found correct. ■ Mr. Bishu Dholui engaged at the MPS is passed away last month, on 24th of August 2019 and in place of him, Mr. Babun Mondal had joined at MPS since 1st September, 2019. This information needs to be updated in the KMDA list. ■ Additionally, one individual Mr. Alok Adhikary, who is the Secretary of the Kakinara Engineers Co-operative Society, was incorrectly listed as a worker.

Sl. No	Stakeholder Group	Details of Consultation
		■ It was also revealed that no appointment letter has been given to the contract workers by the contracting agencies. Monthly payment of wages is done through online bank transfers, and wage slips are also provided to the workers. ■ The workers present during the meeting have confirmed that their ESI and PF contributions are in order and indicated that though the O&M agencies at the Baranagar STP have changed multiple times, their ESI and PF settlements were duly done on time by the respective agencies. ■ The workers shared their positive opinion about the project. Mr. Sujit Kumar Jha, Technical Operator, at Baranagar STP on behalf of all workers present, mentioned the following points: ■ They support and welcome the project in terms of its overall objectives of improving the sewerage system in the area. ■ The workforce is capable to support the O&M work of the project. ■ They have however expressed their concerns on job retention and have requested that all the workers should retain their jobs to maintain their livelihood.
9.	Consultation with the local community residing in Railway Colony, RKPD Road	■ A consultation was conducted with the local community residing at RKPD Road near the cycle stand, which also included the owner of the cycle stand. The RKPD road will be affected by the laying of the sewer pipelines. ■ The cycle stand owner reported that he earns approximately Rs. 500 per day and revealed that the land being utilised for his stand belongs to the Baranagar Municipality, where he pays a yearly tax of approximately Rs. 750. ■ The residents and shop owners also reported that there is a brick sewer line situated below the shops and if any renovation works are required, the requested that machinery be utilised for minimum disruption. ■ RKPD road was observed to be a very busy road and reportedly, there is no alternate route other than RKPD road, therefore suggested that the work be conducted in a manner where there is minimum disruption. ■ The team also provided the participants with information how to access the project's grievance mechanism should they have any concerns in relation to the construction work.
10.	Consultation with the local community residing near MPS	■ There are approximately seven squatter houses and one housing complex comprising of 34 flats situated adjacent to the pumping station. ■ The residents were apprised of the proposed upgradation works particularly the replacement of the sewer pipeline along R.N Tagore road, and were also informed about the timeline of implementation. ■ The team also shared with them the process for conveying any grievances they face during the replacement of the pipelines. The toll free grievance number was shared with the security guard for the Ambi Plaza complex. ■ The participants expressed their willingness to cooperate with the proposed works.

Sl. No	Stakeholder Group	Details of Consultation
11.	Consultation with the local community residing in Railway Colony, RKPD Road	■ A consultation was conducted with the local community, primarily women, residing at the Dakhineshwar Railway Quarters, which is situated near RKPD road. ■ In the quReportedly, there are approximately 150 HHs in the quarters, comprising of approximately 4-5 persons per HH, and all residents are from West Bengal itself. ■ The women are mainly engaged in domestic work; many are also engaged as domestic helpers and are earning approximately Rs. 1000-2000 per month. ■ The residents also reported that there is a manhole in the area which causes a lot of waterlogging in the area, mainly during the rainy season. The area is waterlogging for a few hours and they indicated that this has led to many residents becoming ill with dengue and other water-borne diseases. ■ The team also provided the participants with information on how to access the project's grievance mechanism should they have any concerns in relation to the construction work.

7.5 Stakeholder Engagement Plan

GSSPL 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.

7.5.1 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.

7.5.2 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.

7.6 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**) below.

Table 7.5: Information Disclosure Plan

Topic	Documents to be Disclosed	How & Where	Frequency
Disclosure of the Porposed 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 LRP
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

7.6.1 Information Disclosure with ULBs

KMDA had informed all the concerned ULBs for the 'Pollution Abatement (Interception & Diversion with STP) Works for River Ganga at Howrah, Bally ad 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 13th of November, 2019 between the officials of Baranagar Municipality and Kamarhati Municipality respectively and ERM, to disclose about the KMDA project on the upgradation of the STP and sewerage system at Baranagar and Kamarhati Municipality. 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 Municipal Chairperson and the municipal ward 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 it is assessed, during the construction phase some road side vendors, kiosks may potentially be impacted due to rehabilitation and relaying of the sewer pipelines; this is assessed to be temporary income loss. Survey would be conducted to identify the potentially affected persons. 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 framework document.
- The partcipants requested for information before the commencement of project activities and also demanded 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 Health Officer from the respective municipalities were deployed for 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.**

7.6.2 Disclosure with Community

A disclosure meeting was conducted on the 23rd of November, 2019 between the community at Baranagar Municipality and ERM representatives, to disclose about the KMDA project on the upgradation of the STP and sewerage system at Baranagar and Kamarhati Municipalities. Disclosure meetings were also conducted the potentially affected persons and communities where the sewer pipeline replacement work would be undertaken and at I&D locations.

The following are the main points discussed:

- The ERM team explained to the 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. They were also informed that a compensation is being considered, based on their daily income, only for the period of disruption (when they will be unable to run their business).

- The community members have expressed their support for the project as they view it as beneficial to the community. They however requested that they be informed in advance when the work starts.
- Some members also suggested that once the road work has completed, the roads should be repaired accordingly. The indicated that in the past, certain upgradation works which involved excavation work were not completely repaired, which therefore caused some inconvenience.
- They also suggested that proposed works be conducted in the evenings/ night, to prevent access disruption to the in habitants.
- The members mentioned that since the project is in the public interest, they support the project activities. The minutes of the meetings are provided in the **Appendix K.**

7.6.3 Reporting and Monitoring

It is recommended that during the construction phase of the project, the performance of the SEP 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.

7.7 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 LRP will be based on the Livelihood Restoration Framework (LRF) that has been developed based on international safeguards (IFC Performance Standard) 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

- 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 parties to 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, 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 to 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 comprised 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 or E&S Manager. The complaints /grievances may be received either verbally or through written applications.A Toll Free number 03340055688/689 is 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 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. 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.

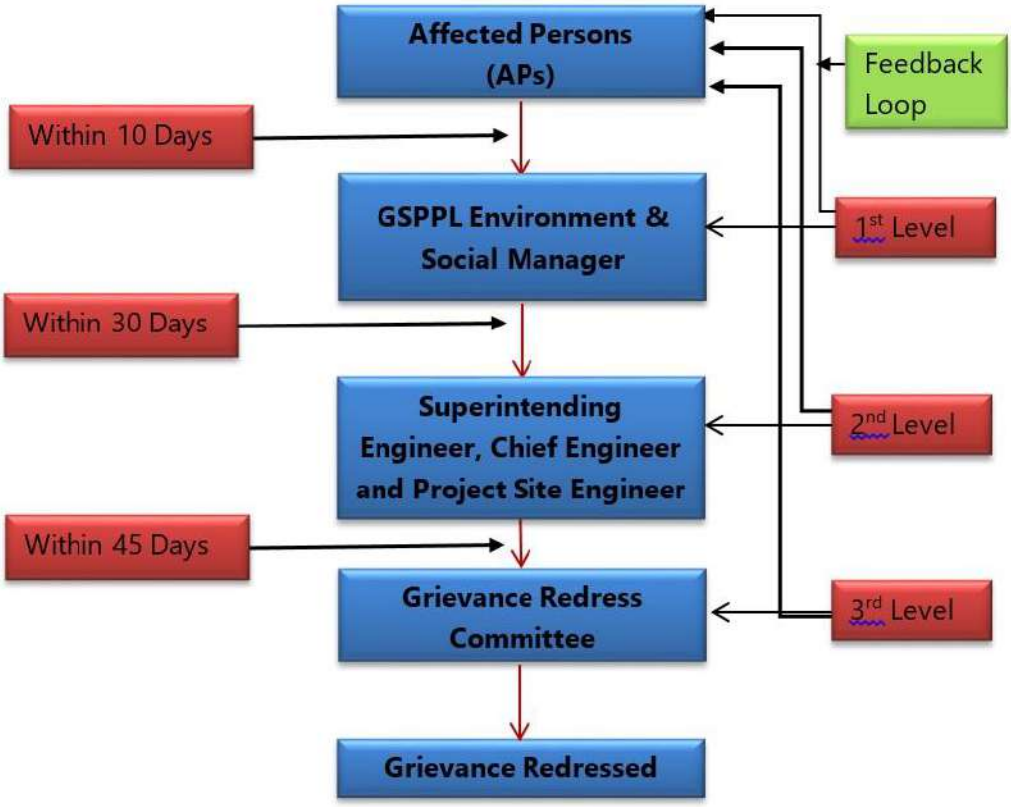
Tier2: Complaints and grievances which remain unresolved, will be escalated to the next tier comprising of the Superintending Engineer, Chief Engineer and Project Site Engineer. Representatives from urban local bodies comprising of both men and women, will also be included as members of the committee. 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** presents the three tier grievance redressal mechanism for addressing external grievances.

Figure 8.1 Grievance Redressal Mechanism for External Stakeholders



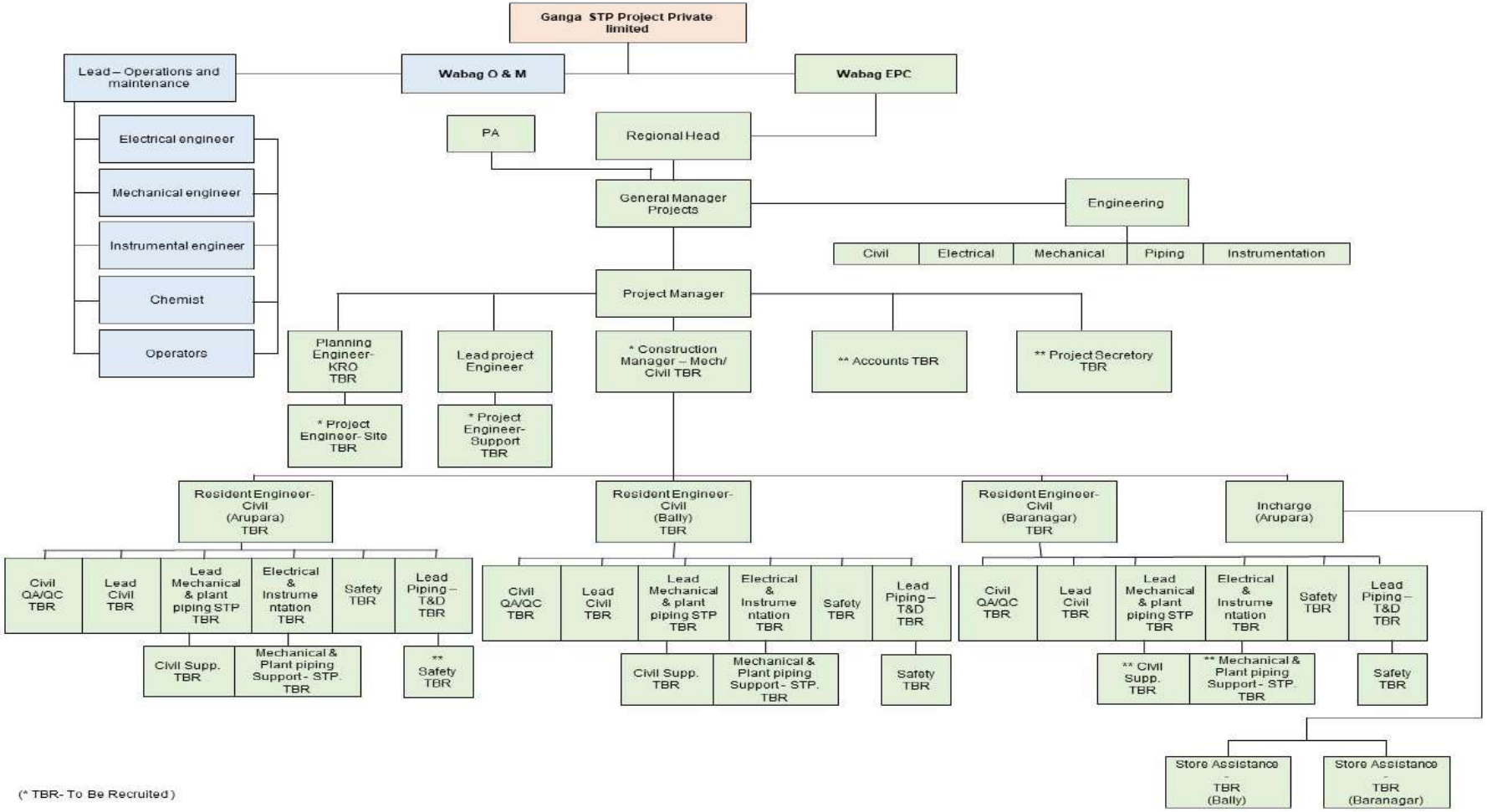
9. ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN

The ESIA for upgradation and renovation of the sewage treatment plant in Baranagar 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 Baranagar 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 Occuopational 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. 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 develpoments regarding the project. However, ultimate responsibility for implementing the provisions of the ESMP will lie with Wabag and peform 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 beingdocumented.The inspection and audit findings are to be implemented by the site In-charge in their respective areas. To ensure contratcor compliance to H&S requirements, E&S manager shall conduct daily checks and inspections. Findings from such inspections will be documneted in the Monthly monitoring reports.

Independent audit shall be conducted during construction and once during operation stage to monitor the implemntation of the ESMP and management plan which also includes the Livelihood Restoration Plan.

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 trainings area 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	Quartely

9.6 Environmental Monitoring

The environmental monitoring programme has been formulated 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 9.2.**

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 De-commissioning and 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., 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 Asthetics	Grading and cleaning of land for demolition activity Emptying of existing structures Demolition of existing structures Storage and disposal of demolition waste Storage and disposal of sludge/silt from decommissioned structure	Visual impact.	Minor (Negative)	Development of Stacking of demolition waste, soil heaps and sludge/silt to be done away from settlements with provision of covers. 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 5.4.1)	GSPPL	GSPPL
Visual and Asthetics	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 5.4.1)	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
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. (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	Storage and handling of chemicals	Soil contamination through spills and leaks	Minor (Negative)	Designated storage area with proper area arrangements	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 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) The waste management plan (including C&D waste as well as Liquid waste) also should contain aspects of adequate storage, diposal, transporation route, training and record keeping for different categories of waste i.e. hazardous waste, non-hazardous waste, solid waste, e-waste, bio-medical waste, municipal solid waste and chemical waste.	GSPPL	GSPPL
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)	GSPPL	GSPPL
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 be designed for the controlled release of storm flows. (Please refer section 5.4.5)	GSPPL	GSPPL
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;	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				Any surplus wastewater from the concrete batching plant will be treated to comply with discharge standards before it is discharged outside the project premise; (Please refer section 5.4.5)		
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
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 SO_2; 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)	Develop a C&D waste management plan; Implementation of a periodic watering and sprinkling regime in particular during the dry season, atleast two times during the day; Minimise the height from which fill materials are unloaded during site backfilling as far as possible. Where 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)	GSPPL	GSPPL
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;	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				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 5.4.3)		
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; 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 rescue personnel are present when work is proceeding;	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				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.	GSPPL	GSPPL
Social Issues Associated with Site Construction Phase						
Loss of Income of Existing Workers	Prior to decomssioning of the STP	The existing workers engaged under the contracting agencies M/s Kakinara Engineers Cooperative Society Ltd. and M/s Sunny Enterprise at the Baranagar STP and MPS respectively, may be be laid off during the new the new O&M phase.	Major (Negative)	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 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.	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				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 (Please refer to Section 5.7)		
Livelihood Restoration Plan for Affetced Persons	Planning Phase Phase	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 (Negative)	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 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: ■ *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 RAP preparation. The contractor should ensure that construction work to take place during off-peak business hour 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 situated next to the MPS. A Temple management plan is required to be developed. Prior to the start of the construction, the shops owners should be made aware of the construction work which will be made available in the local language. Moreover, the affected persons including the general public are to be informed about the project related requirements and information through reliable means of communication. Additionally, basic information such as location, impact estimates, entitlements and implementation schedule, will be presented to affected persons. During construction, the contractors should ensure that the structure near the RoW are not affected and excavation should be carried out to a possible extent to avoid any damages to residential and commercial structure. (Please refer to Section 5.5.2.1)	GSPPL	GSPPL

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)	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.as per applicable regulatory requirement 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. (Please refer to Sections 5.4.10, 5.4.11 and 5.4.12)	GSPPL	GSPPL
	Civil construction during the construction phase of the project.	The civil construction work to be taken place at the STP can provide employment opportunities for women residing in the project area.	Moderate (Negative)	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. 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. (Please refer to Section 5.6)	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 for women residing in the project area.	Moderate	Refer Section 5.6 Ensure the implementation of the Gender Action Plan (GAP) for the 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	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
Environmental Issues Associated with the Operation Phase						
Visual and Asthetics	Physical presence of the STP; Illumination from the STP facility. Operation and Storage of Sludge increasing the Odour	Visual impact and Odour	Minor (Negative)	Appropriate shading of lights to prevent scattering. Tree plantation and odour Monitoring. (Please refer section 5.4.1)	GSPPL	GSPPL
Surface and ground water quality	Oil spills from oil tanks	Impact on soil and ground water environment Contaminated storm water runoff carrying contaminants to Sea Water	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; 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
Surface and ground water quality	Oily water-runoff	Contaminated storm water runoff carrying contaminants to Bagjola and Udaypur Khal	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.	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 Udaypur Khal.	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.	GSPPL	GSPPL
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;	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				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)		
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. (Please refer section 5.4.3)	GSSPL	GSPPL
Noise	Plant operations	Impact on community assets such as water due to water intake and cooking water discharge Increased vehicular traffic in the region Exposure to site accidents and incidents Project Security	Minor (Negative)	Comply with the Community health and safety guidelines presented in 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 5.4.13)	GSPPL	GSPPL
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.	GSPPL	GSPPL
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 (Negative)	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
Community Health and Safety and other issues	Project Operation Phase	Traffic Movement in newly constructed site approach road Risk related to accidental leakage of chlorine gas from the on-site chlorine tonner storage.	Minor (Negative)	Awareness campaign among the community residing adjacent to the road Maintaining healthy relationship with community through CSR activity. (Please refer section 5.4.9) Design of disinfection system involving chlorine tonner storage at the site shall be adopted based on CHEEPO Manual and associated risk control	GSPPL	GSPPL

Project Stage / Affected Aspect	Project Activity	Potential Impacts	Impact Significance	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Mitigation Cost Source
				measures shall be maintained, including access restriction to the chlorine tonner storage area, leakage alarm system, leak absorption system, chlorine blower systems etc. (Please refer Appendix J)		
Social Issues Throughout Project Cycle						
Grievance Redress	Entire Project Cycle	Health and safety risk, Non-payment of wages for workers Community Grievances Compensation and Resettlement	Minor (Negative)	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 decomissioning and construction phase, needs to be developed by GSPPL prior to start of any decommissiong/ 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;
- Structure decontamination and dismantling/decommissioning plan;
- Contaminated material, soil, water and site management plan;
- Testing of sewage/rainwater mix in the existing STP at Baranagar prior to its disposal;
- 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, demolition and other solid waste management plan;
- Surface water, groundwater and contaminated runoff 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 Baranagar 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;
- Surface water, groundwater and contaminated runoff management 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 & Social Monitoring Programme for Project Life Cycle

Project Stage / Affected Component	Potential Impact / Mitigation	Parameters to be Monitored	Measurements	Frequency	Responsibility	Approximate Cost (Rs.)		Budget Source
						Pre-Construction & Construction Phase	Operation 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, PM10,PM2.5	CEM	Continuous	GSPPL	Rs. 100000	Rs. 100000	Installation included in EPC Cost. Monitoring and maintenance in O&M cost
	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 Quarterly	Monitoring done by GSPPL and verification by 3rd Party Environmental Consultant	Rs. 24000	Rs. 24000	ESMP Budget
	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 GSPPL and verification by 3rd Party Environmental Consultant	NA	Rs. 24000	ESMP Budget
Occupational Health and Safety	Accidents or incidents due to operation and maintenance activities, workers' health	Near-misses, incidents, occupational diseases, dangerous occurrences	As to be defined in the H&S Plan to be prepared by RBLTL for the Project	As defined in H&S Plan	GSPPL	Management Time Rs. 20000	Rs. 720000	O&M Cost

	Emergency preparedness –Mock drill record HSE training –Social Medical camp and Others for HSE-June 5th Environmental day celebration National safety Day					Rs. 20000 Rs. 25000 Rs. 150000		
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
	Community disturbance and potential safety hazard due to waterway transportation	Accidents, incidents and complaints	Incidents, accidents and community complaints	Based on occurrence				ESMP Budget
	Public concerns	Complaints from community	As per the grievance redress mechanism	Continuous				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		LRP Budget
		Preparation of LRF for compensation	LRF Document	Before construction work	GSPPL			
		Status of Affected Persons compensated for losses	Compensation Docement/Records Monitoring Reports	Prior to construction work.	GSPPL			
		Disclosure of project information prior to start of project.	As per SEP/ Information Disclosure Plan	Prior to start of construction	GSPPL			
		Number of grievances lodged and addressed	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 Cost +minor cost for engaging the external party		

Access Disruption		Status of implementation of Traffic Management Plan No of registered grievances and redressal status	As per Information Trafficfic Management Plan	construction	GSPPL	Management Cost	Management Cost	ESMP Budget
Intra-state Migrant Workers & Labourers	Potential conflict with local community;	No of registered grievances and redressal status Status of implementation of Labour Management Plan	Incidents, accidents and community complaints	During operation of labour camp.	GSPPL	Management Cost	Management Cost	ESMP Budget
	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 CMP	Incidents, accidents and community complaints	Every 15 days during operation of labour camp.		Management Cost	NA	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 for labour-based work.	Number of women employed as a percentage of total persons employed in construction activities; Number of women workers earning same wage as men workers, as a percentage of total women workers employed in construction activities;	Continuous	GSPPL	Management Cost	Management Cost	ESMP Budget
		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				
		Women should be made aware of the Grievance Redressal Mechanism (GRM) and the Grievance Redressal Committee should also comprise 50% of women members	Number of women members at the Grievance Redressal Committee (GRC)	Continuous				

		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				
Stakeholder Engagement & Grievance Redressal	Health 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 Stakeholder Engagement Plan (SEP) and Grievance Redressal Mechanism	Continuous	GSPPL	Rs. 200,000	Rs. 200,000	ESMP Budget
Consultation and Infomration Disclosure	Project Impacts and status of implementation of ESMP	Disclosure of Environmental and Social Impact Assessment Report; Environmental and Social Management Plan Disclosure of Executive Summary of ESIA and ESMP Reports. Non-technical Summary of Project/ Brochures in Bengali Disclosure of Monthly Monitoring Plan	As per disclosure plan	Continuous	GSPPL	Management cost	Management Cost	
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 Baranagar 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 Adarsh nagar, Satin Sen Nagar, Promod Nagar as described in environmental setting, but it is understood to be short term and only during the de-commissioning and 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 MPS, may potentially be impacted by loss of income if they are not rengaged 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 60 MLD STP would improve the quality of Udyapur canal and prevent direct discharge of raw sewage improving the hygine 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 Performance Standard 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

BARANAGAR SEWAGE TREATMENT PLANT

DOC. NUMBER	REV
10P153 - B0001 - 201	**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 Nº	PAGE Nº	DESCRIPTION

NOTES:

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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 BARANAGAR 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
°C	DEGREE CELCIUS
atm	ATMOSPHERE
cm	CENTIMETER
cm²	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 (°C)	=	C + 273.15	degree Kelvin (°K)	
1 degree Fahrenheit(°F)	=	0.555 (F-32)	degree Celcius (°C)	

5.0 DESIGN BASIS

5.1 FLOW DATA

Reference:

AVERAGE FLOW	=	60	MLD	
	=	60000	m³/d	
	=	2500.00	m³/h	
	=	0.6945	m³/s	
PEAK FACTOR	=	2.25		
PEAK FLOW	=	135	MLD	
	=	135000	m³/d	
	=	5625.00	m³/h	
	=	1.5625	m³/s	
MINIMUM FLOW	=	30	MLD	
	=	30000	m³/d	
	=	1250.00	m³/h	
	=	0.3473	m³/s	

5.2 RAW SEWAGE PARAMETERS

Reference: Schedule 10 : KPI

pH	=	6.5 - 8.0		
TOTAL SUSPENDED SOLIDS, TSS	=	< 600		
	=	600	mg/L	
	=	36000	kg/d	
BIOLOGICAL OXYGEN DEMAND, BOD	=	80 - 250		
	=	250	mg/L	
	=	15000	kg/d	
CHEMICAL OXYGEN DEMAND, COD	=	< 500		
	=	500	mg/L	
	=	30000	kg/d	
VOLATILE SUSPENDED SOLIDS, VSS	=	360	mg/L	
	=	21600	kg/d	
FECAL COLIFORMS NOTE-1	=	10^7-10^8	MPN/100 mL	
MINIMUM SEWAGE TEMPERATURE	=	20	°C	
MAXIMUM SEWAGE TEMPERATURE	=	30	°C	

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

$$P_{atm,H} = P_{atm,0} \times \exp\left\{\frac{-gM_{(H-0)}}{RT}\right\}$$

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	=	101253.0	N/m²
(AT MINIMUM TEMPERATURE)			
ATMOSPHERIC PRESSURE PREVAILING AT SITE	=	101255.4	N/m²
(AT AVERAGE TEMPERATURE)			
ATMOSPHERIC PRESSURE PREVAILING AT SITE	=	101259.8	N/m²
(AT MAXIMUM TEMPERATURE)			

NOTES:

1 AS PER METEROLOGICAL DATA FOR KOLKATTA

6.0 INLET CHAMBER

INLET CHAMBER IS PROVIDED TO ARREST TURBULENCE

AVERAGE FLOW	=	60000	m^3/d
	=	0.6945	m^3/s
PEAK FLOW	=	135000	m^3/d
	=	1.5625	m^3/s
RETENTION TIME AT PEAK FLOW	=	10	s
VOLUME OF INLET CHAMBER REQUIRED	=	15.63	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	=	1.62	m
WIDTH PROVIDED	**=**	**2.00**	**m**
FREEBOARD CONSIDERED	=	0.50	m
VOLUME PROVIDED	=	19.40	m^3
RETENTION TIME PROVIDED	=	12.4	s

NOTES:

7.0 SCREEN CHAMBER

7.1 MECHANICAL SCREEN CHAMBER

TYPE MECHANICAL BAR, STEP TYPE SCREEN

DESIGN AVERAGE FLOW		=	60000	m³/d	
DESIGN PEAK FLOW		=	135000	m³/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		=	0.7813	m³/s	
VELOCITY THROUGH SCREENS		=	1.2	m/s	
NET CLEAR AREA REQUIRED		=	0.66	m²	
LIQUID DEPTH CONSIDERED		=	1.10	m	
NET CLEAR WIDTH REQUIRED		=	0.6	m	
NO. OF OPENINGS REQURIED		=	100	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 REQUIREC		**=**	**9.800**	**m**	
DESIGN VALIDATION					
DESIGN PEAK FLOW		=	0.7813	m³/s	
NET CLEAR AREA FOR SCREENS		=	0.858	m	
VELOCITY THROUGH SCREENS		=	0.92	m/s	
		<=	1.2	m/s	Hence OK
VELOCITY IN APPROACH CHANNEL		=	0.48	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	=	0.92	m/s
V_2	=	VELOCITY IN APPROACH CHANNEL	=	0.48	m/s

SUBSTITUTING THE VALUES,

HEAD LOSS THROUGH SCREEN AT CLEAN CONDITIONS = 45 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	=	1.84	m/s
V_2	=	VELOCITY IN APPROACH CHANNEL	=	0.48	m/s

SUBSTITUTING THE VALUES,

HEAD LOSS THROUGH SCREEN AT 50% CLOGGED CONDITIONS = 231 mm

NOTES:

7.2 MANUAL SCREEN CHAMBER

TYPE MANUAL BAR SCREEN

DESIGN AVERAGE FLOW	=	30000	m³/d
DESIGN PEAK FLOW	=	67500	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	=	0.7813	m³/s
VELOCITY THROUGH SCREENS	=	1.2	m/s
NET CLEAR AREA REQUIRED	=	0.66	m²
LIQUID DEPTH CONSIDERED	=	1.10	m
NET CLEAR WIDTH REQUIRED	=	0.6	m
NO. OF OPENINGS REQURIED	=	100	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	=	0.7813	m³/s	
NET CLEAR AREA FOR SCREENS	=	0.8382	m	
VELOCITY THROUGH SCREENS	=	0.94	m/s	
	<=	1.2	m/s	Hence OK
VELOCITY IN APPROACH CHANNEL	=	0.49	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	=	0.94	m/s
V_2	=	VELOCITY IN APPROACH CHANNEL	=	0.49	m/s

SUBSTITUTING THE VALUES,

HEAD LOSS THROUGH SCREEN AT CLEAN CONDITIONS = 47 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	=	1.88	m/s
V_2	=	VELOCITY IN APPROACH CHANNEL	=	0.49	m/s

SUBSTITUTING THE VALUES,

HEAD LOSS THROUGH SCREEN 50% CLOGGED CONDITIONS = 241 mm

NOTES:

8.0 GRIT CHAMBER

TYPE : DETRITOR TYPE WITH INTEGRAL GRIT CLASSIFIER

DESIGN BASIS

DESIGN PEAK FLOW	=	135000	m³/d
DESIGN AVERAGE FLOW	=	60000	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	= 67500	m³/d
SURFACE OVERFLOW RATE REQUIRED	= 618.3	m³/m²/d
HENCE,		
SURFACE AREA REQUIRED	= 109.18	m²
SIZE OF GRIT CHAMBER REQUIRED	= 10.45	m
SIZE OF GRIT CHAMBER PROVIDED	**= 10.50**	**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	= 67500	m³/d	
SIZE OF GRIT CHAMBER	= 10.50	m	
LIQUID DEPTH OF GRIT CHAMBER	= 0.80	m	
HORIZONTAL VELOCITY OF FLOW, V_h	= 0.094	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	=	30	60	135	MLD
	=	30000	60000	135000	m³/d
	=	0.3473	0.6945	1.5625	m³/s
NO. OF WORKING UNITS	=	1	1	1	No.
DESIGN FLOW PER UNIT	=	0.3473	0.6945	1.5625	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	=	0.3473	0.6945	1.5625	m³/s
LIQUID DEPTH IN CONVERGING SECTION OF FLUME	=	0.261	0.404	0.676	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	=	0.180	0.280	0.470	m

NOTES:

APPROACH CHANNEL

WIDTH OF APPROACH CHANNEL =	2.00	m
LIQUID DEPTH IN APPROACH CHANNEL =	0.770	m
MAXIMUM DESIGN FLOW PER UNIT =	1.5625	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

$$Froude\ Number = \frac{V}{\left(g \times \frac{A}{w}\right)^{0.5}}$$

WHERE

V	=	VELOCITY OF FLOW IN APPROACH CHANNEL	=	1.02	m/s
g	=	ACCELERATION DUE TO GRAVITY	=	9.810	m/s²
A	=	AREA OF FLOW IN APPROACH CHANNEL	=	1.540	m²
W	=	WIDTH OF APPROACH CHANNEL	=	2.00	m

SUBSTITUTING THE VALUES,

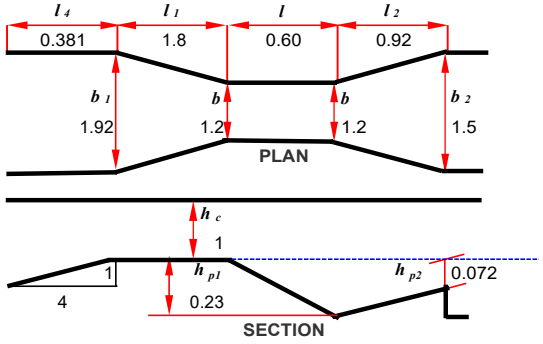
FROUDE NUMBER =	0.38		
<=	0.5	Hence OK	

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	0.770	--	0.770
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	=	60000.00	m³/d	
RETURN FLOW	=	485	m³/d	
EXCESS SLUDGE FLOW	=	1589	m³/d	
PRIMARY INLET AVERAGE FLOW	=	62074.00	m³/d	
RAW SEWAGE PEAK FLOW	=	135000.00	m³/d	
RETURN FLOW	=	485	m³/d	
EXCESS SLUDGE FLOW	=	1589	m³/d	
PRIMARY INLET PEAK FLOW	=	137074.00	m³/d	

		RAW SEWAGE	RETURN FLOW	EXCESS SLUDGE	PRIMARY INLET
AVG. FLOW	m³/d	60000.00	485.00	1589.00	62074.00
TSS	mg/L	600.00	5830.93	8042.8	831.4
	kg/d	36000	2828.00	12780.00	51608.0
BOD	mg/L	250.00	1416.50	2001.26	303.95
	kg/d	15000	687.00	3180.00	18867.0
VSS	mg/L	360.00	2138.15	3187.54	446.28
	kg/d	21600	1037.00	5065.00	27702.0

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	=	62074.00	m³/d
DESIGN PEAK FLOW	=	137074.00	m³/d
NO. OF UNITS	**=**	**2**	**Nos.**
SURFACE LOADING RATE ON PLATES AT AVERAGE FLOW	=	30	m³/m²/d
SURFACE LOADING RATE ON PLATES AT PEAK FLOW	=	60	m³/m²/d

Reference : CPHEEO Manual on Sewerage and Sewage Treatment Plants, 3rd Edition, Page 5 - 53

PLATE AREA REQUIRED PER UNIT AT AVERAGE FLOW	=	1034.567	m²
PLATE AREA REQUIRED PER UNIT AT PEAK FLOW	=	1142.284	m²
HENCE, DESIGN PLATE AREA REQUIRED PER UNIT	=	1142.284	m²

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	m²

LENGTH OF CLARIFIER

NO. OF PLATES REQUIRED PER UNIT	=	816.3	Nos.
NO. OF ROWS CONSIDERED	=	8	Nos.
NO. OF PLATES REQUIRED PER ROW	=	103	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	=	2	m
INCLINATION SPACE FOR PLATES	=	2 X Cos 55°	
	=	1.15	m
LENGTH OF THE UNIT REQUIRED	=	13.3704	m
LENGTH OF THE UNIT CONSIDERED	**=**	**13.70**	**m**
NO. OF PLATES CONSIDERED	=	106	Nos
SURFACE LOADING RATE PROVIDED	=	26.15	m³/m²/d
SURFACE LOADING RATE PROVIDED	=	57.75	m³/m²/d

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	=	11.975	m^2	
WIDTH OF THE CLARIFIER PROVIDED	=	13.700	m	
HENCE, DEPTH REQUIRED BELOW PLATES	=	0.90	m	
SPACE REQUIRED ABOVE PLATES	=	0.90	m	
VERTICAL HEIGHT OF PLATES	=	2 X Sin 55°		
	=	1.64	m	
SPACE PROVIDED FOR SLUDGE COMPRESSION	=	2.40	m	
SPACE REQUIRED FOR SLUDGE SCRAPPER	=	0.20	m	
HENCE, TOTAL SIDE WATER DEPTH REQUIRED	=	6.04	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	=	62074.00	m³/d
TSS FROM RAW SEWAGE	=	36000.0	kg/d
TSS FROM RETURN FLOWS	=	2828.0	kg/d
TSS FROM EXCESS SLUDGE	=	12780.0	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	=	30965	kg/d
HENCE, THICKENED SLUDGE FLOWRATE	=	505.97	m³/d
BOD FROM RAW SEWAGE	=	15000.0	kg/d
BOD FROM RETURN FLOWS	=	687.0	kg/d
BOD FROM EXCESS SLUDGE	=	3180.0	kg/d
BOD REDUCTION FROM RAW SEWAGE AND RETURN FLOWS	=	30%	
BOD REDUCTION FROM EXCESS SLUDGE	=	60%	
BOD IN THICKENED SLUDGE	=	6615.00	kg/d
VSS FROM RAW SEWAGE	=	21600.0	kg/d
VSS FROM RETURN FLOWS	=	1037.0	kg/d
VSS FROM EXCESS SLUDGE	=	5065.0	kg/d
VSS REDUCTION FROM RAW SEWAGE AND RETURN FLOWS	=	60%	
VSS REDUCTION FROM EXCESS SLUDGE	=	60%	
VSS IN THICKENED SLUDGE	=	16622.00	kg/d

MASS BALANCE		PRIMARY INLET	THICKENED SLUDGE	PRIMARY OUTLET
FLOWRATE	m³/d	62074.00	505.97	61568.03
TSS	mg/L	831.40	61199.29	335.29
	kg/d	51608.00	30965.00	20643.0
BOD	mg/L	303.95	13073.9	199
	kg/d	18867.00	6615.00	12252.0
VSS	mg/L	446.28	32851.76	179.97
	kg/d	27702.00	16622.00	11080.0

NOTES:

NO. OF BATCHES FOR SLUDGE WITHDRAWAL	=	24	Nos.	
TIME INTERVAL BETWEEN EACH BATCH	=	60.00	min	
BATCH VOLUME	=	10.542	m^3	
DURATION OF SLUDGE WITHDRAWAL PER BATCH	=	5.00	min	
HENCE,				
SLUDGE WITHDRAWAL FLOWRATE	=	126.50	m^3/h	
SLUDGE PIPE SIZE	=	250	mm	
VELOCITY IN SLUDGE PIPELINE	=	0.72	m/s	

SLUDGE WITHDRAWAL FROM CLARIFIER WILL BE CONTROLLED BASED ON TIMER.

NOTES:

11.0 AERATION TANK

AVERAGE FLOW	=	61568.03	m³/d
PEAK FLOW	=	136568.03	m³/d

INFLUENT CHARACTERISTICS

BOD	=	199	mg/L
TSS	=	335.29	mg/L
VSS	=	179.97	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

$$V = \frac{Y \times Q \times (S_O - S) \times \theta_C}{\{(1 + k_d \times \theta_c) \times X_V\}}$$

WHERE

Y	=	YIELD CO-EFFICIENT	=	0.5	g VSS / g BOD
Q	=	DESIGN FLOW	=	61568.03	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 61568.03 x (199 - 20) x 6] / [(1 + 0.06 x 6) x 2400]

TOTAL VOLUME OF AERATION TANK REQUIRED	=	10129.30	m³
NO. OF TANKS	=	2	Nos.
VOLUME OF EACH TANK REQUIRED	=	5065	m³
LIQUID DEPTH	**=**	**5.65**	**m**
DIAMETER OF AERATION TANK REQUIRED	=	33.79	m
DIAMETER OF AERATION TANK PROVIDED	**=**	**34.60**	**m**
FREEBOARD CONSIDERED	**=**	**0.50**	**m**
TOTAL DEPTH OF AERATION TANK PROVIDED	=	6.15	m

NOTES:

VOLUME OF EACH AERATION TANK PROVIDED				=	5312.40	m³
HYDRAULIC RETENTION PROVIDED				=	4.15	h

FOOD TO MICROORGANISM RATIO

$$F/M = \frac{Q\,S_O}{V\,X}$$

WHERE

Q	=	DESIGN FLOW	=	61568.03	m³/d
S_o	=	INLET BOD CONCENTRATION	=	199	mg/L
V	=	VOLUME OF AEARATION TANK	=	10624.8	m³
X	=	MLSS CONCENTRATION IN AERATION TANK	=	3000	mg/L

SUBSTITUTING THE VALUES

F/M = (61568.03 x 199) / (10624.8 x 3000)

F/M RATIO	=	0.3844	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	=	61568.03	m³/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	=	179.97	mg/L

SUBSTITUTING THE VALUES

$P_{X,TSS}$ = { { [0.368 x 61568.03 x (199 - 20)] / 0.8 } + { 61568.03 x (335.29 - 179.97) } } / 1000

$P_{X,TSS}$	=	14632.26	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	=	61568.03	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 = { { [61568.03 x (199 - 20)] / 0.68 } - { 1.42 x 61568.03 x 0.368 x (199 - 20) } } / 1000

OXYGEN REQUIRED	=	10448	kg/d
INLET BOD	=	199.00	mg/L
OUTLET BOD	=	20.00	mg/L
BOD REMOVED	=	11021.00	kg/d
OXYGEN REQUIRED FOR BOD REMOVAL	=	1.00	kg O_2 / kg BOD
OXYGEN REQUIRED FOR BOD REMOVAL	=	11021	kg/d
OXYGEN PROVIDED	=	11021	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	=	4.15	h
		4-6	h
F/M RATIO	=	0.3844	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	=	11021.00	kg/d
AERATION TIME	=	24.00	h
NO. OF BASINS	=	2	Nos.
AERATION REQUIRED PER BASIN	=	229.61	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

$$P_{atm,H} = P_{atm,0} \times \exp\left\{\frac{-gM(H-0)}{RT}\right\}$$

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:

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	=	9.08	7.54	mg/L
AT ALTITUDE H AND TEMPERATURE T, $C_{s,T,H}$				

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

$$SOTR = \frac{AOTR}{\left\{\left(\frac{\beta . C_{\hat{S},T,H} - C_L}{C_{S,20}}\right) \times 1.024^{T-20} \times \propto \times F\right\}}$$

Reference : Waste Water Engineering – Treatment and Reuse, 4th Edition, Metcalf & Eddy, Page no. 430

WHERE

AOTR	= ACTUAL OXYGEN TRANSFER RATE REQUIRED	229.61	229.61	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 = 229.61 / { [((0.95 x 10.78) - 1) / 9.08] x [1.024 ^ (20 - 20)] x 0.65 x 0.9 }

SOTR = 229.61 / { [((0.95 x 8.95) - 1) / 9.08] x [1.024 ^ (30 - 20)] x 0.65 x 0.9 }

STANDARD OXYGEN TRANSFER RATE REQUIRED =	385.66	374.73	kg/h

DETERMINATION OF AERATION AIR REQUIRED

STANDARD OXYGEN TRANSFER RATE REQUIRED =	385.66	374.73	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] =	5140.30	4994.60	m³/h

12.1 AERATION AIR BLOWER

DESIGN FLOW RATE [1 atm , 20 deg C] =	5140.30	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] =	5654.33	m³/h	
CAPACITY PROVIDED [1 atm , 20 deg C] =	**6200.00**	**m³/h**	
MASS FLOWRATE OF AIR PROVIDED =	7502.00	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	=	61568.03	m³/d
DESIGN PEAK FLOW	=	136568.03	m³/d
RAS RATIO CONSIDERED	=	0.60	
RAS FLOWRATE	=	36940.82	m³/d
MLSS CONCENTRATION IN AERATION TANK	=	3000	mg/L
DESIGN INFLUENT SOLIDS AT AVERAGE FLOW	=	295527	kg/d
DESIGN INFLUENT SOLIDS AT PEAK FLOW	=	520527	kg/d

DESIGN BASIS

TYPE SQUARE TYPE CLARIFIER

NO. OF UNITS	**=**	**2**	**Nos.**
SURFACE OVERFLOW RATE AT AVERAGE FLOW	=	35	m³/m²/d
SURFACE OVERFLOW RATE AT PEAK FLOW	=	50	m³/m²/d
SOLIDS LOADING RATE AT AVERAGE FLOW	=	140	kg/m²/d
SOLIDS LOADING RATE AT PEAK FLOW	=	210	kg/m²/d
AREA REQUIRED AT AVERAGE FLOW BASED ON SOR	=	879.55	m²
AREA REQUIRED AT PEAK FLOW BASED ON SOR	=	1365.69	m²
AREA REQUIRED AT AVERAGE FLOW BASED ON SOLIDS LOADING	=	1055.46	m²
AREA REQUIRED AT PEAK FLOW BASED ON SOLIDS LOADING	=	1239.35	m²

HENCE,

SURFACE AREA OF CLARIFIER REQUIRED	=	1365.69	m²

INLET COLUMN

FLOW FROM AERATION TANK ENTERS CLARIFIER THROUGH A CENTRAL COLUMN.

DESIGN INFLUENT FLOWRATE PER UNIT	=	86754.43	m³/d
VELOCITY THROUGH COLUMN	=	1.2	m/s
DIA OF COLUMN REQUIRED	=	1.04	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	m²

NOTES:

CLARIFIER SIZING

PLAN AREA OF CLARIFIER REQUIRED	=	1367.71	m²
SIZE OF CLARIFIER REQUIRED	=	36.99	m
SIZE OF CLARIFIER PROVIDED	**=**	**37.00**	**m**
SIDE WATER DEPTH	**=**	**3.5**	**m**
FREE BOARD CONSIDERED	=	0.3	m
VOLUME OF CLARIFIER PROVIDED	=	4791.5	m³
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	**=**	**1.50**	**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	=	272.8	m
WEIR LOADING RATE	=	112.9	m³/m.d

DESIGN VALIDATION

SURFACE LOADING RATE AT AVERAGE FLOW	=	22.52	m³/m²/d
	<=	15-35	
SURFACE LOADING RATE AT PEAK FLOW	=	49.96	m³/m²/d
	<=	40-50	
SOLIDS LOADING RATE AT AVERAGE FLOW	=	108.1	kg/m²/d
	<=	70-140	
SOLIDS LOADING RATE AT PEAK FLOW	=	190.4	kg/m²/d
	<=	210	
WEIR LOADING RATE	=	112.9	m³/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

$$Q_R = \frac{X}{(X - X_R)}$$

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 AVERAGEFLOW	=	61568.03	m³/d
RETURN SLUDGE FLOW	=	36940.82	m³/d

EXCESS SLUDGE

BIOMASS GENERATED FROM AERATION TANK	=	14632.26	kg/d
DESIGN AVERAGEFLOW	=	61568.03	m³/d
TSS IN SECONDARY CLARIFIER OUTLET	=	30	mg/L
HENCE, TSS IN EXCESS SLUDGE	=	12785.22	kg/d
MLSS CONCENTRATION	=	8000	mg/L
HENCE, EXCESS SLUDGE FLOW RATE	=	1590.21	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	=	36940.82	m³/d
EXCESS SLUDGE FLOW RATE	=	1590.21	m³/d
TOTAL SLUDGE FLOW RATE	=	38531.03	m³/d
RETENTION TIME CONSIDERED	=	5	min
VOLUME OF SUMP REQUIRED	=	133.8	m³
TYPE	=	ATMOSPHERIC, OPEN	
SHAPE	=	RECTANGULAR	
LIQUID DEPTH	**=**	**3.00**	**m**
LENGTH OF THE SUMP CONSIDERED	**=**	**8.00**	**m**
WIDTH OF THE SUMP REQUIRED	=	5.58	m
WIDTH OF THE SUMP PROVIDED	**=**	**6.00**	**m**
VOLUME OF SUMP PROVIDED	=	144.00	m³

NOTES:

13.3 RAS PUMP

DAILY SLUDGE FLOW RATE	=	38531.03	m³/d	
OPERATING HOURS PER DAY	=	24.0	h	
NO. OF DUTY PUMPS	**=**	**2**	**Nos.**	
NO. OF STANDBY PUMPS	**=**	**1**	**No.**	
CAPACITY OF PUMP REQUIRED	=	802.73	m³/h	
CAPACITY OF PUMP PROVIDED	**=**	**805.00**	**m³/h**	
TYPE	**=**	**SUBMERSIBLE**		
OPERATION	=	CONTINUOUS		
FLUID HANDLED	=	0.8 % RAS SLUDGE		
VFD OPERATION	=	NO		

MASS BALANCE

EXCESS SLUDGE	=	1590.21	m³/d	
DESIGN AVERAGE FLOW TO AERATION TANK	=	61568.03	m³/d	
DESIGN PEAK FLOW TO AERATION TANK	=	136568.03	m³/d	
AVERAGE FLOW FROM SECONDARY CLARIFIER	=	59977.82	m³/d	
PEAK FLOW FROM SECONDAY CLARIFIER	=	134977.82	m³/d	
TSS IN TREATED SEWAGE	=	30.00	mg/L	
	=	1799.34	kg/d	
BOD IN TREATED SEWAGE	=	20.00	mg/L	
	=	1199.56	kg/d	
pBOD IN TREATED SEWAGE	=	18.83	mg/L	
(0.65 x 1.42 x 0.68 x TSS)	=	1129.34	kg/d	
sBOD IN TREATED SEWAGE	=	1.17	mg/L	
	=	1199.56	kg/d	
TSS IN EXCESS SLUDGE	=	12785.22	kg/d	
VSS IN EXCESS SLUDGE	=	5069.51358	kg/d	
SOLIDS DUE TO BIOMASS	=	5069.514	kg/d	
pBOD IN EXCESS SLUDGE	=	3181.83	kg/d	
(0.65 x 1.42 x 0.68 x BIOMASS SOLIDS)				
sBOD IN EXCESS SLUDGE	=	1.87	kg/d	
BOD IN EXCESS SLUDGE	=	3183.70	kg/d	

NOTES:

			AERATION INLET	EXCESS SLUDGE	SECONDARY OUTLET
AVG. FLOW	m^3/d		61568.03	1590.21	59977.82
TSS	mg/L		335.30	8040	30
	kg/d		20643.00	12785.22	1799.34
BOD	mg/L		199.00	2002.1	20
	kg/d		12252.00	3183.70	1199.56
VSS	mg/L		180.00	3188	24
	kg/d		11080.00	5069.51	1439.47

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	=	60000.00	m³/d
RETENTION TIME	=	30	min
NO. OF UNITS	**=**	**1**	**No.**
VOLUME OF TANK REQUIRED	=	1250	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	**=**	**37**	**m**
WIDTH OF TANK REQUIRED	=	9.132	m
WIDTH OF TANK PROVIDED	**=**	**9.20**	**m**
FREEBOARD CONSIDERED	=	0.3	m

14.2 CHLORINATION

DESIGN AVERAGE FLOW	=	60000	m³/d
CHLORINE DOSAGE CONSIDERED	=	10.00	mg/L
CHLORINATION CAPACITY REQUIRED	=	25	kg/h
NO. OF WORKING UNITS	=	1	No.
NO. OF STANDBY UNITS	=	1	No.
CAPACITY OF EACH CHLORINATOR REQUIRED	=	25	kg/h
CAPACITY OF EACH CHLORINATOR PROVIDED	**=**	**25**	**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	=	505.97	m³/d
BATCH VOLUME OF SLUDGE FROM THICKENER	=	10.542	m³
NO. OF BATCHES CONSIDERED FOR STORAGE	=	3	Nos.
WORKING VOLUME OF SUMP REQUIRED	=	31.63	m³
TYPE	**=**	**ATMOSPHERIC, OPEN**	
SHAPE	=	SQUARE	
LIQUID DEPTH	**=**	**3.00**	**m**
LENGTH OF THE TANK CONSIDERED	**=**	**3.60**	**m**
WIDTH OF THE TANK REQUIRED	=	2.93	m
WIDTH OF THE TANK PROVIDED	**=**	**3.20**	**m**
VOLUME OF EACH TANK PROVIDED	=	34.56	m³

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	=	505.97	m³/d
OPERATING HOURS	=	24.0	h
NO. OF DUTY PUMPS	**=**	**2**	**Nos.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	10.55	m³/h
CAPACITY OF PUMP PROVIDED	**=**	**11.00**	**m³/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		=	505.97	m³/d
TSS IN THICKENED SLUDGE		=	30965.00	kg/d
VSS IN THICKENED SLUDGE		=	16622.00	kg/d
BOD IN THICKENED SLUDGE		=	6615.00	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		=	2530	m³
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		=	21.46	m
DIA OF DIGESTER PROVIDED		**=**	**22.70**	**m**
DIA OF CONE AT THE TOP		=	4	m
HEIGHT OF TOP CONE PROVIDED		=	3.49	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		**=**	**1.48**	**m**
VSS DESTRUCTION		=	50%	
Reference: CPHEEO Manual on Sewerage and Sewage Treatment Systems, 2013				
THICKENED SLUDGE VSS		=	16622.00	kg/d
VSS DESTROYED		=	8311.00	kg/d
GAS PRODUCED	1 atm 20 deg C	=	0.9	m³/kg VSS destroyed
		=	7480.00	m³/d
Reference: CPHEEO Manual on Sewerage and Sewage Treatment Systems, 2013				
VSS LOADING RATING		=	2.50	kg/m³/d
			1.6 - 6.5	kg/m³/d
Reference: CPHEEO Manual on Sewerage and Sewage Treatment Systems, 2013				

NOTES:

MASS BALANCE

TSS IN THICKENED SLUDGE	=	30965.00	kg/d
VSS DESTROYED	=	8311.00	kg/d
SOLIDS IN DIGESTER AFTER DIGESTION	=	22654.00	kg/d
BOD STABILISATION IN DIGESTER	=	60%	
BOD IN DIGESTER AFTER DIGESTION	=	2646	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	505.97	505.97
TSS	mg/L	61199.30	44773.5
	kg/d	30965.00	22654.00
BOD	mg/L	13073.90	5229.6
	kg/d	6615.00	2646.00
VSS	mg/L	32851.80	16425.9
	kg/d	16622.00	8311.00

15.5 DIGESTER MIXING PUMP

VOLUME OF EACH DIGESTER	=	3318.7	m³
MIXING TURNDOWN PER DAY	=	3	Nos.
CAPACITY OF PUMP REQUIRED	=	9956.1	m³/d
OPERATING HOURS	=	24	h
NO. OF DUTY PUMPS / DIGESTER	**=**	**1**	**No.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	414.84	m³/h
CAPACITY OF PUMP PROVIDED	**=**	**500.00**	**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	°C
WINTER AVERAGE AMBIENT TEMPERATURE	=	15	°C
SUMMER AVERAGE AMBIENT TEMPERATURE	=	45	°C
MINIMUM SEWAGE TEMPERATURE	=	20	°C
MAXIMUM SEWAGE TEMPERATURE	=	30	°C
AVERAGE WINTER GROUND TEMPERATURE	=	20	°C
AVERAGE SUMMER GROUND TEMPERATURE	=	32	°C

DIGESTER DIMENSIONAL DATA

NUMBER OF DIGESTERS		=	2	Nos.
DIAMETER OF CYLINDRICAL PART	D	=	22.70	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	=	3.49	m
HEIGHT OF UPPER DOME	h_2	=	1.20	m
HEIGHT OF BOTTOM CONE	h_4	=	1.48	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, **$Q = m C_p dT$**

WHERE

m	=	SLUDGE FEEDING FLOW RATE	=	22.00	22.00	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	=	127.9	383.5	kW

NOTES:

HEAT LOSS FROM UPPER CONE & DOME

DIAMETER OF CYLINDRICAL PART	D	=	22.70	m
DIAMETER OF UPPER CONE	d	=	4.00	m
HEIGHT OF UPPER CONE	h	=	1.48	m

ANGLE OF UPPER CONE α = **ATAN (h / [(D / 2) - (d / 2)])**

= ATAN { 1.48 / [(22.7 / 2) - (4 / 2)] } = 8.99 °

UPPER CONE & DOME SURFACE AREA **A = π h [(D/2) + (d/2)] / Sin α + π d h_1**

= PI x 1.48 x [(22.7 / 2) + (4 / 2)] / SIN 8.99 = 412.31 m²

HEAT TRANSFER COEFFICIENT OF UPPER CONE & DOME

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 CONE & DOME	412.31	412.31	m²
T_1	=	DIGESTER TEMPERATURE	35	35	°C
T_2	=	AMBIENT TEMPERATURE	45	15	°C

SUBSTITUTING THE VALUE

= 3.04 x 412.31 x (35 - 45) @ WINTER

= 3.04 x 412.31 x (35 - 15) @ SUMMER

HEAT LOSS FROM UPPER CONE & DOME	=	-12535	25069 W
	=	-12.535	25.069 kW

NOTES:

HEAT LOSS FROM CYLINDRICAL PART ABOVE GROUND

DIAMETER OF CYLINDRICAL PART	D	=	22.70 m
HEIGHT OF CYLINDER ABOVE GROUND	h	=	6.20 m
SURFACE AREA OF CYLINDER ABOVE GROUND	$A = \pi D h$	=	442.15 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	=	442.15	442.15	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	=	-13442	26883	W
	=	-13.442	26.883	kW

HEAT LOSS FROM CYLINDRICAL PART BELOW GROUND

DIAMETER OF CYLINDRICAL PART	D	=	22.70 m
HEIGHT OF CYLINDER BELOW GROUND	h	=	2.00 m
SURFACE AREA OF CYLINDER BELOW GROUND	$A = \pi D h$	=	142.63 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	=	142.63	142.63	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	=	856	4279	W
	=	0.856	4.279	kW

NOTES:

HEAT LOSS FROM BOTTOM CONE

DIAMETER OF CYLINDRICAL PART	D	=	22.70	m
DIAMETER OF BOTTOM CONE	d	=	5.00	m
HEIGHT OF BOTTOM CONE	h	=	1.48	m

ANGLE OF BOTTOM CONE $\beta = \text{ATAN}\ (\ h\ /\ [\ (D\ /\ 2) - (d\ /\ 2)\ ]\ )$

= ATAN { 1.48 / [(22.7 / 2) - (5 / 2)] } = 9.49 °

BOTTOM CONE SURFACE AREA $A = \pi\ h\ [\ (D/2) + (d/2)]\ /\ \text{Sin}\ \beta$

= PI x 1.48 x [(22.7 / 2) + (5 / 2)] / SIN 9.49 = 390.58 m²

HEAT TRANSFER COEFFICIENT OF BOTTOM 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	0.35	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/(m².K)
A	=	SURFACE AREA OF LOWER CONE	=	390.58	390.58	m²
T_1	=	DIGESTER TEMPERATURE	=	35	35	°C
T_2	=	GROUND TEMPERATURE	=	32	20	°C

SUBSTITUTING THE VALUES

HEAT LOSS FROM BOTTOM DOME	=	2930	14647	W
	=	2.93	14.647	kW

HEAT LOSS SUMMARY

HEAT LOSS FROM UPPER CONE & DOME	=	-12.535	25.069	kW
HEAT LOSS FROM CYLINDER ABOVE GROUND	=	-13.442	26.883	kW
HEAT LOSS FROM CYLINDER BELOW GROUND	=	0.856	4.279	kW
HEAT LOSS FROM BOTTOM CONE	=	2.93	14.647	kW
TOTAL HEAT LOSS FROM DIGESTER	=	-22.191	70.878	kW
NO. OF DIGESTERS	=	2	2	Nos.
HEAT LOSS TO BE COMPENSATED FOR DIGESTER	=	-44.382	141.756	kW

NOTES:

15.7 SLUDGE RECIRCULATION PUMP

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	=	22.00	m^3/h	
RECIRCULATION FLOW RATE REQUIRED	=	66.00	m^3/h	
NO. OF DUTY PUMPS	**=**	**2**	**Nos.**	
NO. OF STANDBY PUMPS	**=**	**2**	**Nos.**	
CAPACITY OF PUMP REQUIRED	=	33.00	m^3/h	
CAPACITY OF PUMP PROVIDED	**=**	**33.00**	**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	=	127.9	383.5	kW
HEAT LOSS FROM DIGESTER	=	-44.382	141.756	kW
TOTAL HEAT REQUIRED	=	83.518	525.256	kW
SAFETY FACTOR	=	15%	15%	
HEAT EXCHANGER CAPACITY REQUIRED	=	96.1	604.1	kW
HEAT EXCHANGER CAPACITY	=	604.1	kW	

TYPE : PIPE IN PIPE HEAT EXCHANGER

NO. OF UNITS	**=**	**2**	**Nos.**
HEAT EXCHANGER CAPACITY REQUIRED	=	303	kW
HEAT EXCHANGER CAPACITY PROVIDED	**=**	**325**	**kW**

COLD FLUID

FEED SLUDGE FLOWRATE	=	22.00	m^3/h
FEED SLUDGE TEMPERATURE	=	20	°C
RECIRCULATION SLUDGE FLOWRATE	=	66	m^3/h
RECIRCULATION SLUDGE TEMPERATURE	=	35	°C
COLD FLUID FEED TEMPERATURE	=	31.25	°C
COLD FLUID FLOWRATE PER EXCHANGER	=	44	m^3/h

NOTES:

FEED FLOWRATE	=	44	m³/h	
SPECIFIC HEAT CAPACITY OF FEED	=	1.162	kWh/(m³.K)	
HEAT EXCHANGER CAPACITY	=	325	kW	
HENCE, INCREASE IN TEMPERATURE	=	6.36	°C	
SLUDGE TEMPERATURE AFTER HEATING	=	37.70	°C	

HOT WATER REQUIREMENT

HEAT EXCHANGER CAPACITY	=	325	kW
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 REQUIRED PER HEAT EXCHANGER	=	13.99	m³/h
TOTAL HOTWATER REQUIRED	=	27.98	m³/h

HEAT EXCHANGER DESIGN SUMMARY

TYPE	PIPE IN PIPE HEAT EXCHANGER			
NO. OF UNITS		**=**	**2**	**Nos.**
CAPACITY		**=**	**325**	**kW**
			SLUDGE	**HOTWATER**
SUPPLY TEMPERATURE		=	31.25	80.00
RETURN TEMPERATURE		=	37.70	60.00
FLOW RATE		=	44.00	14.00
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	=	27.98	m³/h
NO. OF DUTY PUMPS	**=**	**1**	**No.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	27.98	m³/h
CAPACITY OF PUMP PROVIDED	**=**	**28.00**	**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	=	28	m³/h
RETENTION TIME CONSIDERED	=	5	min
CAPACITY OF TANK REQUIRED	=	2.4	m³
TYPE	=	**ATMOSPHERIC, CLOSED**	
	=	**INSULATED**	
SHAPE	=	CIRCULAR	
EFFECTIVE LIQUID DEPTH	**=**	**1.50**	**m**
DIA OF THE TANK REQUIRED	=	1.43	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	m³

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	=	505.97	m^3/d
HOURLY FLOW RATE OF SLUDGE	=	21.08	m^3/h
NO. OF COMPARMENTS	=	2	Nos.
RETENTION TIME	=	6	h
WORKING VOLUME OF EACH COMPARTMENT REQUIRED	=	63.25	m^3
TYPE	**=**	**ATMOSPHERIC, OPEN**	
SHAPE	=	RECTANGULAR	
LIQUID DEPTH	**=**	**5.00**	**m**
LENGTH OF THE TANK CONSIDERED	**=**	**3.80**	**m**
WIDTH OF THE TANK REQUIRED	=	3.33	m
WIDTH OF THE TANK PROVIDED	**=**	**3.80**	**m**
VOLUME OF EACH TANK PROVIDED	=	72.20	m^3

SLUDGE COLLECTED IN THE TANK WILL BE ALLOWED TO SETTLE. SUPERNATANT WILL BE WITHDRAWN FROM THE SUMP.

MASS BALANCE

DIGESTED SLUDGE FLOWRATE	=	505.97	m^3/d
TSS IN DIGESTED SLUDGE	=	22654.00	kg/d
TSS IN SUPERNATANT	=	4000	mg/L
DENSITY OF SUPERNATANT	=	1000	kg/m^3
CENTRIFUGE FEED CONSISTENCY	=	6%	
DENSITY OF CENTRIFUGE FEED SLUDGE	=	1050	kg/m^3

BASED ON ITERATIVE MASS BALANCE ACROSS CENTRIFUGE FEED SUMP

DIGESTED SLUDGE FLOWRATE	=	349.67	m^3/d	
DIGESTED SLUDGE SOLIDS	=	22030	kg/d	

		DIGESTED SLUDGE	CENTRIFUGE FEED	SUPERNATANT
FLOW	m^3/d	505.97	349.67	156.30
TSS	mg/L	44773.50	63002.3	3993
	kg/d	22654.00	22030.00	624.00
BOD	mg/L	5229.60	6225.9	3000
	kg/d	2646.00	2177.00	469.00
VSS	mg/L	16425.90	23113.4	1464.89905
	kg/d	8311.00	8082.03	228.97

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	=	349.67	m^3/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	=	21.86	m^3/h
CAPACITY OF PUMP PROVIDED	**=**	**22.00**	**m^3/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	=	349.67	m³/d
DESIGN POLYMER FLOW RATE	=	69.60	m³/d
DESIGN HYDRAULIC FLOW	=	419.27	m³/d
OPERATING HOURS PER DAY	=	16.0	h
OPERATING DAYS PER WEEK	=	7.0	d
CAPACITY OF CENTRIFUGE REQUIRED	=	26.21	m³/h
CAPACITY OF CENTRIFUGE PROVIDED	=	**27.00**	**m³/h**
DESIGN INLET SOLIDS	=	22030.00	kg/d
SOLIDS HANDLING CAPACITY OF CENTRIFUGE	=	1376.90	kg/h
SOLIDS CAPTURE RATE	=	90%	
DEWATERED CAKE SOLIDS	=	19827	kg/d
DEWATERED CAKE CONCENTRATION	=	20%	
DEWATERED CAKE DENSITY	=	1100	kg/m³
DEWATERED CAKE FLOWRATE	=	90.13	m³/d
	=	99.143	T/d

MASS BALANCE

DEWATERED CAKE	=	90.13	m³/d		
	=	5.640	m³/h		
CENTRATE FLOW RATE	=	329.14	m³/d		

		CENTRIFUGE FEED	DEWATERED CAKE	CENTRATE
FLOW RATE	m³/h	21.86	5.64	20.58
	m³/d	349.67	90.13	329.14
TSS	mg/L	63002.30	219982.25	6693.201
	kg/d	22030.00	19827.00	2203.00
BOD	mg/L	6225.90	21738.6	661.421
	kg/d	2177.00	1959.30	217.70
VSS	mg/L	23113.40	3712.47	3712.449
	kg/d	8082.03	7273.83	808.20

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	=	22030.00	kg/d	
DWPE DOSAGE CONSIDERED	=	2.5	kg/T of Solids	
HENCE,				
DWPE REQUIRED (100%)	=	55.08	kg/d	
DWPE REQUIRED (COMMERCIAL GRADE)	=	55.08	kg/d	
SOLUTION CONCENTRATION IN PREPARATION TANK	=	0.20%		
SOLUTION DENSITY	=	1000	kg/m³	
SOLUTION VOLUME IN PREPARATION TANK	=	27.54	m³/d	
DWPE DOSING TANK				
SOLUTION CONCENTRATION IN DOSING TANK	=	0.20%		
DENSITY OF SOLUTION	=	1000	kg/m³	
STORAGE VOLUME REQUIRED	=	27.54	m³	
NO. OF DUTY UNITS	**=**	**1**	**No.**	
NO. OF STANDBY UNITS	**=**	**0**	**No.**	
VOLUME OF EACH TANK REQUIRED	=	27.54	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	=	1.722	m^3/h
NO. OF DUTY PUMPS	**=**	**1**	**No.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	1722	LPH
CAPACITY OF PUMP PROVIDED	**=**	**2175**	**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	=	2175	LPH
SOLUTION CONCENTRATION AFTER DILUTION	=	0.10%	
DILUTION RATIO	=	1 : 2	
POWER WATER REQUIRED	=	2175	LPH
VOLUMETRIC FLOWRATE AFTER DILUTION	=	4350	LPH

STORAGE REQUIRED

POLYELECTROLYTE WILL BE RECEIVED IN CARBOUYS.

STORAGE SPACE REQUIRED	=	15	d
CHEMICAL REQUIRED	=	55.08	kg/d
STORAGE REQUIRED	=	826.2	kg
NET WEIGHT OF CARBOUY	=	25	kg
NO. OF CARBOUYS TO BE STORED	=	34	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	=	7480.00	m³/d

TYPE: MEMBRANE GAS HOLDER

NO. OF UNITS		=	**1**	**No.**
STORAGE TIME REQUIRED		=	**25%**	
VOLUME OF EACH GAS HOLDER REQUIRED		=	1870	m³
VOLUME OF EACH GAS HOLDER PROVIDED		=	**2150**	**m³**
STORAGE TIME PROVIDED		=	6.9	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]	=	374	m³/h
CAPACITY OF FLARE PROVIDED	**[1 atm , 20 °C]**	=	**375**	**m³/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]	=	312	m³/h
CAPACITY OF BLOWER PROVIDED	**[1 atm , 20 °C]**	=	**315**	**m³/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]	=	312	m³/h
CAPACITY OF SCRUBBER PROVIDED	**[1 atm , 20 °C]**	=	**315**	**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]	=	7480.00	m³/d
CAPACITY OF GAS ENGINE REQUIRED		=	715.4	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	=	650	kW
HEAT AVAILABLE FROM HT CIRCUIT	=	542	kW
HEAT REQUIRED FROM EXHAUST GAS	=	108	kW
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	=	4.70	m³/h
EXHAUST GAS FLOW RATE	=	4238	kg/h
EXHAUST GAS SUPPLY TEMPERATURE	=	466	°C
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	**m³/h**
HYDRAULIC RETENTION TIME PROVIDED	=	20	min
OPERATING VOLUME REQUIRED	**=**	**8.33**	**m³**
LIQUID DEPTH	**=**	**3.00**	**m**
DIAMTER OF THE TANK CONSIDERED	**=**	**2.00**	**m**
VOLUME OF EACH TANK PROVIDED	=	9.50	m³

18.4 PLANT DRAIN PUMPS

DESIGN FLOW RATE	=	25.00	m³/h
NO. OF DUTY PUMPS	**=**	**1**	**No.**
NO. OF STANDBY PUMPS	**=**	**1**	**No.**
CAPACITY OF PUMP REQUIRED	=	25.00	m³/h
CAPACITY OF PUMP PROVIDED	**=**	**25.00**	**m³/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

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} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)	CO (mg/m^3)	NH3 ($\mu g/m3$)	HC as CH4(ppm)	H2S ($\mu g/m3$)
AAQ-1, Baranagar West Dumping site									
1	11.06.2019 to 12.06.2019	142.5	55.2	8.6	51.7	0.86	28.8	1.61	<10.0
2	14.06.2019 to 15.06.2019	95.1	42.9	7.4	43.5	0.78	19.6	1.52	<10.0
3	17.06.2019 to 18.06.2019	84.7	51.9	7.0	38.6	0.68	22.7	1.6	<10.0
AAQ-2, Adarsha Nagar									
1	11.06.2019 to 12.06.2019	123.6	52.9	7.3	43.8	0.73	21.6	1.69	<10.0
2	14.06.2019 to 15.06.2019	94.9	51.1	6.8	35.2	0.57	18.5	1.48	<10.0
3	17.06.2019 to 18.06.2019	95.0	58.5	6.6	35.2	0.76	16.5	1.76	<10.0
AAQ-3, Pramod Nagar									
1	11.06.2019 to 12.06.2019	83.7	47.4	6.5	30.6	0.62	17.3	1.45	<10.0
2	14.06.2019 to 15.06.2019	72.6	40.9	6.2	26.8	0.54	14.7	1.16	<10.0
3	17.06.2019 to 18.06.2019	96.3	54.9	7.2	41.3	0.82	19.8	1.25	<10.0

APPENDIX F AMBIENT NOISE QUALITY MONITORING RESULTS

Location code		N-1	N-2	N-3	N-4
Location Name		Baranagar Site West Dumping Site	Adharsha Nagar	Pramod Nagar	Baranagar Site
Time (in Hrs.)	(05.00-06.00) hrs	62.4	62.8	58.2	62.4
	(06.00-07.00) hrs	63.2	60.6	63	65.2
	(07.00-08.00) hrs	64.6	61.3	61.9	65.6
	(08.00-09.00) hrs	61.5	55.7	67.1	69.4
	(09.00-10.00) hrs	61.1	59.8	61.1	60.4
	(10.00-11.00) hrs	66.2	67.2	68.3	64.9
	(11.00-12.00) hrs	62	61.8	61.8	61.5
	(12.00-13.00) hrs	61.5	59.3	59.9	63.6
	(13.00-14.00) hrs	60.9	60.4	58.2	58.4
	(14.00-15.00) hrs	59.7	59.9	61.7	68.2
	(15.00-16.00) hrs	60.9	62.5	59.3	65.6
	(16.00-17.00) hrs	59.3	60.5	62.3	57
	(17.00-18.00) hrs	58.5	58.1	57.1	58.8
	(18.00-19.00) hrs	58.2	57.7	56.4	57.4
	(19.00-20.00) hrs	60.5	55.6	60.3	60
	(20.00-21.00) hrs	57.4	54.3	57.8	55.2
	(21.00-22.00) hrs	56.1	50.1	51.2	52.8
	(22.00-23.00) hrs	52.7	45.7	46.1	52.7
	(23.00-00.00) hrs	47.7	48.8	46.7	46.7
	(00.00-01.00) hrs	49.6	47.9	50.1	48.2
	(01.00-02.00) hrs	50.3	48.6	56.8	49.8
	(02.00-03.00) hrs	53.7	49.1	51.4	49.3
	(03.00-04.00) hrs	55.4	46.3	52.9	52.7
	(04.00-05.00) hrs	58.8	48.8	54.3	57

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 : Baranagar STP Road -Up							
SL. NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	Total	PCU
		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	1	5	6	4	16	14.5
2	10.00-11.00	0	4	5	5	14	10.25
3	11.00-12.00	0	5	4	4	13	10
4	12.00-13.00	0	3	4	3	10	7.5
5	13.00-14.00	0	3	3	2	8	6.25
6	14.00-15.00	0	2	3	1	6	4.75
7	15.00-16.00	0	3	4	0	7	6
8	16.00-17.00	0	6	4	3	13	10.5
9	17.00-18.00	0	4	3	2	9	7.25
10	18.00-19.00	0	2	2	1	5	4
11	19.00-20.00	0	0	0	0	0	0
12	20.00-21.00	0	0	2	0	2	1.5
13	21.00-22.00	0	0	1	0	1	0.75
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	0	0	0	0
22	6.00-7.00	0	0	0	0	0	0
23	7.00-8.00	0	1	1	0	2	1.75
24	8.00-9.00	1	3	3	2	9	9.25
Total Numbers		**2**	**41**	**45**	**27**	**115**	**94.25**

LOCATION : Baranagar STP Road - Down							
SL. NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED VEHICLES	Total	PCU
		Heavy Motor Vehicles	Light Motor Vehicles	Two/Three Wheelers			
	(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	1	4	8	2	15	14
2	10.00-11.00	1	5	9	4	19	16.75
3	11.00-12.00	0	3	10	4	17	12.5
4	12.00-13.00	1	3	9	3	16	14.25
5	13.00-14.00	0	2	11	2	15	11.25
6	14.00-15.00	0	4	10	5	19	14
7	15.00-16.00	1	4	14	3	22	19
8	16.00-17.00	0	4	12	4	20	15
9	17.00-18.00	0	5	10	7	22	16
10	18.00-19.00	0	3	11	4	18	13.25
11	19.00-20.00	0	3	8	3	14	10.5
12	20.00-21.00	0	0	6	2	8	5.5
13	21.00-22.00	0	0	2	2	4	2.5
14	22.00-23.00	0	0	0	1	1	0.5
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	0	1	1	0.5
22	6.00-7.00	0	0	2	3	5	3
23	7.00-8.00	1	2	5	4	12	10.75
24	8.00-9.00	1	4	9	7	21	17.25
Total Numbers		**6**	**46**	**136**	**61**	**249**	**196.5**

LOCATION : Belghoria Expressway Towards Airport							
SL. NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	Total	PCU
		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	155	809	271	25	1260	1489.75
2	10.00-11.00	140	779	317	29	1265	1451.25
3	11.00-12.00	168	608	208	9	993	1272.5
4	12.00-13.00	193	703	241	3	1140	1464.25
5	13.00-14.00	201	683	190	0	1074	1428.5
6	14.00-15.00	173	708	230	0	1111	1399.5
7	15.00-16.00	231	731	245	1	1208	1608.25
8	16.00-17.00	200	681	238	0	1119	1459.5
9	17.00-18.00	179	640	260	5	1084	1374.5
10	18.00-19.00	147	697	255	2	1101	1330.25
11	19.00-20.00	185	670	230	0	1085	1397.5
12	20.00-21.00	201	713	237	0	1151	1493.75
13	21.00-22.00	238	550	195	1	984	1410.75
14	22.00-23.00	247	595	210	0	1052	1493.5
15	23.00-00.00	221	331	107	0	659	1074.25
16	00.00-1.00	160	60	50	0	270	577.5
17	1.00-2.00	121	38	20	0	179	416
18	2.00-3.00	130	30	18	0	178	433.5
19	3.00-4.00	147	45	16	0	208	498
20	4.00-5.00	139	107	20	1	267	539.5
21	5.00-6.00	145	308	43	0	496	775.25
22	6.00-7.00	168	609	188	5	970	1256.5
23	7.00-8.00	187	730	217	2	1136	1454.75
24	8.00-9.00	162	789	268	11	1230	1481.5
Total Numbers		**4238**	**12614**	**4274**	**94**	**21220**	**28580.5**

LOCATION : Belghoria Expressway towards Dakhineswar							
SL. NO.	TIME	MOTORIZED VEHICLES			NON-MOTORIZED	Total	PCU
		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	130	851	285	36	1302	1472.75
2	10.00-11.00	136	842	303	42	1323	1498.25
3	11.00-12.00	149	776	256	21	1202	1425.5
4	12.00-13.00	170	696	280	1	1146	1416.5
5	13.00-14.00	179	565	203	8	947	1258.25
6	14.00-15.00	224	662	180	1	1066	1469.5
7	15.00-16.00	253	701	226	0	1180	1629.5
8	16.00-17.00	245	690	209	2	1144	1582.75
9	17.00-18.00	238	735	240	14	1227	1636
10	18.00-19.00	219	748	270	10	1247	1612.5
11	19.00-20.00	248	708	233	4	1193	1628.75
12	20.00-21.00	217	737	263	5	1222	1587.75
13	21.00-22.00	269	728	250	3	1250	1724
14	22.00-23.00	230	691	204	1	1126	1534.5
15	23.00-00.00	192	350	115	0	657	1012.25
16	00.00-1.00	168	115	56	0	339	661
17	1.00-2.00	172	75	30	0	277	613.5
18	2.00-3.00	158	37	22	0	217	527.5
19	3.00-4.00	130	30	16	0	176	432
20	4.00-5.00	168	59	15	6	248	577.25
21	5.00-6.00	211	237	48	5	501	908.5
22	6.00-7.00	190	630	241	17	1078	1389.25
23	7.00-8.00	168	709	235	12	1124	1395.25
24	8.00-9.00	153	782	258	14	1207	1441.5
Total Numbers		**4617**	**13154**	**4438**	**190**	**22399**	**30428.5**

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-**Unemp 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-**Unemp 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 □
	Bio-gas □	Dried Cow dung with straw, leafs □			Other Specify □
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 Shee	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……		

<table>
<tr><td rowspan="2">Do any household members have any permanent</td><td>Yes □ (if yes explain by giving the member co</td><td>Asthma □ Breathing problem □
Cancer □ Diabetes □
Diarrhoea □</td></tr>
<tr><td>No □</td><td>Any other, specify.....</td></tr>
<tr><td colspan="3">Did any of the household members suffer from any water borne diseases within the last 12 months?</td></tr>
<tr><td colspan="2">Yes □ (if yes explain by giving the member code)</td><td>No □</td></tr>
<tr><td colspan="3">Do the locality faces water-logging situation frequently in the last one year? .....
.....</td></tr>
<tr><td colspan="3">Did any of the family members suffer from any vector borne diseases or water borne diseases in last three months?
.....
.....</td></tr>
<tr><td colspan="3">Did you get any foul smell due to STP operations? Yes □ No □</td></tr>
</table>

Signature of the Respondent

APPENDIX J CONSEQUENCE ANALYSIS & QUANTITATIVE RISK ASSESSMENT FOR CHLORINE TONNER STORAGE

1. Risk Assessment

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 Baranagar by WABAG.
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 formulation of a site specific 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 - Chlorine Tonner Storage

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 has been first estimated for severity of consequence and secondly through calculation of Individual Risk levels as Iso-risk contour around the source of hazard. Risk associated with the chemical storage have been determined quantitatively as the product of likelihood/probability and severity/consequence and represented through the probability of death to a person per year at any spatially located point around the facility.

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**)

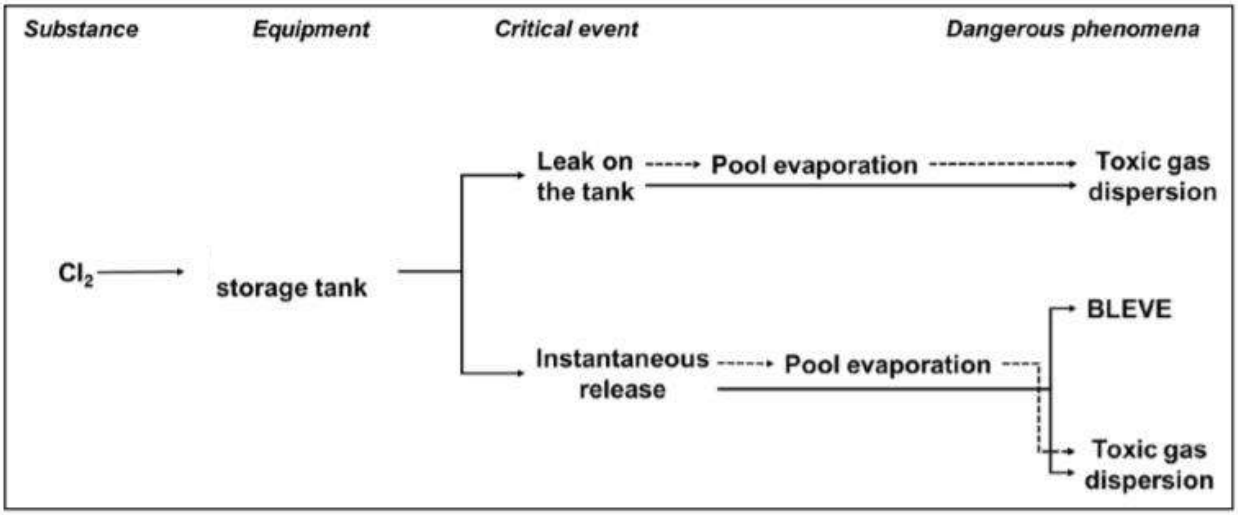
Table 1.3: Frequency Categories and Criteria

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 X 10^{-6}	Remote
2	50mm diameter hole	5 X 10^{-6}	Remote
3	25mm diameter hole	5 X 10^{-6}	Remote
4	13mm diameter hole	1 X 10^{-5}	Remote
5	6mm diameter hole	4 X 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.

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.

Consequence 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:

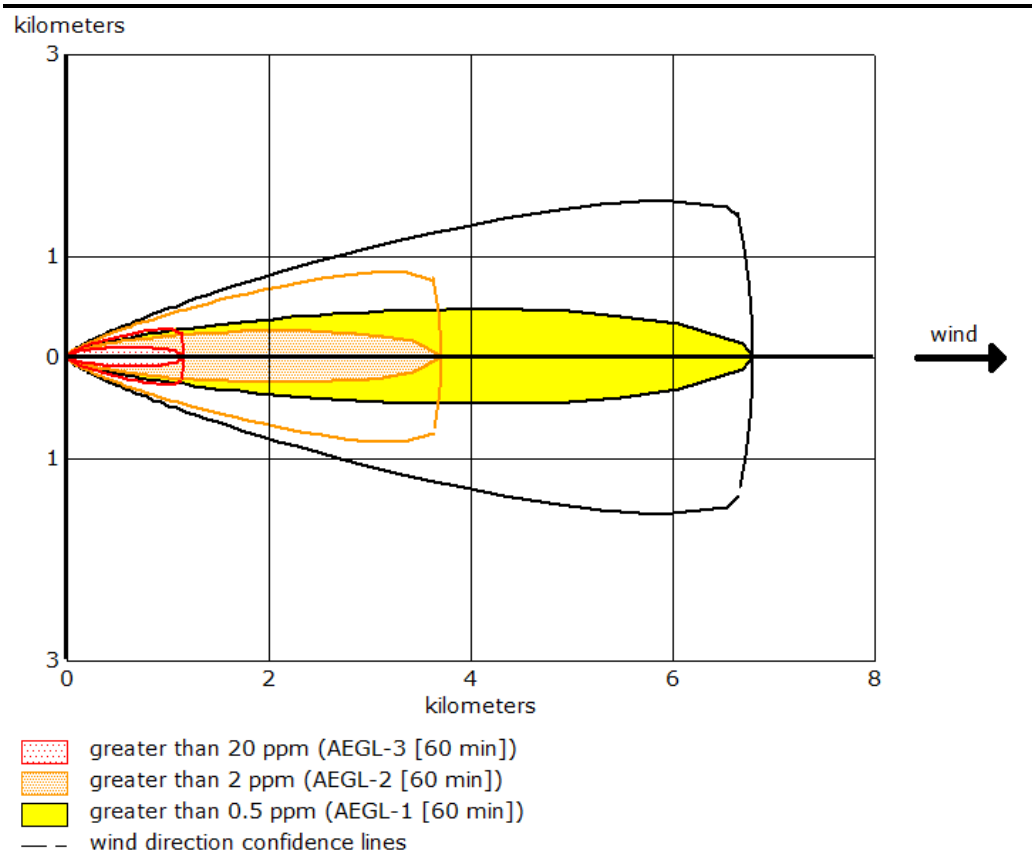
[1] AEA Technology, HSE Guidance Document

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;*
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.

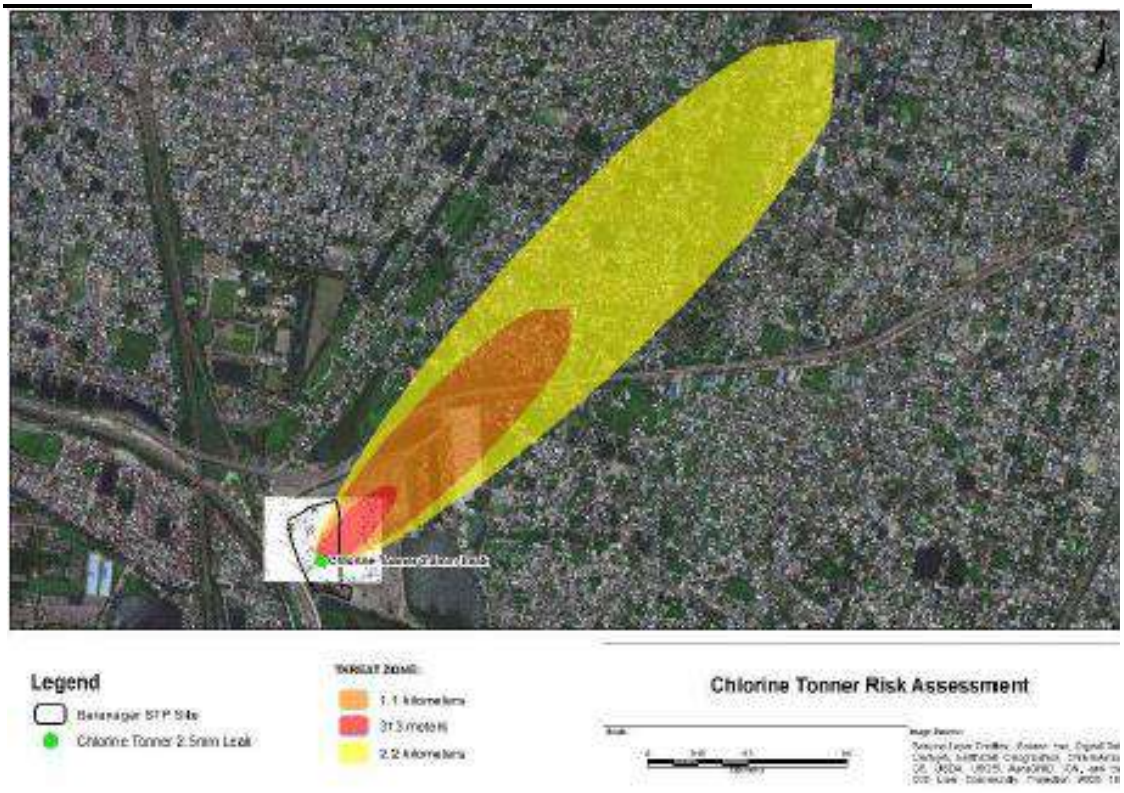
Scenario 1： Chlorine Tonner － 2.5 mm leak

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］）

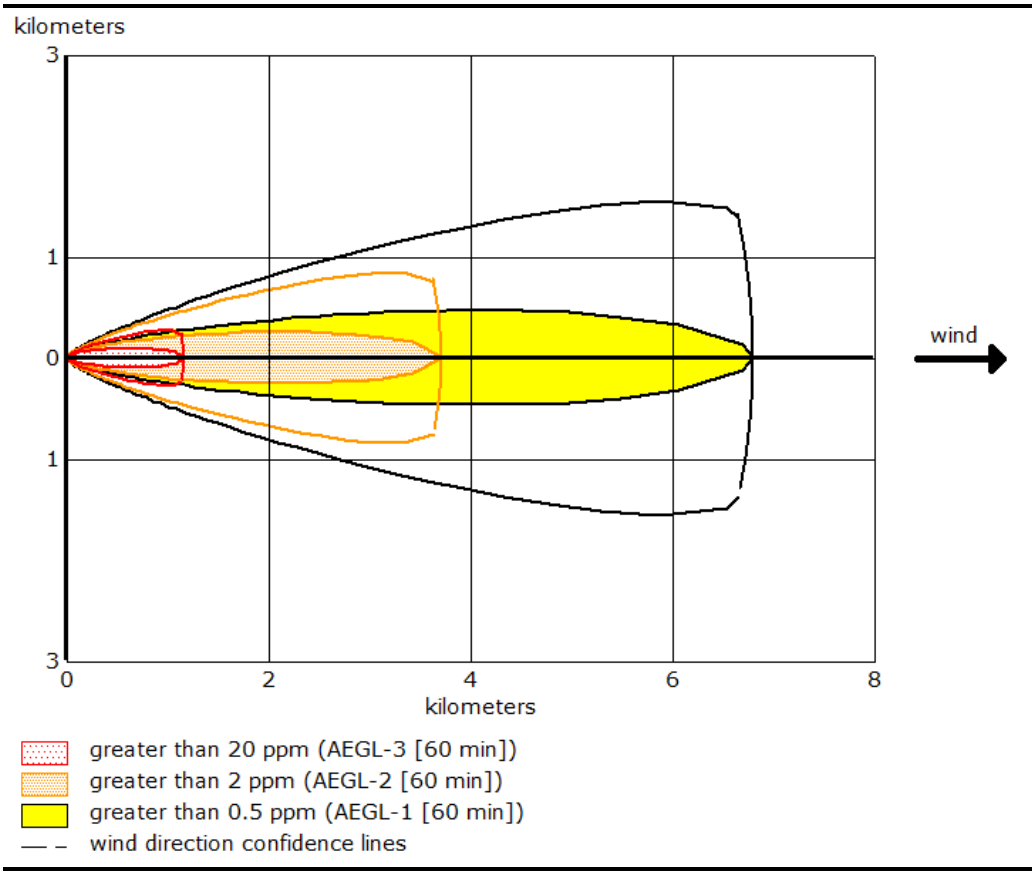
Yellow： 6800 meters --- （0.5 ppm = AEGL-1［60 min］）

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.

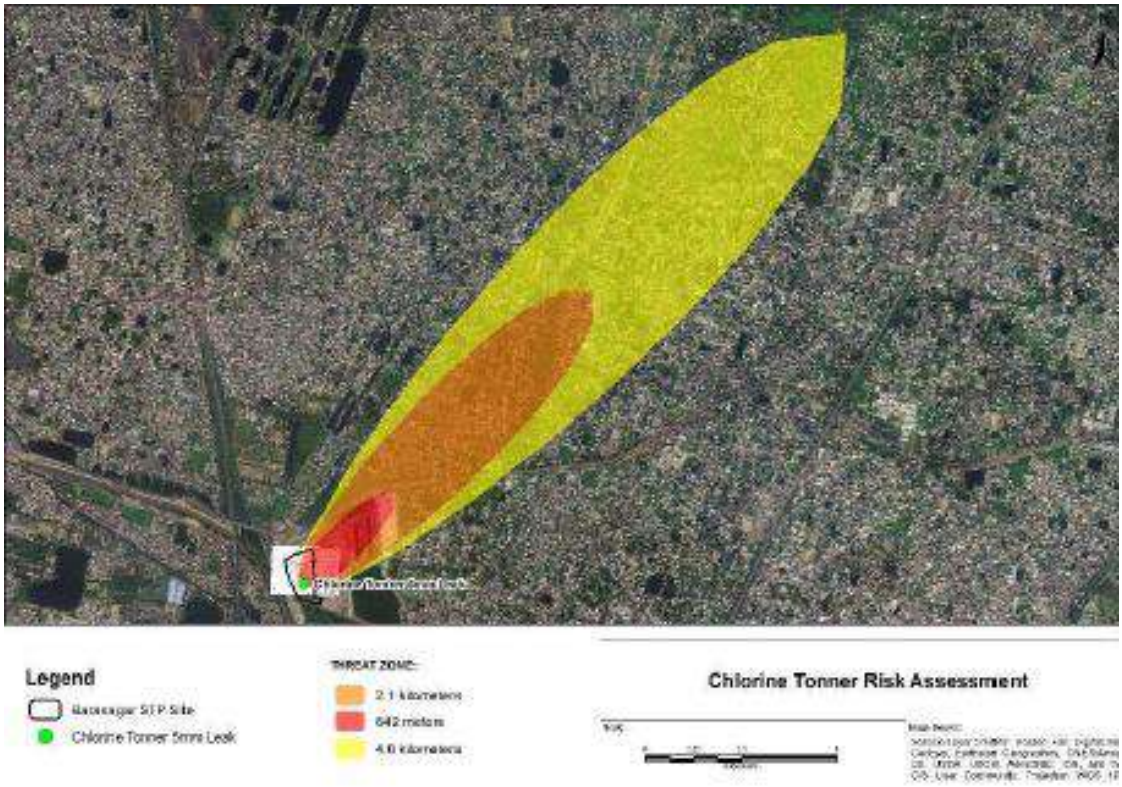
Scenario 2： Chlorine Tonner – 5 mm leak

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])

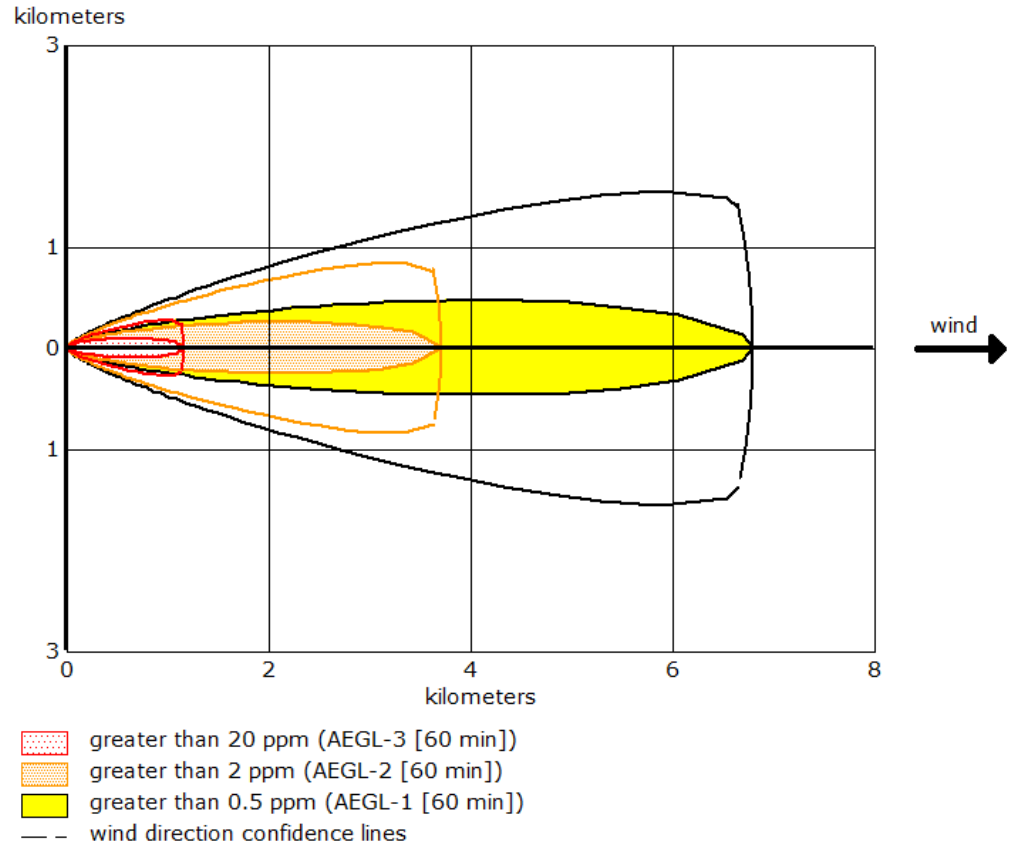
Yellow: 6800 meters --- (0.5 ppm = AEGL-1 [60 min])

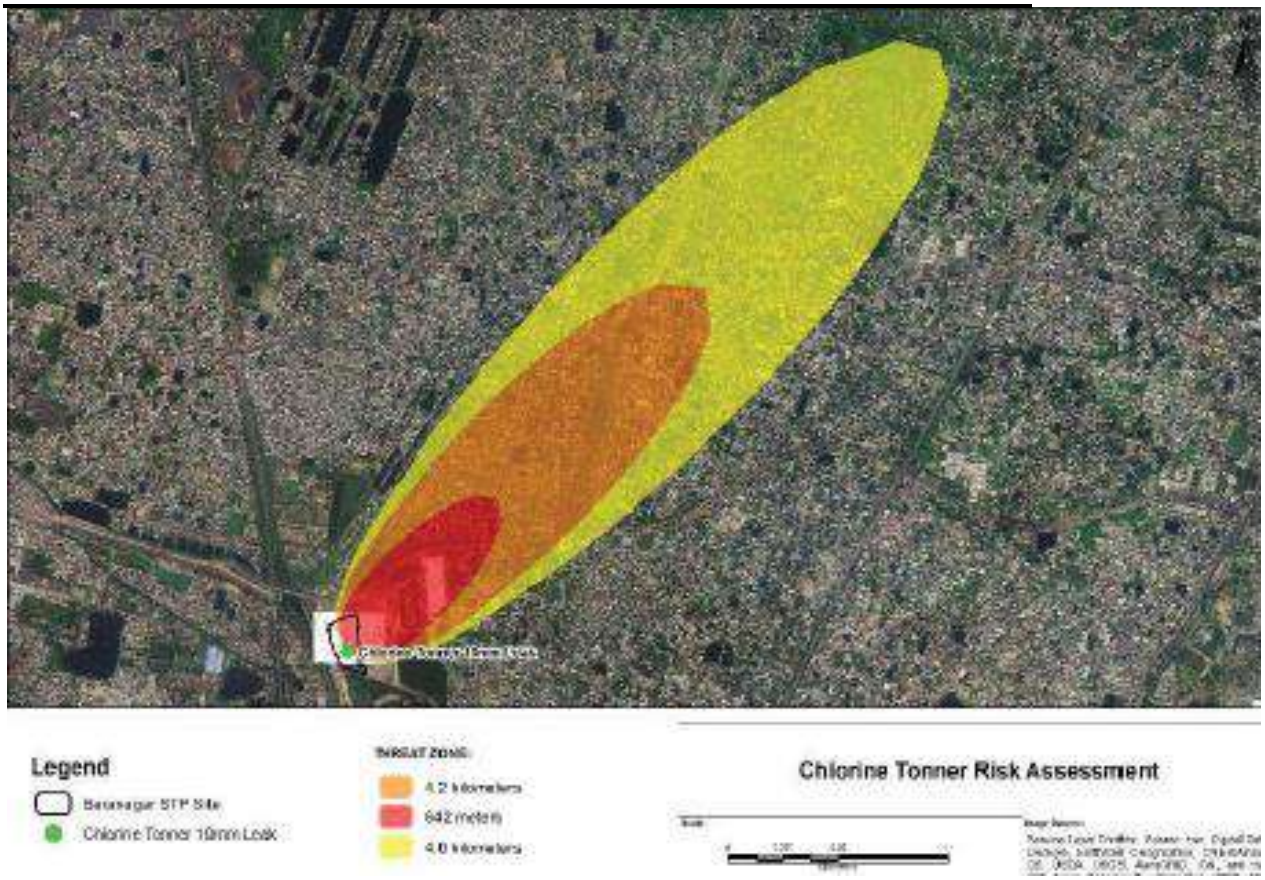
The maximum effect resulting from failure of chlorine tonner (5mm leak) will be experienced within a maximum radial distance of 1200m from the source with potential lethal effects within 1 hour.

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 X 10^{-6}, 1 X 10^{-5} and 4 X 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 45^{o} 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

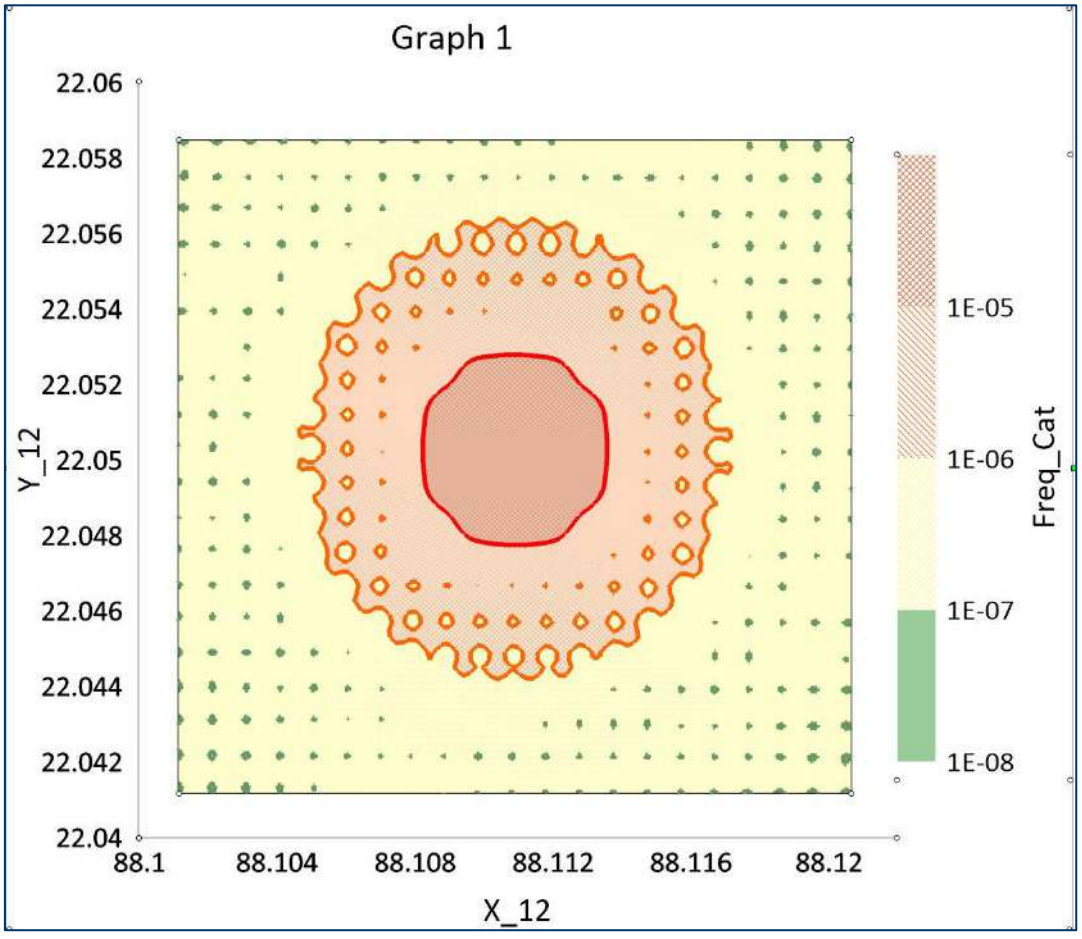
Release Scenario	Probability of Fatality (Probit)	Endpoint Distance (m)
Catastrophic (Cas)	0.5	543
	0.2	684
	0.05	858
Leak 13mm Hole (L13)	0.5	300
	0.2	408

Release Scenario	Probability of Fatality (Probit)	Endpoint Distance (m)
	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 Baranagar 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:

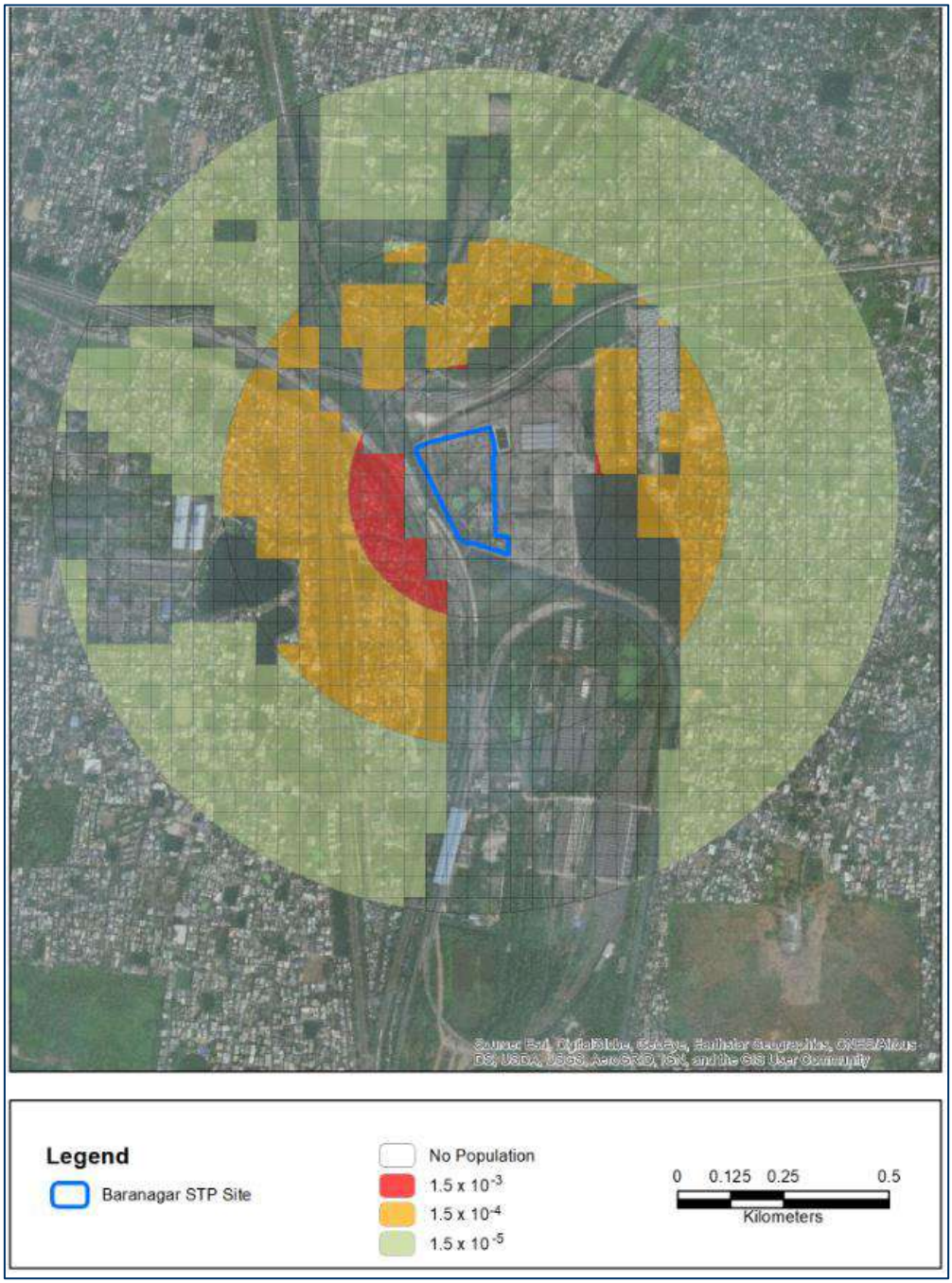
$$\mathbf{PLL}_{(x,y)} = \left[\mathbf{IR}_{(x,y)} \times \mathbf{NP}_{(x,y)} \right]$$

- $PLL_{(x,y)}$ 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)	450
1.5 X 10^{-4} (amber)	32700
1.5 X 10^{-5} (green)	103200

Figure 1.6: Societal Risk as Potential Loss of Life (PLL)



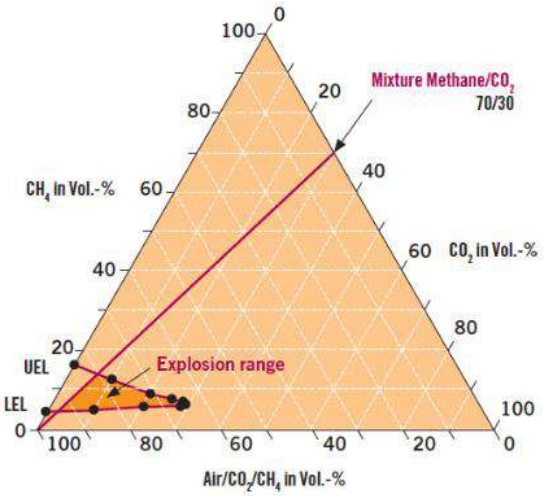
1.6. RA Discussion - Biogas

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 defiecient atmosphere, hazards associated with pathogens and due to confined space entry.

For the purposes of this risk assessment, the fire and exploson 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 digestors and the gas storage. The xplosion 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 resuting 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 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.

- ***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.
- ***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 spayed on the Chlorine leak as it tends to make the leak worse because of corrosive effect. If the leak occurs in a 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:

<u>Command, Co-ordination and Response Team</u>

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 Baranagar 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： Baranagar	Village：	
	Date： 31st May, 2019 and 21st of July 2019	Ward no： Union：	
D	*Attended By*		
	Sr.	Name	Designation
	1.	Sri. Sudit kr Jha	Operator
	2.	Sri. APurba Bhattacharyya	Helper
	3.	Sri. Swapan kr Chanda	Helper
	4.	Sri Gopal Biswas	Maintenance Staff
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： This STP Operated And maintained by Kankinara Cooperative Society. The STP is not operating last 20 years.		

31st of May, 2019

- The consultations with the existing contractual workers revealed that there are approximately 20 workers who work for 8 hours with three shifts throughout the day.
- None of the existing contractual workers indicated having received any training on Health & Safety trainings and they were not seen to be utilizing any Personal Protective Equipment（PPE）.
- Some workers indicated facing health issues such as eye irritation during to the smoke emitted from the neighbouring dumping yard.
- Out of the 20 workers, only 2 workers were residing in the STP premises.
- As the STP premises does not presently have a proper barricade, certain livestock were observed within the premises which were coming from the neighbouring dumping site. During the rainy season, water from the neighbouring dumping site also seeps into the premises.
- For their drinking water, the workers revealed that they sometimes utilize the water pump in the premises but mostly purchase the drinking water.
- The workers indicated that they earn an approximate monthly income of INR 8000 and all have Personal Provident Fund（PPF） accounts.
- It was revealed that all workers are all local workers.
- There is a nearby khal–Udaypur khal where they release the treated water. Consultation with the community living nearby the STP reveal that none of the community are dependent on the khal for domestic.

21st of July 2019

The consultation with the workers at the STP revealed the following：

- The workers are aware of the project and that there is a potential for a 1200 mm pipeline to be laid under the Belghoria expressway and under the railway line, from the Baranagar Main Pumping Station.
- There are a total of 20 staff presently working who have 4 shifts, morning, day, night and general shift.

21st of July 2019

31st of May, 2019

Kamkinara Engineers Coop Society (1)

ESIA Study for Three STP Locations
Stakeholder Consultation Participant List

Venue: Baranagar STP. Date: 21/7/2019.

Sl. No.	Name	Designation	Contact No.	Signature
1.	Sudit Kr. Jha.	Technician	9330455995	Sudha
2.	Ranjit Das.	OP.	9836753913.	
3.	Siddhartha Sankar Sen	Engineer.	983019727D.	
4.	Anup Kr. Das.	Maint. Helper	9933634139.	
5.	Khokan Dey	Operator	9433339383.	
6.	Apurba Bhattacharyya	Maint Helper.	9432279208.	Apurba Bhattacharya
7.	Swapan Kr. Chanda	"	8697879542.	Swapan kr Chanda
8.	Tushar Pramanik	Operator	9007482996.	
9.	Mrinal Dey	"	801748348.	
10.	Nityananda Goswami	"	9830913465	
11.	Subhas Ch. Sarkar.	"	9231819998.	
12.	Haranath Biswas.	"	9007790183.	
13.	Gopal Biswas	Elec. Maint. Staff	8834825716.	Gopal Biswas
14.	Amulya Ratan Das	Operator	9563847490	

10 - 25 yrs

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 Baranagar–Kamarhati MPS	
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： Baranagar–Kamarhati MPS	Village：	
	Date： 22/7/2019	Ward no： Union：	
D	*Attended By*		
	Sr.	Name	Designation
	1.	Sri. S. Ghosh	Supervisor
	2.	Sri. Jiban Rudra	Operator
	3.	Sri. Pintu Rudra	Operator
	4.	Sri. Anil Yadav	Helper
	5.	Sri Rakesh Hela	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 Baranagar and Kamarhati area and as the Pipelines are Damaged the Pump operators Bye pass the .water at Bagjola Khal ,beside B.T. Road and Pacha Khal near Belgharia Expressway. This MPS is Well maintained and operated by Sunny Enterprise .		
	▪ A consultation was conducted with the existing contractual workers at the Baranagar Main Pumping Station（MPS）. ▪ The consultation revealed that there are over 12 staff working at the MPS and they are employed by the contractor Sunny Enterprise. ▪ They presently work in shifts i.e. morning, day, night and the general shift. ▪ They indicated that since the pipelines from Baranagar and Kamarhati municipalities are damaged, the untreated waste water is discharged into the Bagjola Khal, next to B.T. Road.		

(2)

ESIA Study for Three STP Locations
Stakeholder Consultation Participant List

Venue: Baranagar STP Date: 22/9/2019

Sl. No.	Name	Designation	Contact No.	Signature
15	Suprajit Ray	Operator	9874 36493 /2	
16.	Abhijit Bhattacharyya	"	98306724 76.	
17	Tapan Kr. Das	"	983684 3546.	
18.	Tarak nath Barik	"	8293550 240.	
19.	Bijay Das.	"	842085 4058.	
20.	Sukanta Bhattacharyya.	Operator Lab Asst.	842085 4107	

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 Morning Market at G. L. Tagore road .	
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: Baranagar	Village :	
	Date: 24/8/2019	Ward no: 13 & 14 Union :	
D	*Attended By*		
	Sr.	Name	Designation
	1.		
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 Market : The market vendors use to seat regularly both side of G. L. Tagore road from Das para to Neogi para . Vegetables , Fish and meat are sold here . Per day income approx ranging from 200 to 500 .		
	1. What do you know about this project? Tell us your opinion regarding this project in details: 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 . After hearing about the proposed work the local people and vendors cordially welcome the Project . 2. Advantages/ disadvantages of the project and Suggestions on the advantages/ disadvantages: They are ready to cooperate at the time of implementation but they deny to sign in any paper. 3. Approximate income of vendors per day is around INR 200 to INR 500. 4. The market is starting from 6 am to 1.30pm and peak hours of market from 7am to 12 pm. 5. Since it is a very busy road the local people have suggested the project word to be done at night.		

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:*	Baba Sitaram Vidyapith Shiv Mandir High School

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: Baranagar	Village:
Date: 3/8/2019	Ward no: 2 Union:

D *Attended By*

Sr.	Name	Designation
1.	Mr. Radhey Shyam Tripathi	Head Master
2.	Mr. Raj Sekhar Sarkar	Asst. Teacher
3.	Mrs. Anjali Kumari Nag	Asst. Teacher
4.	Mr. Kishor Kumar Das	Clerk
5.	Mrs. Rupa Maji	Asst. Teacher
6.	Mr. Ajay Kumar Pandey	Asst. Teacher
7.	Mrs. Urmimala Roy Choudhury	Asst. Teacher
8.	Mrs. Arunima Chatterjee	Asst. Teacher

E *Purpose of Consultation* Focus group Discussion, with The School Teacher's nearer to I&D 1 ,Baranagar

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 detail of the School : The School estd in the year 1969. The Total no of student is 730 (approx). Co-ed, Secondary School, School timings 10.30 to 4.30 and Saturday is half day from 10.30 t0 2 pm .This is a State Govt aided School, Vacation is in Durga Puja and in Summer . Midday meal served to the Students, and separate Toilet is there for Ladies .

1. **What do you know about this project? Tell us your opinion regarding this project in details:** The Teacher's are not aware of the proposed Project . They are ready to cooperate for the implementation of the project as they are facing the Odour at the time when MPS is in Operation.

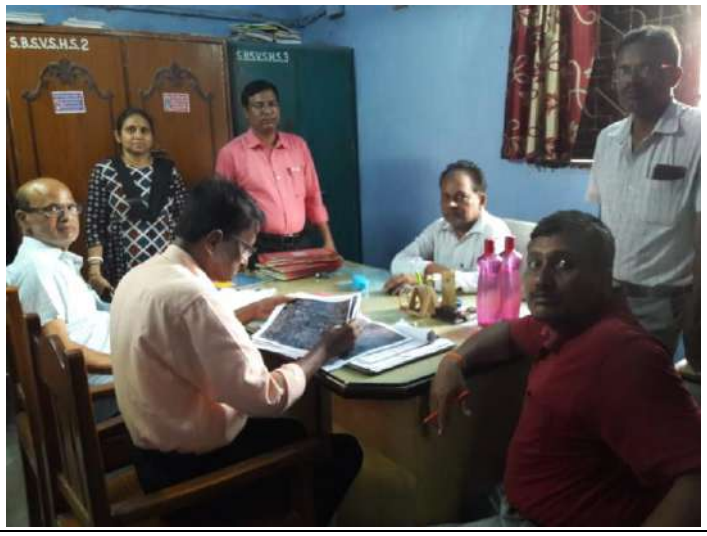
2. **Advantages/ disadvantages of the project and Suggestions on the advantages/ disadvantages:** We discussed about the probable traffic disruption may occur during the construction work of I&D 1 as the I&D 1 is just opposite to the School and the road width is 7.5 ft . In this matter the Opinion of the School Teacher is that – If the work to be done in Sunday and it is better if it is implemented in the vacation .
3. **Impacts of the project on roads/ environment/ water sources (river or canal etc.) and suggestions for minimizing the impacts:** There will be no Traffic disruption in course of Implementation it may be for 3 days to 1 week so their suggestion is that work to be done in Vacation.

4. **Project's impacts on the women of the community. :** NA

5. **Impacts on religious institutions or any other historical/ traditional / archaeological sites and suggestions to minimize the impacts. :** There is a Shiv Temple in the same Premises and their suggestion is to avoid the evening period .

6. **Impact on livelihood/ agriculture/ income and their changes (better or worse):** The odour comes when the MPS is running and in the rainy season Total School compound is water logged so if the drainage system to be improved it will be better for this area.

7. **Suggestions for developing the living conditions of locality:** For developing the living conditions of locality, according to the Teacher's the drainage system to be Improved.



ESIA Study for Three STP Locations
Stakeholder Consultation Participant List

Venue: Baba Sitaram Vidyapith Shiv mandir High School. Date: 3/8/2019

Sl. No.	Name	Designation	Contact No.	Signature
1.	Mr. Radhey Shyam Tripathi	Head Master	9433959368	[signature] (Stamp: Shri Baba Sita Ram Vidyapith Shivamandir High School, 7/A, Mill Approach Road, Kolkata-5?)
2.	Mr. Raj Sekhar Sarkar	A. Teacher 2 PED.	~~9433959368~~ 9073563730	Sarkar R Rajshekhar
3	Anjali Kumari Nag.	A.T	9831068911 ~~9831319351~~	Anjali 3/8/19.
4.	Kishor Kumar Das	Clerk	9163789472	KDas 3/8/19
5.	Rupa Majhi	Para Teacher	9830975878	Rupa 3/8/19.
6.	Ajay Kr. Pandey	A. Teacher	8821010412	Ajay Kr. Pandey
7	Urmimala Ray Chaudhury	Assistant Teacher	9051622108	Urmi 03/08/19.
8.	Aruenima Chatterjee	Para Teacher	9836000522	AChatterjee 3/8/19

STAKEHOLDER CONSULTATION

A	*Project Title：*		
B	*Stakeholder Title：*	SPS UP Hindi School Upper Primary	
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： Baranagar	Village：	
	Date： 3/8/2019	Ward no： 2 Near I&D 1 Union：	
D	*Attended By*		
	Sr．	Name	Designation
	1．	Mr． Kartick Prasad Choudhury	Head Master
	2．	Mr． Salauddin Ansari	Asst Teacher
	3．	M/S Tahera Jahari	Asst Teacher
	4．	Mr． Avishek Gosh	Asst Teacher
	5．	Mr． Praveen Lal（absent on that day）	Asst Teacher
	6．		
	7．		
	8．		
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 detail of the School： The School estd in the year 1969． The Total no of student is 459（approx）． Co-ed, Upper Primary School, School timings 10．30 to 4．30 and Saturday is half day from 10．30 t0 2 pm ．This is a State Govt aided School, Vacation is in Durga Puja and in Summer ． Midday meal served to the Students, and separate Toilet is there for Ladies ．		
	8. What do you know about this project? Tell us your opinion regarding this project in details： The Teacher's are not aware of the proposed Project ． They are ready to cooperate for the implementation of the project as they are facing the Odour at the time when MPS is in Operation．		
	9. Advantages／ disadvantages of the project and Suggestions on the advantages／ disadvantages： We discussed about the probable traffic disruption may occur during the construction work of I&D 1 as the I&D 1 is just opposite to the School and the road width is 7．5 ft ． In this matter the Opinion of the School Teacher is that – If the work to be done in Sunday and it is better if it is implemented in the vacation ．		
	10. Impacts of the project on roads／ environment／ water sources（river or canal etc．） and suggestions for minimizing the impacts： There will be Traffic disruption in course of Implementation and it may be for 3 days to 1 week so their suggestion is that work to be done in Vacation ．		
	11. Project's impacts on the women of the community．： There will be no major impact of the project on the womenfolk．		
	12. Impacts on religious institutions or any other historical／ traditional ／ archaeological sites and suggestions to minimize the impacts． ： There is a Shiv Temple in the same Premises and their suggestion is to avoid the evening Period ．		
	13. Impact on livelihood／ agriculture／ income and their changes（better or worse）： The odour comes when the MPS is running and in the rainy season Total School compound is water logged so if the drainage system to be improved it will be better for this area ．		
	14. Suggestions for developing the living conditions of locality： For developing the living conditions of locality, according to the Teacher's the drainage system to be Improved．		

ESIA Study for Three STP Locations
Stakeholder Consultation Participant List

Venue: SPS U.P. Hindu School. Upper Primary Date: 3/9/2019

Sl. No.	Name	Designation	Contact No.	Signature
1.	Md. Salauddin Ansari.	A.T.	9681878047	
2.	Tahera Jahan.	A.T.	9038274308	Tahera Jahan
3.	Mr. Kaustab Prasad Chowdhury	Head Master	8981136241	
4.	Mr. ~~Abhishek~~ Avishek Ghosh	A.T.	8918270779	Avishek Ghosh
5	Mr. Parveen Lal.			
6.				
7.				

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:*	34 b Bus Stand Near Dunlop More (Radha Motors)	
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: Baranagar	Village:	
	Date: 24/8/2019	Ward no: 14 Union:	
D	*Attended By*		
	Sr.	Name	Designation
	1.	Mr. Ramashankar Singh	
	2.	Mr. Arup Banerjee	Time Keeper
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.		
	Key Points Discussed:		
	Brief detail of the 34B Bus stand : This is situated on the roadside of the G.L. Tagore Road. Now the total approx 25-30 Buses are in running condition out of 40 nos. All buses are in the same position at nigh after the end of the trip and starts again next day from G.L.Tagore road. The schedule of running of bus is from 6am to 11pm.		
	15. What do you know about this project? Tell us your opinion regarding this project in details: The bus driver, the helpers, the time keeper and the person supervising the stand were not aware about the Project.		
	16. Advantages/ disadvantages of the project : Discussed about the advantages of this work they agreed.		
	17. Impacts of the project on road and suggestions for minimizing the impacts: According to them the buses no 43 &Dakshineswar Mini from Tobin Road are also operating in this road so traffic disruption may cause during the implementation period.		
	18. Suggestions of the Bus Operating Person / Persons : They will cooperate during the implementation of work. They requested to inform them before starting of work so that they can rearrange the place of morning buses and also shift few buses on the road back side of ISI. According to them it will be better if the work starts after forth coming DurgaPuja.		
	19. Peak hours of Bus service from 8am to 11 am and 5pm to 9pm		
	20. This Bus route is run by private entities		
	21. G.L.Tagore road will be closed due to the project work and its alternative option is B.T. Road.		

ESIA Study for Three STP Locations
Stakeholder Consultation Participant List

Venue: 34 B Bus Stand 13 No. Ward Date: 24/8/2019

SL No.	Name	Designation	Contact No.	Signature
	Rama Shankar Singh		9830652736	RS Singh
	Anup Banerjee	Time keeper	8013406803	AB

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:*	Toto stand on Ramkrishna, Paramahansa Dev road near Dakshineswar Bus Stand

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: Baranagar	Village:
Date: 24/8/2019	Ward no: 14 Union:

D *Attended By*

Sr.	Name	Designation
1.	Sri. SubirHalder	Driver (owner)
2.	Sri. Bikram Yadav	Driver (owner)
3.	Sri. Sati nath Ghosh	Driver (owner)

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 stand :. The Toto stand is running from last 4 years and 40 to 50 (approx) Toto's are running daily from early morning to late night at about 11pm.

1. What do you know about this project? Tell us your opinion regarding this project in details: 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. After hearing about the proposed work the Toto drivers cordially welcome the Project.
2. Advantages/ disadvantages of the project and suggestions on the advantages/ disadvantages: They are ready to cooperate at the time of implementation and they requested give them prior information so that they can rearrange the stand as and when necessary.
3. Approximate income of Toto drivers per day is around INR 300 to INR 500.
4. Peak hours of Toto service from 7 am to 11 am and 4pm to 9pm
5. This Toto stand is located near Dakhineshwar Temple. Since thousands of people come to worship throughout the year in this temple. This is the reason the Toto drivers has suggested the project work at night. So that the worshiper and passenger do not fall under any circumstances.

FSLA Study for Taree STP Location
Stakeholder Consultation Participant List

Venue: Toto Stand, Baranagar Date: 24/8/2019.

Sl. No.	Name	Designation	Contact No.	Signature
1)	Subir Halder		8017509775	Subir Halder
2)	Bikram Yadav		6291586758	B. Yadav
3)	Sati Nath Ghosh		9883203811	

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 Baranagar STP and MPS	
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:	Main Pumping Station, Dunlop	
		Kamarhati Municipal Corporation	
	Date	16th of September 2019	
D	*Attended By (Full List attached)*		
	Sr.	Name (*Key attendees*)	Organization/ Individual
	1	Biswajit Kr. Sarkar	Asst. Engineer (Civil), KMDA
	2	Mithun Barua	Asst. Engineer (Mech.), KMDA
	3	There was no representation on behalf of NMCG	
	4	Alok Adhikari	Secretery, M/s Kakinara Engineers Co-operative Society
	5	There was no representation from M/s Sunny Enterprise	
	6	Ananta Sinha	VA Tech Wabag
	7	Sunil Kumar Ganguly	VA Tech Wabag
	8	Arindam Talukdar	VA Tech Wabag
	9	Twelve (12) Workers from Baranagar STP	Individuals
	10	Ten (10) Workers from Baranagar-Kamarhati MPS	Individuals
	11	Mayanka Singh, Soumyajit Basu, Ajoy Gupta	ERM
E	*Purpose of Consultation*		
	■ To obtain a clear understanding on the existing contract arrangement between KMDA and the Contracting Agency engaged at the Baranagar STP and MPS. ■ To understand the contract arrangement between the Contracting Agencies and their workers including the remuneration structure. ■ 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 meeting began with a discussion between representatives of KMDA, Kakinara Engineers Co-operative Society (told to be representing M/s. Sunny Enterprise as well), VA Tech Wabag as well as ERM India Pvt. Ltd, to understand the existing contractual arrangement between KMDA and the two agencies, M/s. Sunny Enterprise and M/s. Kakinara Engineers Co-operative Society. ■ It was established that the commissioning and O&M for the STP and the MPS begun in 1996. ■ Discussions has established different time period for the O&M agencies engaged by KMDA at the Baranagar STP and Baranagar-Kamarhati MPS since 1996 as below:		

O &M Agency at Baranagar STP	Time Period
M/s Neo Parisrutan Pvt. Ltd.	1996 to 2011
M/s Roy Enterprise	2011 to 2012
M/s Kakinara Engineers Co-operative Society	2012 to 2016 2016 to Present
O &M Agency at Baranagar-Kamarhati MPS	**Time Period**
M/s Sunny Enterprise	1996 to Present

- Points clarified by M/s. Kakinara Engineers Co-operative Society was contracted on price bid basis during 2012 at the first phase with annual extension of the contract tenure and subsequently during 2016 in second phase (with annual extension cycle) and the existing contract tenure is valid till 31st December 2019.
- It has been clarified by the representative of M/s. Kakinara Engineers Co-operative Society that the O&M contractual arrangement with KMDA is purely on lumpsum basis on O&M job guarantee and does not include man-power guarantee (i.e. how many skilled/ un-skilled workers needs to be engaged). The existing workers remained engaged at the STP and MPS locations, whereas different O&M agencies were engaged by KMDA at different phases based on tendering process. While formalizing of the O&M contracting process by KMDA, the existing workers were re-engaged by the O&M agency purely based on informal advice by KMDA considering context of the livelihood of the workers. During the contracting process of the O&M agency, wages of the workers were also re-adjusted by the O&M agency in presence of worker's representatives, KMDA as well as political party representatives.
- When asked about the context, in the event of premature cessation of the the contract, representatives from the contracting agency indicated that, they will abide by the "Pre-mature Ceasation of Contract" condition under their O&M contract and will close their activity within maximum three working days and will be liable to clear all dues related wage, PF/ESI, gratuity (as applicable) and the contractor agency will not have any other legal liability towards the existing contractual workers, as per their contract.
- Mr. Mithun Barua, Assistant Engineer representing KMDA has also seconded the fact that although there is no formal condition (s) or legal liability stipulated under the O&M contract agreements related to the engagement of skilled or unskilled workers, however while formulating any O&M contract agreement with the different agencies for the STP or associated infrastructure (pumping stations), KMDA provides first priority towards re-engagement of the existing workers by the new O&M agencies out of humanitarian grounds as Principal Employer and it will seek to do so, wherever feasible. He has also mentioned that any decision on the re-engagement of the existing workers can be discussed and clarified with the higher authorities in KMDA.
- Representative from ERM has briefed the existing workers present during the meeting on the objective and importance of the project under Namami Gange Mission and National Mission for Clean Ganga (NMCG) constituted under Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India.
- Representative from VA Tech Wabag has explained their involvement context based on PPP based HAM for the demolition and construction of the Baranagar STP, renovation of the pumping stations, repairing, desilting and laying new pipelines under the project's 24 month construction and subsequent O&M phase of 15 years thereafter.
- Representative from VA Tech Wabag has also clarified that there will be no operations of the existing sewerage treatment and handling infrastructure as well as no requirement of existing worker enagagement during the 24 months construction phase which is yet to start. They have also clarified that the new STP will have modernised operation procedures based on SCADA and less dependency on the man-power.
- Furthermore, the names mentioned in the list of workers shared by KMDA (hereinafter stated as "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 O&M agencies as well as their co-workers at the respective locations. This exercise thus revealed the folllwoing facts:

- Name of Mr. Jiban Rudra who is engaged at Baranagar-Kamarhati MPS for last 15 years (as confirmed by his co-wrokers) was not included in the KMDA list. This fact is cross checked against the site attendance list and found correct.
- Mr. Bishu Dholui engaged at the MPS is passed away last month, on 24th of August 2019 and in place of him, Mr. Babun Mondal had joined at MPS since 1st September, 2019. This information needs to be updated in the KMDA list.
- Additionally, one individual Mr. Alok Adhikary, who is the Secretary of the Kakinara Engineers Co-operative Society, was incorrectly listed as a worker.
- This have been established that, there are total twenty (20) workers presently engaged at Baranagar STP and total eleven (11) workers presently engaged at Baranagar-Kamarhati MPS.

- It was also revealed that no appointment letter has been given to the contract workers by the contracting agencies. Monthly payment of wages is done through online bank transfers, and wage slips are also provided to the workers.
- The workers present during the meeting has confirmed that their monthly salary along with ESI and PF contributions are in order as on date and indicated that though the O&M agencies at the Baranagar STP have changed multiple times, their ESI and PF settlements were duly done on time by the respective agencies.
- As reported by the workers engaged at Baranagar STP, the STP was commissioned in 1996 and remained fully functional till 2011.
- The workers shared their positive opinion about the project. Mr. Sujit Kumar Jha, Technical Operator, at Baranagar STP on behalf of all workers present, mentioned the following points:
  - They support and welcome the project in terms of its overall objectives of improving the sewerage system in the area.
  - The workforce is capable to support the O&M work of the project.
  - They have however expressed their concerns on job retention and have requested that all the workers should retain their jobs to maintain their livlihood.

Photo Evidence:

PROJECT NAME: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY FOR UPGRADATION OF SEWAGE TREATMENT PLANT (STP) IN BARANAGAR
PROGRAMME: CONSULTATION WITH WORKERS AT STP AND ASSOCIATED FACILITIES, BARANAGAR
VENUE: BARANAGAR SEWAGE TREATMENT PLANT (STP), BARANAGAR
DATE: MONDAY, 16th OF SEPTEMBER 2019

Sl No	Name	Occupation/Designation	Address and Contact No.	Signature
1	Bishwajit Kr. Sarkar	A.E (civil)	EE/ GPCD(NM) GAP, W&S/ Sector KMDA. 9804116550	BKS
2.	Mithun Barua.	AE (Mech.)	MD-I/E-M Sector/KMDA 59, Nagrul Park, Kol- 115 9836575859	[illegible]
3	Konkinara Eng. Co. Sng.	Secretary	Mob - 9804211058 (Alok Adhikary)	[illegible]
4	S.K. Ganguly	Chief Manager - Wabag	VA TECH WABAG	[illegible]
5	ANANTA SINHA	Chief Manager	VA TECH WABAG	[illegible]
6	Arindam Talukdar	Marketing Lead East	Va Tech Wabag Ltd	Arindam Talukdar
7.	Sujit Kumar Apha	Technical -	Baranagar S.T.P	Su Apha
8	Khokan Dey	Operator	Baranagar S.T.P	Khokan Dey
9	Anup Kumar Das	DO	DO	Anup Kr. Das
10	Swapan Kr. Chanda	DO	DO	Swapan Kr. Chanda
11	Subhas Chandra Sarkar	Operator	Baranagar STP	S. Ch Sarkar
12	Bijay Das	Do	Do	[illegible]
13	Gopal Biswas.	Electrical DO	DO	Gopal Biswas.
14	APURBA BHATTACHARYA.	DO	DO	Apurba Bhattacharya.
15	MRINAL DEY	DO	DO	Mrinal Dey
16	Tarak Nath Banik	DO	DO	Tarak Nath Banik
17	Tapan Kr. Ray	DO	DO	Tapan Kr. Ray
18	Nityananda Swami	DO	DO	Nityananda Swami
19	Subhasis Ghosh.	Supervisor	MPS	S Ghosh.
20.	Basudev Das	Helper	MPS	वासुदेव दास
21.	Anil Yadav	Operator	MPS	Anil Yadav

22.	Pintu Rudra	Operator	MPS.	Pintu Rudra.
23.	Jibon Rudra	Operator	MPS.	Jibon Rudra
24.	Kartick Barick	Electrical	MPS.	
25.	Gopal Rabi Das	Helper	MPS.	गोपाल रविदास
26.	Surender Rabi Das.	Helper.	MPS.	Surender. Rabi Das
27.	Rakesh Hela	Helper.	MPS.	राकेश हेला
28.	Tanweer Alam Shah	Helper.	MPS.	तनवीर आलम शह
29	Mayanka Singh Nongpiur	ERM India Pvt Ltd	8451058225	Mayanka Singh
30.	AJOY GUPTA	ERM.	ERM Kolkata	
31.	Soumyajit Basu	ERM India Pvt. Ltd.	ERM Kolkata	

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 RKPD Road	
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: Baranagar	Village:	
	Date: 11th of February, 2020	Ward no: Union:	
D	*Attended By*		
	Sr.	Name	Designation
	1.		
E	*Purpose of Consultation:*		
	To provide awareness about the proposed upgradation works and gather their inputs and suggestions on the project.		
F	*Key Points Discussed:*		

- A consultation was conducted with the local community residing at RKPD Road near the cycle stand, which also included the owner of the cycle stand. The RKPD road will be affected by the laying of the sewer pipelines.
- The ERM team was accompanied by the Wabag team and the purpose of the consultation was to provide an awareness about the proposed upgradation works, the implementation timeline and as well as to gather their suggestions and inputs. The team gave a detailed briefing about the duration of work, which will be approximately three days, as well as the nature of disruption.
- The cycle stand owner reported that he earns approximately Rs. 500 per day and revealed that the land being utilised for his stand belongs to the Baranagar Municipality, where he pays a yearly tax of approximately Rs. 750.
- The residents and shop owners also reported that there is a brick sewer line situated below the shops and if any renovation works are required, the requested that machinery be utilised for minimum disruption.
- RKPD road was observed to be a very busy road and reportedly, there is no alternate route other than RKPD road, therefore suggested that the work be conducted in a manner where there is minimum disruption.
- The team also provided the participants with information how to access the project's grievance mechanism should they have any concerns in relation to the construction work.
- The names and signatures of the participants could not be obtained.

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 Community near Lifting Station	
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: RN Tagore Road, Baranagar-Kamarhati Main Pumping Station	Village:	
	Date: 11th of February, 2020	Ward no: Union:	
D	*Attended By*		
	Sr.	Name	Designation
	1.		
E	*Purpose of Consultation:*		
	To provide awareness about the proposed upgradation works and gather their inputs and suggestions on the project.		
F	*Key Points Discussed:*		

- A consultation was conducted with the local residents at R.N Tagore Road, who are situated near the Baranagar-Kamarhati Main Pumping Station.
- There are approximately seven squatter houses and one housing complex comprising of 34 flats situated adjacent to the pumping station.
- The residents were apprised of the proposed upgradation works particularly the replacement of the sewer pipeline along R.N Tagore road, and were also informed about the timeline of implementation.
- The team also shared with them the process for conveying any grievances they face during the replacement of the pipelines. The toll free grievance number was shared with the security guard for the Ambi Plaza complex.
- The participants expressed their willingness to cooperate with the proposed works.

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 Women Community Members at Dakhineshwar Railway Quarters RKPD Road	
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: Baranagar	Village:	
	Date: 11th of February, 2020	Ward no: Union:	
D	*Attended By*		
	Sr.	Name	Designation
	1.	Participants' List is attached.	
E	*Purpose of Consultation:* Focus group Discussion,		
	To provide awareness about the proposed upgradation works and gather their inputs and suggestions on the project.		
F	*Key Points Discussed:*		

- A consultation was conducted with the local community, primarily women, residing at the Dakhineshwar Railway Quarters, which is situated near RKPD road. The purpose of the consultation was to conduct an awareness about the replacement of the sewer pipelines to be undertaken at RKPD Road which is a road they access on a daily basis.
- Thus, the community will potentially be faced with access disruption when utilising the RKPD road during the construction phase.
- Reportedly, there are approximately 150 HHs in the quarters, comprising of approximately 4-5 persons per HH, and all residents are from West Bengal itself.
- The women are mainly engaged in domestic work; many are also engaged as domestic helpers and are earning approximately Rs. 1000-2000 per month.
- The residents also reported that there is a manhole in the area which causes a lot of waterlogging in the area, mainly during the rainy season. The area is waterlogging for a few hours and they indicated that this has led to many residents becoming ill with dengue and other water-borne diseases.
- The team also provided the participants with information on how to access the project's grievance mechanism should they have any concerns in relation to the construction work.
- There were a total of two participants during the consultation.

APPENDIX L INFORMATION DISCLOSURE

INFORMATION DISCLOSURE WITH ULBS

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 :*	Baranagar Municipality- 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 : Baranagar Municipality Office	Village :
	Date : 13/11/2019	Ward no : Union :

D *Attended By*

Sr.	Name	Designation
1.	Smt. AparnaMoulik	Chairperson
2.	Sri Jayanta Roy	Vice Chairman
3.	Sri. Achintya Kumar Hajra	Executive Officer
4.	Sri Kartik Kumar Jana	Sanitary Inspector
5.	Sri Arnab Dutta	Sanitary Inspector
6.	Sri T.P. Biswas	Engineer (Wabag)
7.	Smt. Jyoti Das	ERM
8.	Sri. Subhasis Chakrabarti	ERM

E *Purpose of ULB* Discussion,

Disclose about the Baranagar STP Project implemented by KMDA under one of the Namami Gange Program at 24th Parganas (North).

Key Points Discussed :

A meeting was conducted with the officials of Baranagar Municipality to disclose about the KMDA project on the upgradation of the STP and sewerage system at Baranagar and Kamarhati Municipality.

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, 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.

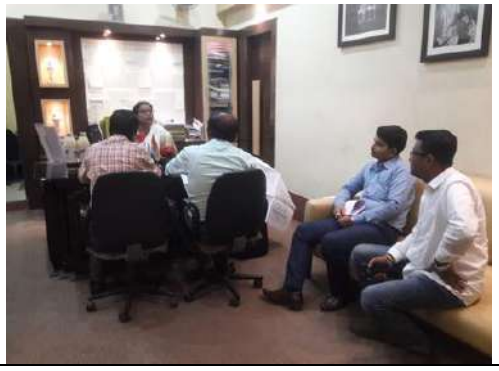
The ERM team also informed about the potential short-term disturbance in the neighbourhoods near the STP, during the de-commissioning and construction phase. However, it was highlighted that these impacts are temporary and will be addressed through proper mitigation measures.

Survey would be conducted to identify the potentially affected persons. 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 framework document.

The Chairperson informed that her area is facing additional traffic load due to the closure of the Tallah Bridge, so proper traffic management measures should be taken for the sewerage pipeline work. They also requested for prior information before commencement of work, the project timeline and the project design.

The members present 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. They also informed that the Tallah bridge is currently under construction and the road access for heavy vehicles has been restricted. They thus requested that the proposed pipeline works in that area should take place after the bridge construction is complete.

Following this, the Executive Officer and Chairman deployed the Health Officer for a joint visit to the project area, to understand the potential areas for disruption.



	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 :*	Kamarhati Municipality-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 :* Disclosure Meeting with Kamarhati Municipality Officials

Location : Kamarhati Municipality Office	Village :
Date : 13/11/2019	Ward no : Union :

D *Attended By*

Sr.	Name	Designation
1.	Sri. Gopal Saha	Chairman
2.	Sri. Monoj Bhattacharjee	Executive Officer
3.	Sri. Samit Talukder	Health Officer
4.	Smt. Jyoti Das	ERM
5.	Sri. Subhasis Chakrabarti	ERM

E *Purpose of ULB* Discussion,

Disclose about the Baranagar 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 officials of Kamarhati Municipality to disclose about the KMDA project on the upgradation of the STP and sewerage system at Baranagar and Kamarhati Municipality.

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, noise as well as community health and safety during the construction phase. Also highlighted were the potential social impacts such as temporary livelihood loss and access disruption, during the laying and replacement of the sewer pipelines, particularly the pipeline leading from the MPS in Kamarhati Municipality to the STP in Baranagar Municipality, which includes Morning Market area and 34 B Bus Stand, GL Tagore Road. It was however mentioned that these impacts are temporary and will be addressed through proper mitigation measures.

The ERM team also informed about the potential short-term disturbance in the neighbourhoods near 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.

Survey would be conducted to identify the potentially affected persons. 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 framework document.

The members of the municipality had requested for the STP project design as well as the timeline of the project. The members mentioned that since the project is in the public interest, they have agreed to offer their full cooperation during the implementation of the project works.

The ULB members however requested for prior information before the implementation of the proposed works.

Following this, the Executive Officer and Chairman deployed the Health Officer for a joint visit to the project area, to understand the potential areas for disruption.

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 Baranagar Municipality
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 Baranagar STP Project	
	Location： Baranagar Municipality	Village：
	Date： 23．11．2019	Ward no： Union：

D *Attended By*

Sr．	Name	Designation
1．	Jayanta Singha	Affected persons
2．	Saheb Pramanik	
3．	Swaray Adhikari	
4．	Anita Devi Shaw	
5．	Sunny Kumar Shaw	
6．	Pintu Rayak	
7．	Hira Lal Shaw	
8．	Subhash Mitra	
9．	Munna Chowdhury	
10．	Jyoti Das	ERM
11．	Subhasis Chakrabarti	ERM

E *Purpose of Meeting*

Disclose about the Baranagar 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 at RKPD Road, Baranagar Municipality to disclose about the KMDA project on the upgradation of the STP and sewerage system at Baranagar and Kamarhati Municipalities．

The ERM team explained to the 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 have expressed their support for the project as they view it as beneficial to the community． They however requested that they be informed in advance when the work starts．

Some members also suggested that once the road work has completed, the roads should be repaired accordingly． The indicated that in the past, certain upgradation works which involved excavation work were not completely repaired, which therefore caused some inconvenience．

They also suggested that proposed works be conducted in the evenings／ night, to prevent access disruption to the in habitants．

The members mentioned that since the project is in the public interest, they support the project activities．

APPENDIX M NMCG MINUTES OF 2ND REVIEW MEETING DATED 22ND OCTOBER, 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.

Annexure 1: 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. Apaual, ADB
12. Sh. Senthil Kumar , NMCG
13. Sh. Sherya Sharda, PwC

APPENDIX N CONCESSIONAIRE'S LETTER TO KMDA DATED 27TH NOVEMBER, 2019

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.

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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.**

(SWADHIN SAMANTARAY)
Head-Capital Projects

VA TECH WABAG LIMITED

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

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APPENDIX O IBAT SCREENING

Proximity Report

BALLY 2

Country: India

Location: [22.6, 88.3]

Date of analysis: 25 February 2020

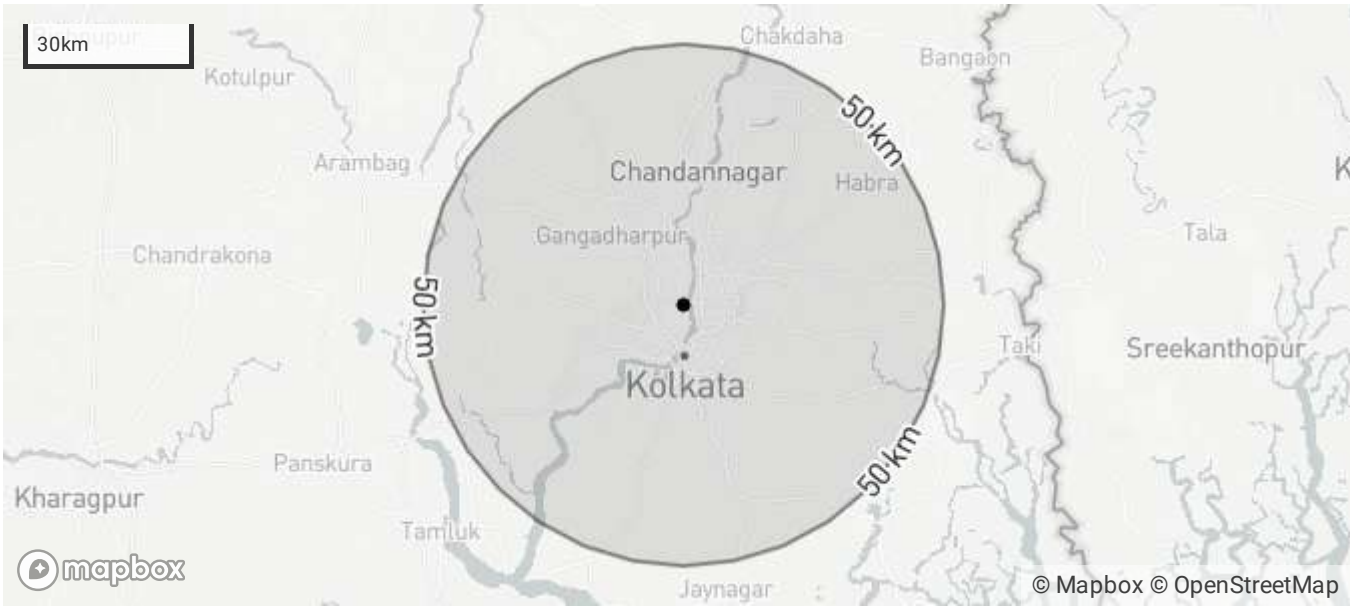
Buffers applied: 50.0 km

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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