DRAFT EIA REPORT

FOR

PROPOSED WASTE TO ENERGY PROJECT (30MW)

AT

DSIIDC INDUSTRIAL AREA, SECTOR-5, BAWANA, DELHI

CATEGORY 'A'

BASELINE STUDY PERIOD: MARCH 2023-MAY 2023

MCPL/EIA/THE/2022-23/14/00/ September,2024

TOR FILE NO. & DATE: J-13012/04/2023-IA-I(T)dated 10.01.2024

PROJECT PROPONENT

M/S JINDAL URBAN WASTE MANAGEMENT (BAWANA) LIMITED, DELHI

ENVIRONMENTAL CONSULTANT

MANTEC CONSULTANTS PVT. LTD.

(QCI Accredited EIA Consultant certificate No.: NABET/EIA/23-26/RA 0305_April 20, 2026)

(NABET Accredited EIA consultant, MoEF & NABL approved Laboratory)

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Undertaking by Project Proponent

The Environmental Impact Assessment Report for "**Proposed Waste to Energy Project (30MW) at DSIIDC Industrial Area, Sector-5, Bawana, Delhi** " prepared by our consultants and has been reviewed thoroughly. I, Sandip Dutt, on behalf of M/s Jindal Urban Waste Management (Bawana) Limited, hereby undertake that the data and information provided in the report are correct to the best of our understanding, and we own responsibility for correctness of contents of the EIA report.

Mr. Sandip Dutt
Director
(Authorized Signatory)

Undertaking by the Head of the Accredited Consultant Organization

I, A. S. Brara, hereby, confirm that the above mentioned experts have prepared the EIA of M/s Jindal Urban Waste Management (Bawana) Limited for "**Proposed Waste to Energy Project (30MW) at DSIIDC Industrial Area, Sector-5, Bawana, Delhi**" at Mantec Consultants Pvt. Ltd.

I also confirm that I shall be fully accountable for any misleading information mentioned in this statement.

Signature	:
Name	: Mr. A.S. Brara
Designation	: CMD

Name of the EIA Consultant Organization: Mantec Consultants Pvt. Ltd., Noida-201301

NABET Certificate No. NABET/EIA/2326/RA 0305 Validity April 20, 2026

ANNEXURE-VII (As per NABET format)

DECLARATION BY CONSULTANTS

Declaration by Experts contributing to the preparation EIA – .

I, hereby, certify that I was a part of the EIA team in the following capacity that developed the EIA report for **"Waste to Energy Project (30 MW) at DSIIDC Industrial Area, sector-5, Bawana, Delhi-110039 by M/s Jindal Urban Waste Management (Bawana) Limited".**

EIA Coordinator:

Name	Mr. A.S. Brara
Period of Involvement	March, 2023 to till now;
Contact Information	0120-4215000
Signature & Date	ASBrara

Assistant EIA Coordinator:

Name	Dr. B.J Prasad
Period of Involvement	March, 2023 to till now;
Contact Information	0120-4215000
Signature & Date	Prasad

Functional Area Experts

S. No.	Functional Areas	Name of the Experts	Involvement (task & period)	Signature & Date
1	AP*	Mr. A.S. Brara (FAE)	**March, 2023 - till now;** • Identification of Air Quality Monitoring Network • Supervision of ambient air quality monitoring • Review of primary air quality monitoring	ASBrara

			report and analysis • Addressing air quality issues in EIA Report and suggesting mitigation measures for impacts due to air pollution and review • Review and analysis of primary meteorological data	
2	WP*	Mr. A.S. Brara (FAE)	**March, 2023 - till now;** • Identification of water sampling locations, their time and frequency pertaining to site conditions • Counter checking of analysis of data by literature study and consultation with local people and concerned departments • Identification of water quality by analysis report study and detection of potential hazards due to developmental activity • Checking of water availability by literature study and by interacting concerned Govt. Officials like GWB and irrigation dept.	AS Brara
		Mr. Ranjan Kumar Keshri (FAA)	**March, 2023 - till now;** • Assisted FAE for Selection of the water Monitoring stations and development of EMP, Identification of water quality by analysis report study and detection of potential hazards due to developmental activity, Checking of water availability by literature study and by interacting concerned Govt. Officials like GWB and irrigation dept.	Ranjan K. Keshri
		Akhil PM (TM)	**April 2024-till now;** • Assisted FAE for Selection of the water Monitoring stations and development of EMP, Identification of water quality by analysis report study	Akhil

3	SHW*	Mrs. Rekha Singh (FAE)	**March, 2023 – August, 2023;** • Assess the waste sources and status in the study area. After studying the sources have prepared the Impact report and suggested Mitigation measures and development of EMP	
		Mr. Nilesh Vitthal Potdar (FAE)	**September, 2023 – till now;** • Assess the waste sources and status in the study area. After studying the sources have prepared the Impact report and suggested Mitigation measures and development of EMP	
		Mr. Ranjan Kumar Keshri (FAA)	**March, 2023 – till now;** • Assisted FAE in Devising measures to minimize wastes; recycle and disposal. • Identification methods of recycling and reuse Ensured incorporation of the same into the EIA report.	Ranjan Kr. Keshri
4	SE	Mr. Braj Vallabh Pandey (FAE)	**March, 2023 - till now;** • Design and develop format/ questionnaire for baseline survey, social changes arising out of development projects and assessment of data so collected • Evaluation of socio economic status of tribal/ non- tribal areas • Assessment of social impact • Collection of secondary information Survey tool design • Reconnaissance study, transect walk Community participation, Mitigation plan	Braj Vallabh Pandey

			• Stakeholder consultation	
		Mr. Pankaj Kumar (FAA)	**March, 2023 - till now;** • Data mining from Census of India 2011 and other sources. Assisted in report making under the guidance of the FAE.	Pankaj
5	EB	Mr. Kamal Kumar Saxena (FAE)	**March, 2023 - till now;** • Identification of potential impact due to the project interventions and developing mitigation measures by direct field study.	Saxena
		Mr. Gajanand Mallick (FAE)	**March, 2023 – April, 2024;** • Identification of potential impact due to the project interventions and developing mitigation measures by direct field study and consulting the stakeholders like forest and wildlife officials, local people etc.	
		Ajay Singh Negi (FAA)	**March, 2023 – February, 2024;** • Ecology and Biodiversity conditions in the core and buffer zone. With the help of the literature and the data collected during the site visit the report was prepared and related impact and mitigation measures and EMP was prepared.	
		Mr. Navneet Shukla (TM)	**May, 2024 - till now;** • Assisting in the preparation of EB report and mitigation measures and EMP.	Navneet Shukla

6	HG*	Mr. R. K. Khanna (FAE)	**March, 2023 - till now;** • Identification of the water sources and drainage pattern • Analyze them to identify the likely impacts • Devise mitigation measures and assisted in preparation of the EIA report.	
7	GEO*	Mr. S.I. Tanveer (FAE)	**March, 2023 - till now;** • Identification of Geological condition of the project site and After studying the possible sources have prepared the Impact, risk report and suggested Mitigation measures and development of EMP	
8	SC*	Dr. B.J Prasad (FAE)	**March, 2023 - till now;** • Review of soil quality and soil type for establishing the baseline condition. • Assessing the impact on soil due to various activities of the project. • Suggest mitigation measures for control the adverse impact and soil conservation.	Prasad
		Mr. Susheel Kumar Yadav (FAA)	**September 2023 - till now;** • Assisted FAE in review of the soil quality of the study area as well as core zone. Help analyzing possible impacts due to the proposed project and in suggesting mitigation measures	
		Mr. Kamal Kumar Saxena (TM)	**March, 2023 - till now;** • Assisted FAE in review of the soil quality of the study area as well as core zone. Help analyzing possible impacts due to the proposed project and in suggesting mitigation measures	Saxena.

9	AQ*	Mr. A.S. Brara (FAE)	**March, 2023 - till now;** • Analysis of air quality data, meteorological data, traffic data etc. as per the requirements of Pollution Dispersion model (ISCST3) • Assessment of secondary data requirements for modeling, collection of secondary data like mixing height, stability class etc. • Predict air quality using pollution dispersion model (ISCST3) • Interpretation, analysis and presentation of predicted results of pollution dispersion modeling • Review and finalization of report	AS Brara
		Mr. Susheel Kumar Yadav (TM)	**September 2023 - till now;** • Assisting in Analyzing of air quality data, meteorological data, traffic data etc. as per the requirements of Pollution Dispersion model (ISCST3) • Assisting in Assessment of secondary data requirements for modeling, collection of secondary data like mixing height, stability class etc.	Sushil Yadav
		Mr. Akhil PM (TM)	**April 2024-till now;** • Assisting in Analyzing of air quality data, meteorological data, traffic data etc. as per the requirements of Pollution Dispersion model (ISCST3) • Assisting in Assessment of secondary data requirements for modeling, collection of secondary data like mixing height, stability class etc.	Akhil
10	NV*	Mr. A. S. Brara (FAE)	**March, 2023 - till now;** • Identification of Noise Quality Monitoring	

			Network and noise sensitive location along the project stretch • Supervision of ambient noise quality monitoring • Review of noise quality monitoring report • Addressing noise related issues in EIA report and suggesting measures for impacts due to noise pollution. Analysis of noise quality data, traffic data etc. as per the requirement of mathematical model of FHWA-TNM Interpretation, analysis and presentation of predicted results.	
11	LU*	Mr. Jaideep (FAE)	**March, 2023 - till now;** • Identification and collection of satellite images and other associated maps for the project area Creation of GIS data base and processing of satellite imageries	Jaideep Singh
12	RH*	Mr. P.K. Srivastava (FAE)	**March, 2023 - till now;** • Identification of the potentially hazardous material and events that night occur during various Phases of the project • Devising contingency plan for each type of hazard • Incorporation of the same in the EIA report.	Prabhat Kumar
		Mr. Shrinath Kumar (FAA)	**March, 2023 - till now;** • Devising contingency plan for each type of hazard Incorporation of the same in the EIA report.	
		Mr. Abhishek Saxena (TM)	**November, 2023 - till now;** • Assisting for each type of hazard Incorporation of the same in the EIA report.	

S. No.	Functional Area Code	Complete name of the Functional Areas
1	AP	Air Pollution Prevention, Monitoring & Control
2	WP	Water Pollution Prevention, Control & Prediction of impacts
3	SHW	Solid Waste & Hazardous Waste Management
4	SE	Socio-Economics
5	EB	Ecology & Biodiversity
6	HG	Hydrology, Ground Water & Water Conservation
7	GEO	Geology
8	SC	Soil Conservation
9	AQ	Meteorology, Air Quality Modeling & Prediction
10	NV	Noise/Vibration
11	LU	Land Use
12	RH	Risk Assessment & Hazard Management

Terms of Reference(TOR)			
Sr. No.	**ToR Points**	**Compliance**	**Reference**
1.1 Socio-economic Study			
1	Public Health Delivery Plan including the provisions of drinking water supply for local population shall be in the EIA/EMP Report. Status of the existing medical facilities in the project area shall be discussed. Possibilities of strengthening of existing medical facilities, construction of new medical infrastructure etc. will be explored after assessing the need of the labour force and local populace.	This aspect has been covered in Chapter-3, Section No. 3.17.6 of EIA report.	Page No. 196 of EIA report
2	All the tasks including conducting public hearing shall be done as per the provisions of EIA Notification, 2006 and as amended from time to time. Public hearing issues raised and compliance of the same shall be incorporated in the EIA/ EMP report in the relevant chapter.	Public Hearing will be conducted as per EIA Notification 2006. This condition will be complied at the time of FEIA/EMP report after public hearing. Refer Chapter 7, Section 7.1.	Page No. 265 of EIA report
3	Statement on the commitments (activity-wise) made during public hearing to facilitate the discussion on the CER in compliance of the Ministry's OM F. No. 22- 65/2017-IA.III dated 30th September, 2020 shall be submitted. Tentative no. of project affected families shall be identified and accordingly appropriate Rehabilitation &Resettlement plan shall be prepared.	CER plan based on outcome of Public Hearing and action plan along with budgetary provision will be included in the Final EIA report. Refer Chapter 10, Section 10.10 The land for the project is in physical possession of MCD and it does not involve R&R issue.	Page No. 346 of EIA report
4	Details of settlement in 10 km area shall be submitted.	Settlement in 10 km area is given in Chapter-3	Page No. 175 of EIA report
5	Harnessing solar power within the premises of the plant particularly at available roof tops and other available areas shall be formulated and for expansion projects, status of implementation shall also be submitted.	The proposed project will install LED solar lights for street. Refer Chapter-2 Section No. 2.16	Page No. 51 of EIA report
2. Environmental Management And Biodiversity Conservation			

1	Cumulative Environmental Impact Assessment study of all the existing and proposed projects in the 15-km radius of the proposed project shall be conducted.	The details of Cumulative Impact Assessment are described in Chapter-4 Section No. 4.3.6 of EIA report.	Page No. 239 of EIA report
2	Details of characterization of Municipal solid waste, its segregation process and disposal of waste management plan shall be submitted along with EIA.	Municipal solid waste, its segregation process and disposal of waste management plan has been discussed in the Chapter-2 of EIA report. Characteristic of MSW is given in Section 2.10.1	Page No. 26 of EIA report
3	A plan shall be submitted to minimize the least use of hard plastic getting burn into the incinerators.	Hard plastic Management plan is given in the Chapter-2 Section 2.13 of EIA Report.	Page No. 50 of EIA report
4	A study shall be carried out that commissioning of the project can decrease air emission level in the surrounding area as compare to current situation.	This aspect has been described in Chapter-4, Section 4.3.2.4 of EIA report.	Page No. 231 of EIA report
5	Proximate and ultimate analysis, Calorific value of municipal waste proposed to be brought from nearby MSW shall be carried out for design purpose of boilers. Mass balance of waste in the process shall be submitted.	All these details are given in the Chapter-2, Section 2.11.1 of EIA Report. Proximate and ultimate analysis report is enclosed as **Annexure V**.	Page No. 42 of EIA report
6	Toxicity Characteristic Leachate Procedure (TCLP) test shall be conducted for Characterization of leachate, any potential of leaching heavy metals into the surrounding areas as well as into the groundwater. TCLP analysis of heavy metals, texture, bulk density, Cation Exchange Capacity of Heavy metals in the flyash and bottom ash shall be conducted for existing nearby plant.	TCLP report of leachate is given in Chapter-2, Section 2.11.1 of EIA report. TCLP report of fly ash & bottom ash is enclosed as **Annexure IV**.	Page No. 42 of EIA report
7	The remedial measures for arresting dust generation on roads and atmosphere, Air pollution control measures including NOx control measure, treatment of leachate and stabilizing the slopes shall be taken up. Implementation plan along with timelines and financial allocations for Scientific and engineered closure of existing landfill shall be submitted.	The air pollution control, water pollution control and leachate treatment systems have been described in Chapter 4 of the EIA report. There is no existing land landfill project of Jindal.	Page No. 228 of EIA report

8	Detailed Geo-hydrological study shall be conducted w. r. t hydraulic gradient, porosity and infiltration around 2 km of the landfill site.	Geo-hydrological study has been described in Chapter 3, Section 3.6 of EIA report.	Page No. 58 of EIA report
9	Aquifer characteristics shall be clearly mapped by conducting in-situ studies.	Aquifer characteristics aspect has been incorporated in Chapter 3, Section 3.6.4	Page No. 58 of EIA report
10	Treatment and disposal of leachate shall be submitted. No water from the plant is allowed to enter into canal/ nallah/ stream.	Leachate treatment system has been in Chapter-2, Section 2.11.1 The project is based on ZLD and water will be discharged from plant.	Page No. 42 of EIA report
11	Details regarding Flue gas treatment, ash generation and its disposal/utilization method shall be submitted.	The flue gas cleaning system (FGCS) is mentioned in Chapter-2 Section 2.10.7.	Page No. 39 of EIA report
12	Monitoring of dioxins and furans and other heavy metals shall also be carried out in the stack emissions as per the Municipal Solid Waste Rules, 2016 for one season of the existing nearby waste to energy plant.	Monitoring of dioxins and furans and other heavy metals will be done during operation has been mentioned in Chapter-3. Monitoring of dioxins and furans and other heavy metals of existing WtE plant is given as **Annexure -V**	Page No. 137 of EIA report
13	Impact of existing integrated facility on natural environment be studied and a comparative statement clearly mentioning the impacts on existing water bodies, and other ecologically sensitive areas within 10 km radius of project be submitted.	The impact of existing integrated facility on existing water bodies is mentioned in Chapter 4, Section 4.3.3. There is no ecological sensitive area in 10 km radius.	Page No. 233 of EIA report
14	A comparative chart shall be prepared with changes observed from previous baseline study (existing nearby Waste to Energy Plant) and present baseline study.	A comparative Table has been prepared and changes observed are given in Chapter-3, Section 3.15.	Page No. 139 of EIA report
15	An epidemiological study shall be carried out within 5 km range of the existing integrated facility.	The details of epidemiological study in 5km radius is given in Section 3.17.6.2 of Chapter 3.	Page No. 196 of EIA report
16	Detailed action plan shall be prepared for maintenance of air pollution control equipment.	The maintenance of air pollution control equipment is mentioned in Chapter 2, Section 2.10.7.1 of EIA report.	Page No. 40 of EIA report

17	Pond and ground water quality (10 locations within 2 km radius of the plant boundary) shall be studied and report be submitted along with EIA/EMP. Action plan for Ground water monitoring stations on all hotspots like schools/hospitals within 2 km radius of the plant boundary be submitted.	Monitoring of Pond and Ground water within 2 km radius (Annexure-VIII) of the plant boundary has been incorporated in the Chapter-3, Section 3.12.4 of EIA report. Action plan for monitoring at hotspots like schools/hospitals is given in Chapter-6.	Page No. 92 of EIA report
18	Baseline Study for Heavy metals in Ground water, Surface water and soil to be carried out and incorporated in EIA/EMP report.	Baseline Study for Heavy metals (**Annexure-III**), Ground water, Surface water and soil has been incorporated in Chapter-3, Section 3.12.3 of EIA report.	Page No. 76 of EIA report
19	Details pertaining to water source, treatment and discharge should be provided.	The water will be taken from waste water of PPCL/Delhi Jal Board. The water will be treated to make it suitable for industrial use. All treated waste water of the plant will be utilized and recycled in the process and there will be no any liquid discharge from the plant, Henceforth, the project will adhere to the Zero Liquid Discharge (ZLD) concept. Details are given in Chapter-2 Section 2.4.1 of EIA report.	Page Nos. 19 of EIA report
20	Zero Liquid Discharge plan shall be submitted.	All water will be utilized and recycled in the process and there will be no any liquid discharge from the plant, Henceforth, the project will adhere to the Zero Liquid Discharge (ZLD) concept. Details are given in Chapter-2 Sections 2.4.1 of EIA report.	Page No. 19 of EIA report
21	Action plan for development of green belt (40% of total project cover area) along the periphery plantation with 90% survival rate and detailed plan for thick plantation in the surrounding Nallah/stream shall be submitted.	Details of Green Belt development plan as per stipulation are given in Chapter-10, Section 10.9 of EIA report.	Page No. 340 of EIA report
22	PP shall submit action plan for using treated Sewage/Domestic wastewater for its operations.	Treated Sewage/Domestic wastewater plan is mentioned in Chapter 2, Section 2.4.1 of EIA report.	Page No. 19 of EIA report
23	Project Proponent to conduct Environmental Cost Benefit Analysis for the project in EIA/EMP Report.	Environmental Cost Benefit for the proposed project is given in the Chapter-9 of EIA report.	Page No. 321 of EIA report

24	An action plan shall be prepared for Water shed development within 10 km radius of the plant boundary in consultation with reputed government institution.	Water shed development within 10 km radius of the plant boundary is given in the Chapter-7, Section 7.6 of the EIA report.	Page No. 303 of EIA report
25	A detailed plan need to be submitted for undertaking extensive green plantation within 10 km radius of the plant focusing on water reservoir, school, hospital and other institutional area and same need to be incorporated in EIA/EMP report.	A detailed plan for undertaking Green Belt development is given in Chapter-10, Section 10.9 of EIA report.	Page No. 340 of EIA report
26	Recommendations of the Commission for Air Quality Management in National Capital Region and Adjoining Areas shall be submitted	Recommendations of Commission for AQ management in NCR and its recommendations (Annexure-XII) are given in Chapter-4, Section 4.2.4.1	Page No. 215 of EIA report
3.1 Disaster Management			
1	Disaster Management Plan shall be prepared and incorporated in EIA/EMP report	Disaster Management Plan has been incorporated in the Chapter-7, Section 7.5 of the EIA report.	Page No. 289 of EIA report
4.1 Miscellaneous			
1	PP shall submit details of court cases and its status for the project.	There is no court case pertaining to this project. Refer Chapter 2, Section 2.21	Page No. 54 of EIA report
2	A letter shall be submitted certified that the JSW is the current bidder and it has valid consent.	The project will be implemented on PPP mode with MCD. Jindal Urban Infrastructure Limited is the successful bidder for the proposed project. Refer Chapter 1, Section 1.1.	Page No. 1 of EIA report
3	The PP should submit the photograph of monitoring stations & sampling locations. The photograph should bear the date, time, latitude & longitude of the monitoring station/sampling location. In addition to this PP should submit the original test reports and certificates of the labs which will analyze the samples.	The photograph of monitoring stations & sampling locations detailing date, time etc. is given in Chapter-3 of EIA report. The original test reports of laboratory are given as Annexure-III. NABL Certificate of the laboratory Annexure-II is given in Chapter-12	Page No. 365 of EIA report
4	Aerial view video of project site shall be recorded through drone and be submitted.	Aerial view video of project site has been recorded.	Noted
Standard Terms of Reference for (Thermal Power Plants **5.0 Statutory Compliance**			

1	The proposed project shall be given a unique name in consonance with the name submitted to other Government Departments etc. for its better identification and reference.	The unique name of the project is "Proposed Waste to Energy (30MW) at DSIIDC Industrial Area, Sector-5, Bawana by Jindal Urban Waste Management (Bawana) Limited".	-
2	Vision document specifying prospective long term plan of the project shall be formulated and submitted.	------	
3	Latest compliance report duly certified by the Regional Office of MoEF&CC for the conditions stipulated in the environmental and CRZ clearances of the previous phase(s) for the expansion projects shall be submitted.	This is fresh and new proposed project.	
6. Details Of The Project And Site			
1	The project proponent needs to identify minimum three potential sites based on environmental, ecological and economic considerations, and choose one appropriate site having minimum impacts on ecology and environment. A detailed comparison of the sites in this regard shall be submitted.	The same has been given in Chapter-5, Section-5.1, of the EIA Report	Page No. 247 of EIA report
2	Executive summary of the project indicating relevant details along with recent photographs of the proposed site (s) shall be provided. Response to the issues raised during Public Hearing and the written representations (if any), along with a time bound Action Plan and budgetary allocations to address the same, shall be provided in a tabular form, against each action proposed.	Executive summary has been attached with the EIA Report. Public hearing action plan will be submitted during the submission of FEIA report.	
3	Harnessing solar power within the premises of the plant particularly at available roof tops and other available areas shall be formulated and for expansion projects, status of implementation shall also be submitted.	At the time of proposed Project LED solar lights for street has been proposed. The same has been given in Chapter-2, Section 2.16 of the EIA report	Page No. 51 of EIA report
4	The geographical coordinates (WGS 84) of the proposed site (plant boundary), including location of ash pond along with topo sheet (1:50,000 scale) and IRS satellite map of the area, shall be submitted. Elevation of plant site and ash pond with respect to HFL	The co-ordinates of the Project have been provided in the EIA report in Chapter-1, Section 1.4	Page No. 2 of EIA report

	of water body/nallah/River and high tide level from the sea shall be specified, if the site is located in proximity to them.		
5	Layout plan indicating break-up of plant area, ash pond, green belt, infrastructure, roads etc. shall be provided.	The layout plan of the Proposed WtE has been given in Chapter-2, Section 2.2 of the EIA report.	Page No. 14 of EIA report
6	Land requirement for the project shall be optimized and in any case not more than what has been specified by CEA from time to time. Item wise break up of land requirement shall be provided.	The land for the project has been handed over by MCD (Annexure-XVI) and it does not involve R&R issue.	-----
7	Present land use (including land class/kism) as per the revenue records and State Govt. records of the proposed site shall be furnished. Information on land to be acquired including coal transportation system, laying of pipeline, ROW, transmission lines etc. shall be specifically submitted. Status of land acquisition and litigation, if any, should be provided.	The project will be implemented on PPP mode with MCD. Jindal Urban Infrastructure Limited is the successful bidder for the proposed project. Refer Chapter 1, Section 1.1.	Page No. 1 of EIA report
8	If the project involves forest land, details of application, including date of application, area applied for, and application registration number, for diversion under FCA and its status should be provided along with copies of relevant documents.	The project does not involve Forest land and hence this is not applicable.	
9	The land acquisition and R&R scheme with a time bound Action Plan should be formulated and addressed in the EIA report.	R&R is not applicable for this project	-----
10	Satellite imagery and authenticated topo sheet indicating drainage, cropping pattern, water bodies (wetland, river system, stream, nallahs, ponds etc.), location of nearest habitations (villages), creeks, mangroves, rivers, reservoirs etc. in the study area shall be provided.	The details have been given in Chapter-3, Section 3.8 of the EIA Report	Page No. 63 of EIA report
11	Topography of the study area supported by toposheet on 1:50,000 scale of Survey of India, along with a large scale map preferably of 1:25,000 scale and the specific information whether the site requires any filling	Details are given in Chapter-1, Section 1.4 of EIA/EMP report.	Page No. 2 of EIA report

	shall be provided. In that case, details of filling, quantity of required fill material; its source, transportation etc. shall be submitted.		
7. Ecology Biodiversity And Environment			
1	A detailed study on land use pattern in the study area shall be carried out including identification of common property resources (such as grazing and community land, water resources etc.) available and Action Plan for its protection and management shall be formulated. If acquisition of grazing land is involved, it shall be ensured that an equal area of grazing land be acquired and developed and detailed plan submitted.	The Landuse and Land cover details of the study area has been given in Chapter-3, Section 3.8 of the EIA report	Page No. 63 of EIA report
2	Location of any National Park, Sanctuary, Elephant/Tiger Reserve (existing as well as proposed), migratory routes / wildlife corridor, if any, within 10 km of the project site shall be specified and marked on the map duly authenticated by the Chief Wildlife Warden of the State or an officer authorized by him.	There is no wildlife sanctuary within 10km radius of the study area.	-----
3	A mineralogical map of the proposed site (including soil type) and information (if available) that the site is not located on potentially mineable mineral deposit shall be submitted.	The project site is located in DSIIDC Industrial Area, Bawana. Hence, this condition may not be applicable for this project.	
4	The water requirement shall be optimized (by adopting measures such as dry fly ash and dry bottom ash disposal system, air cooled condenser, concept of zero discharge) and in any case not more than that stipulated by CEA from time to time, to be submitted along with details of source of water and water balance diagram. Details of water balance calculated shall take into account reuse and recirculation of effluents.	Water Requirement for the project has been given in Chapter-2, Section 2.4 of the EIA report.	Page No. 17 of EIA report
5	Water body/Nallah (if any) passing across the site should not be disturbed as far as possible. In case any Nallah / drain is proposed to be diverted, it shall be ensured that the diversion does not	The Nallah passing through the site has not been diverted and the layout map showing the same is given in Chapter-2, Section 2.2 of the EIA report.	Page No. 14 of EIA report

	disturb the natural drainage pattern of the area. Details of proposed diversion shall be furnished duly approved by the concerned Department of the State.		
6	It shall also be ensured that a minimum of 500 m distance of plant boundary is kept from the HFL of river system / streams etc. and the boundary of site should also be located 500 m away from railway track and National Highways.	The nearest water body is the Western Yamuna canal at a distance of 32 metres from the project site. Nearest Railway station is Narela which is approximately 6kms from the project site.	
7	Hydro-geological study of the area shall be carried out through an institute/ organization of repute to assess the impact on ground and surface water regimes. Specific mitigation measures shall be spelt out and time bound Action Plan for its implementation shall be submitted.	The same has been given in the EIA report in Chapter-3, Section 3.6.3	Page No. 58 of EIA report
8	Detailed Studies on the impacts of the ecology including fisheries of the River/Estuary/Sea due to the proposed withdrawal of water / discharge of treated wastewater into the River/Sea etc shall be carried out and submitted along with the EIA Report. In case of requirement of marine impact Assessment study, the location of intake and outfall shall be clearly specified along with depth of water drawl and discharge into open sea.	ZLD has been envisaged in the proposed project and the details have been mentioned in Chapter-2, Section 2.4.1 of the EIA report	Page No. 19 of EIA report
9	Source of water and its sustainability even in lean season shall be provided along with details of ecological impacts arising out of withdrawal of water and taking into account inter-state shares (if any). Information on other competing sources downstream of the proposed project and commitment regarding availability of requisite quantity of water from the Competent Authority shall be provided along with letter / document stating firm allocation of water.	The source of water is blow down water of M/s Pragati Power Corporation Limited and no water will be withdrawn from any natural water bodies. Hence, there will be no impact on ecology and downstream users. The commitment letter for water supply is given as Annexure-XVI .	
10	Detailed plan for rainwater harvesting and its proposed utilization in the plant shall be furnished. In addition, wherever ground water is drawn, PP shall submit detailed plan of Water charging activity to be undertaken.	The same has been given in the EIA report in Chapter-2, Section 2.15	Page No. 51 of EIA report

11	Feasibility of near zero discharge concept shall be critically examined and its details submitted.	ZLD has been envisaged in the proposed project and the details have been mentioned in Chapter-2, Section 2.4.1 of the EIA report	Page No. 19 of EIA report
12	Optimization of Cycles of Concentration (COC) along with other water conservation measures in the project shall be specified.	The Cycles of Concentration (COC) and water conservation measures are given in Chapter-2, Section 2.4 of the EIA report.	Page No. 17 of EIA report
13	Plan for recirculation of ash pond water and its implementation shall be submitted.	This is a MSW based power plant. Hence, there is no ash slurry from this project.	
14	Detailed plan for conducting monitoring of water quality regularly with proper maintenance of records shall be formulated. Detail of methodology and identification of monitoring points (between the plant and drainage in the direction of flow of surface / ground water) shall be submitted. It shall be ensured that parameter to be monitored also include heavy metals. A provision for long-term monitoring of ground water table using Piezometer shall be incorporated in EIA, particularly from the study area.	As per the proposed monitoring plan Ground water and surface water quality will be regularly monitored including the monitoring of Heavy metals. Detailed monitoring plan is provided in Chapter-6 of EIA report.	Page No. 247 of EIA report
15	Hazards Characterization: Past incidents of hazard events within 10km radius of project area with detailed analysis of causes and probability of reoccurrence.	The same has been provided in Chapter-7, Section 7.4 of the EIA report.	Page No. 266 of EIA report
8. Environmental Baseline Study And Mitigation Measures			
1	One complete season (critical season) site specific meteorological and AAQ data (except monsoon season) as per latest MoEF&CC Notification shall be collected along with past three year's meteorological data for that particular season for wins speed analysis and the dates of monitoring shall be recorded. The parameters to be covered for AAQ shall include PM10, PM2.5, SO2, NOx, CO and Hg. The location of the monitoring stations should be so decided so as to take into consideration the upwind direction, pre-dominant	The Air quality Monitoring was carried out in the Pre-Monsoon season (March 2023-May2023). The same has been provided in Chapter-3, Section 3.13 of the EIA report	Page No. 112 of EIA report

	downwind direction, other dominant directions, habitation and sensitive receptors. There should be at least one monitoring station each in the upwind and in the pre - dominant downwind direction at a location where maximum ground level concentration is likely to occur.		
2	In case of expansion project, air quality monitoring data of 104 observations a year for relevant parameters at air quality monitoring stations as identified/stipulated shall be submitted to assess for compliance of AAQ Standards (annual average as well as 24 hrs).	Not Applicable as this is a new project	
3	A list of industries existing and proposed in the study area shall be furnished.	The same has been given in Chapter-4, Section 4.3.6 of the EIA report.	Page No. 239 of the EIA report
4	Cumulative impacts of all sources of emissions including handling and transportation of existing and proposed projects on the environment of the area shall be assessed in detail. Details of the Model used and the input data used for modelling shall also be provided. The air quality contours should be plotted on a location map showing the location of project site, habitation nearby, sensitive receptors, if any. The wind-rose and isopleths should also be shown on the location map. The Cumulative study should also include impacts on water, soil and socio-economics.	Cumulative impacts assessment of the nearby industries have been carried out and the same has been given in Chapter-4, Section 4.3.6 of the EIA report. Detailed Cumulative Study has been annexed as Annexure-XIII.	Page No. 239 of the EIA report
5	Radio activity and heavy metal contents of coal to be sourced shall be examined and submitted along with laboratory reports.	This is not applicable as this is a proposed WtE project which uses MSW as its raw material	
6	Fuel analysis shall be provided. Details of auxiliary fuel, if any, including its quantity, quality, storage etc. should also be furnished.	This is a proposed WtE plant which uses MSW as its raw material. The composition of MSW has been given in Chapter-5, Section 5.2 of the EIA report.	Page No. 247 of the EIA report

7	Quantity of fuel required, its source and characteristics and documentary evidence to substantiate confirmed fuel linkage shall be furnished. The Ministry's Notification dated 02.01.2014 regarding ash content in coal shall be complied. For the expansion projects, the compliance of the existing units to the said Notification shall also be submitted.	Quantity of required MSW is approximately 3000TPD. MSW will be supplied by MCD (Letter attached as Annexure-XVI .	
8	Details of transportation of fuel from the source (including port handling) to the proposed plant and its impact on ambient AAQ shall be suitably assessed and submitted. If transportation entails a long distance it shall be ensured that rail transportation to the site shall be first assessed. Wagon loading at source shall preferably be through silo/conveyor belt.	The raw material for this proposed WtE plant is MSW which will be received in in covered trucks. The details have been provided in Chapter-2, Section 2.8 of the EIA report.	Page No. 22 of the EIA report
9	For proposals based on imported coal, inland transportation and port handling and rail movement shall be examined and details furnished. The approval of the Port and Rail Authorities shall be submitted.	The raw material for this proposed project is MSW and hence this is not applicable for this project	
10	Details regarding infrastructure facilities such as sanitation, fuel, restrooms, medical facilities, safety during construction phase etc. to be provided to the labour force during construction as well as to the casual workers including truck drivers during operation phase should be adequately catered for and details furnished.	All these facilities shall be provided to the labour and truck drivers during construction phase which has been mentioned in Chapter-4, Section 4.2.7 of the EIA report	Page No. 217 of the EIA report
9. Environmental Management Plan			
1	EMP to mitigate the adverse impacts due to the project along with item - wise cost of its implementation in a time bound manner shall be specified.	The same has been described in Chapter-10 of the EIA report	Page No. 323 of the EIA report
2	A Disaster Management Plan (DMP) along with risk assessment study including fire and explosion issues due to storage and use of fuel should be prepared. It should take into account the maximum inventory of storage at site at any point of time. The risk contours should be plotted on the plant layout map clearly showing which of	A Disaster Management Plan (DMP) has been prepared for the proposed project and it has been described in Chapter-7, Section 7.5 of the EIA report	Page No. 289 of the EIA report

	the proposed activities would be affected in case of an accident taking place. Based on the same, proposed safeguard measures should be provided. Measures to guard against fire hazards should also be invariably provided. Provision for mock drills shall be suitably incorporated to check the efficiency of the plans drawn.		
3	The DMP so formulated shall include measures against likely Fires/Tsunami/Cyclones/Storm Surges/ Earthquakes etc., as applicable. It shall be ensured that DMP consists of both On-site and Off-site plans, complete with details of containing likely disaster and shall specifically mention personnel identified for the task. Smaller version of the plan for different possible disasters shall be prepared both in English and local languages and circulated widely.	A Disaster Management Plan (DMP) has been prepared for the proposed project and it has been described in Chapter-7, Section 7.5 of the EIA report	Page No. 289 of the EIA report
4	Details of fly ash utilization plan as per the latest fly ash Utilization Notification of GOI along with firm agreements /MoU with contracting parties including other usages etc. shall be submitted. The plan shall also include disposal method / mechanism of bottom ash along with monitoring mechanism.	The same has been given in Chapter-2, Section 2.7 of the EIA report.	Page No. 22 of the EIA report
10. Green Belt Development			
1	Detailed scheme for raising green belt of native species of appropriate width (50 to 100 m) and consisting of at least 3 tiers around plant boundary not less than 2000 tree per ha with survival rate of more than 85%shall be submitted. Photographic evidence must be created and submitted periodically including NRSA reports in case of expansion projects. A shrub layer beneath tree layer would serve as an effective sieve for dust and sink for CO_2 and other gaseous pollutants and hence a	The greenbelt development plan for the proposed project has been given in Chapter-10, Section 10.9 of the EIA report.	Page No. 340 of the EIA report

	stratified green belt should be developed.		
2	Over and above the green belt, as carbon sink, plan for additional plantation shall be drawn by identifying blocks of degraded forests, in close consultation with the District Forests Department. In pursuance to this the project proponent shall formulate time bound Action Plans along with financial allocation and shall submit status of implementation to the Ministry every six months.	The financial allocation for the greenbelt development has been given in Chapter-10, Section 10.9.3 of the EIA report.	Page No. 346 of the EIA report
11. Socio-economic Activities			
1	Socio-economic study of the study area comprising of 10 km from the plant site shall be carried out through a reputed institute / agency which shall consist of detail assessment of the impact on livelihood of the local communities.	The details of the study has been mentioned in Chapter-3, Section 3.17 of the EIA report	Page No. 175 of the EIA report
2	Action Plan for identification of local employable youth for training in skills, relevant to the project, for eventual employment in the project itself shall be formulated and numbers specified during construction & operation phases of the Project.	The details of the study has been mentioned in Chapter-3, Section 3.17.5.1 of the EIA report	Page No. 178 of the EIA report
3	If the area has tribal population, it shall be ensured that the rights of tribals are well protected. The project proponent shall accordingly identify tribal issues under various provisions of the law of the land.	The details of the study has been mentioned in Chapter-3, Section 3.17.5.6 of the EIA report	Page No. 186 of the EIA report
4	A detailed CER plan along with activities wise break up of financial commitment shall be prepared in terms of the provisions OM No. 22-65/2017-IA.III dated 30.09.2020.CER component shall be identified considering need based assessment study and Public Hearing issues. Sustainable income generating measures which can help in upliftment of affected section of society, which is consistent with the traditional skills of the people shall be identified.	Details have been incorporated in Chpter-10, Section-10.10 of the EIA report	Page No. 346 of the EIA report

5	While formulating CER schemes it shall be ensured that an in-built monitoring mechanism for the schemes identified are in place and mechanism for conducting annual social audit from the nearest government institute of repute in the region shall be prepared. The project proponent shall also provide Action Plan for the status of implementation of the scheme from time to time and dovetail the same with any Govt. scheme(s). CER details done in the past should be clearly spelt out in case of expansion projects.	CER activities including the cost will be implemented after conducting of Public Hearing and will be incorporated in the Final EIA report.	Page No. 346 of the EIA report
6	R&R plan, as applicable, shall be formulated wherein mechanism for protecting the rights and livelihood of the people in the region who are likely to be impacted, is taken into consideration. R&R plan shall be formulated after a detailed census of population based on socio economic surveys who were dependent on land falling in the project, as well as, population who were dependent on land not owned by them.	R&R is not applicable for this proposed project as the land is allotted to the proponent by MCD.	
7	Assessment of occupational health and endemic diseases of environmental origin in the study area shall be carried out and Action Plan to mitigate the same shall be prepared.	Occupational health and safety measures have been incorporated in Chapter-10, Section 10.3.8 of the EIA report.	Page No. 322 of the EIA report
8	Occupational health and safety measures for the workers including identification of work related health hazards shall be formulated. The company shall engage full time qualified doctors who are trained in occupational health. Health monitoring of the workers shall be conducted at periodic intervals and health records maintained. Awareness programme for workers due to likely adverse impact on their health due to working in non-conducive environment shall be carried out and precautionary measures like use of personal equipment's etc. shall be provided. Review of impact of various health measures undertaken at	Occupational health and safety measures have been incorporated in Chapter-10, Section 10.3.8 of the EIA report.	Page No. 331 of the EIA report

	intervals of two to three years shall be conducted with an excellent follow up plan of action wherever required.		
12. Corporate Environment Policy			
1	Does the company has a well laid down Environment Policy approved by its Board of Directors? If so, it may be detailed in the EIA report.	The same has been attached as Annexure-X.	
2	Does the Environment Policy prescribe for standard operating process / procedures to bring into focus any infringement / deviation / violation of the environmental or forest norms / conditions? If so, it may be detailed in the EIA.	The same has been attached as Annexure-X.	
3	What is the hierarchical system or Administrative order of the company to deal with the environmental issues and for ensuring compliance with the environmental clearance conditions. Details of this system may be given.	The same has been attached as Annexure-XI.	
4	Does the company has compliance management system in place wherein compliance status along with compliances / violations of environmental norms are reported to the CMD and the Board of Directors of the company and / or shareholders or stakeholders at large? This reporting mechanism should be detailed in the EIA report.	The same has been attached as Annexure-XI.	
13.Miscellaneous			
1	All the above details should be adequately brought out in the EIA report and in the presentation to the Committee.	The same has been complied.	
2	Details of litigation pending or otherwise with respect to project in any Court, Tribunal etc. shall invariably be furnished.	Currently, there are no court cases against the proposed project. The same has been mentioned in Chapter-2, Section 2.21 of the EIA report	Page No. 54 of the EIA report
3	In case any dismantling of old plants are envisaged, the planned land use & land reclamation of dismantled area to be furnished.	Not applicable as this is a proposed project.	
14. Additional ToR For Coastal Based Thermal Power Plants Projects (TPPS)			

1	Low lying areas fulfilling the definition wetland as per Ramsar Convention shall be identified and clearly demarcated w.r.t the proposed site.	Not Applicable for this project as this is not a coastal thermal power plant	
2	If the site includes or is located close to marshy areas and backwaters, these areas must be excluded from the site and the project boundary should be away from the CRZ line. Authenticated CRZ map from any of the authorized agencies shall be submitted.	Not Applicable for this project as this is not a coastal thermal power plant	
3	The soil levelling should be minimum with no or minimal disturbance to the natural drainage of the area. If the minor canals (if any) have to be diverted, the design for diversion should be such that the diverted canals not only drains the plant area but also collect the volume of flood water from the surrounding areas and discharge into marshy areas/major canals that enter into creek. Major canals should not be altered but their embankments should be strengthened and desilted.	Not Applicable for this project as this is not a coastal thermal power plant	
4	Additional soil required for levelling of the sites should as far as possible be generated within the site itself in such a manner that the natural drainage system of the area is protected and improved.	Not Applicable for this project as this is not a coastal thermal power plant	
5	Marshy areas which hold large quantities of flood water to be identified and shall not be disturbed.	Not Applicable for this project as this is not a coastal thermal power plant	
6	No waste should be discharged into Creek, Canal systems, Backwaters, Marshy areas and seas without appropriate treatment. Wherever feasible, the outfall should be first treated in a Guard Pond and then only discharged into deep sea (10 to 15 m depth). Similarly, the Intake should be from deep sea to avoid aggregation of fish and in no case shall be from the estuarine zone. The brine that comes out from Desalinization Plants (if any) should not be discharged into sea without adequate dilution.	Not Applicable for this project as this is not a coastal thermal power plant	

7	Mangrove conservation and regeneration plan shall be formulated and Action Plan with details of time bound implementation shall be specified, if mangroves are present in Study Area.	Not Applicable for this project as this is not a coastal thermal power plant	
8	A common Green Endowment Fund should be created by the project proponents out of EMP budgets. The interest earned out of it should be used for the development and management of green cover of the area.	Not Applicable for this project as this is not a coastal thermal power plant	
9	Impact on fisheries at various socio economic level shall be assessed.	Not Applicable for this project as this is not a coastal thermal power plant	
10	An endowment Fishermen Welfare Fund should be created out of CER grants not only to enhance their quality of life by creation of facilities for Fish Landing Platforms / Fishing Harbour / cold storage, but also to provide relief in case of emergency situations such as missing of fishermen on duty due to rough seas, tropical cyclones and storms etc.	Not Applicable for this project as this is not a coastal thermal power plant	
11	Tsunami Emergency Management Plan shall be prepared wherever applicable and Plan submitted prior to the commencement of construction work.	Not Applicable for this project as this is not a coastal thermal power plant	
12	There should not be any contamination of soil, ground and surface waters (canals & village pond) with sea water in and around the project sites. In other words necessary preventive measures for spillage from pipelines, such as lining of Guard Pond used for the treatment of outfall before discharging into the sea and surface RCC channels along the pipelines of outfall and intake should be adopted. This is just because the areas around the projects boundaries could be fertile agricultural land used for paddy cultivation.	Not Applicable for this project as this is not a coastal thermal power plant	

CHAPTER 1 : INTRODUCTION

1.1. INTRODUCTION OF PROJECT

The Swachh Bharat Mission (SBM) launched by Govt. of India in 2014 highlights "city sanitation plan" and state sanitation strategy. It recommends installation of MSW based Waste to Energy (WtE) power projects as potential vehicle to address the surmounting woes of municipal solid waste (MSW) of cities and metro towns.

Solid Waste Management (SWM) is a vital service provided by Urban Local Bodies to its citizens to ensure a healthier environment, standard of living, health and sanitation facilities. Solid Waste Management (SWM) Rules, 2016 issued by the MoEF&CC and various directions given by regulatory agencies, especially Hon'ble National Green Tribunal (NGT), from time to time, have provided the necessary benchmarks for SWM in the country.

Realizing these requirements, the proposed Municipal Solid Waste (MSW) to Energy generating project is one of the most efficient and environmental friendly solution for tackling the municipal solid waste problem of Delhi, For this purpose, the Authority has selected Jindal Urban Infrastructure Limited (JUIL) through competitive bidding process for development, operation, and maintenance of Waste to Energy (WtE) processing facility of 3000TPD, as per Solid Waste Management (SWM) Rules 2016, at Narela-Bawana, Delhi through Public-Private Partnership (PPP) on Design, Build, Finance, Operate and Transfer basis. MCD has earmarked 15 acres land out of land parcel of approximately 35 acres for setting up the WtE facility at Bawana, Delhi. M/s Jindal Urban Waste Management (Bawana) Limited is the successful bidder for the proposed project. The letter in this regard is attached as **Annexure-VI.**

The projected quantum of MSW generation by the year 2016 & 2031 is as follows:

Table 1.1: Projection of Solid Waste Generation in Delhi

Year	2016	2021	2031
Per capita waste Generation	490 g/day	560 g/day	690 g/day
Population (Delhi)	185 lacs	205 lacs	251 lacs

Waste Generation (Delhi)	9065 TPD	11,480 TPD	17,319 TPD

Source: *MPD 2021, NCRPB though Delhi Development Authority, 2019*

Jindal Urban Infrastructure Limited (JUIL) has formed SPV - JINDAL URBAN WASTE MANAGEMENT (BAWANA) LIMITED to develop Waste to Energy project at Bawana (30 MW)" project with a view to reduce the problem associated with disposal of solid waste at landfill, thereby complying with the various regulations as well as the objective and goal set for the Country under the Swachh Bharat Mission (SBM).

ToR for this project has been granted by MoEF&CC vide letter no. J-13012/04/2023-IA.I (T) dated 10/01/2024.

1.2. NEED OF THE PROJECT

Municipal Corporation of Delhi (MCD) has taken several initiatives in waste management in its jurisdiction in order to meet the target of 100% solid waste processing and scientific disposal of unprocessed quantities of MSW. MCD has proposed to develop a Waste to Energy (WtE) Project at Narela-Bawana site through Public-Private Partnership mode.

1.3. PROJECT PROPONENT

Name and Address of the Project:

Waste to Energy Project (30MW) at DSIIDC Industrial Area, Sector-5, Bawana, Delhi-110039 by M/s Jindal Urban Waste Management (Bawana) Limited.

Name & Address of Project Proponent:

Mr. Sandip Dutt (Authorized Signatory)

E-mail:info.juwmbl@jindalecopolis.com; sandip.dutt@jindalecopolis.com

1.4. PROJECT LOCATION AND SITE SURROUNDINGS

1.4.1. Location

The proposed Waste to Energy project site is located at Bawana Industrial area, Delhi. The Co-ordinates of the project site are as follows:

1. 28°47‘41.49"N, 77°3’42.51"E
2. 28°47’46.08"N, 77°3’36.54"E
3. 28°47’53.53"N, 77°3’43.80"E
4. 28°47’49.56"N, 77°3’48.06"E
5. 28°47’47.84"N, 77°3’47.27"E
6. 28°47’47.12"N, 77°3’47.43"E
7. 28°47’46.70"N, 77°3’47.84"E

Google map showing project location is given in **Figure 1.1,** Google image showing project site and surrounding within 10km is given in **Figure 1.2.** Sensitivity Map of 10km is given in **Figure. 1.3** & Toposheet showing distances of Delhi –Haryana Interstate Boundary from the project site is given in **Figure 1.4 & Figure 1.5.**

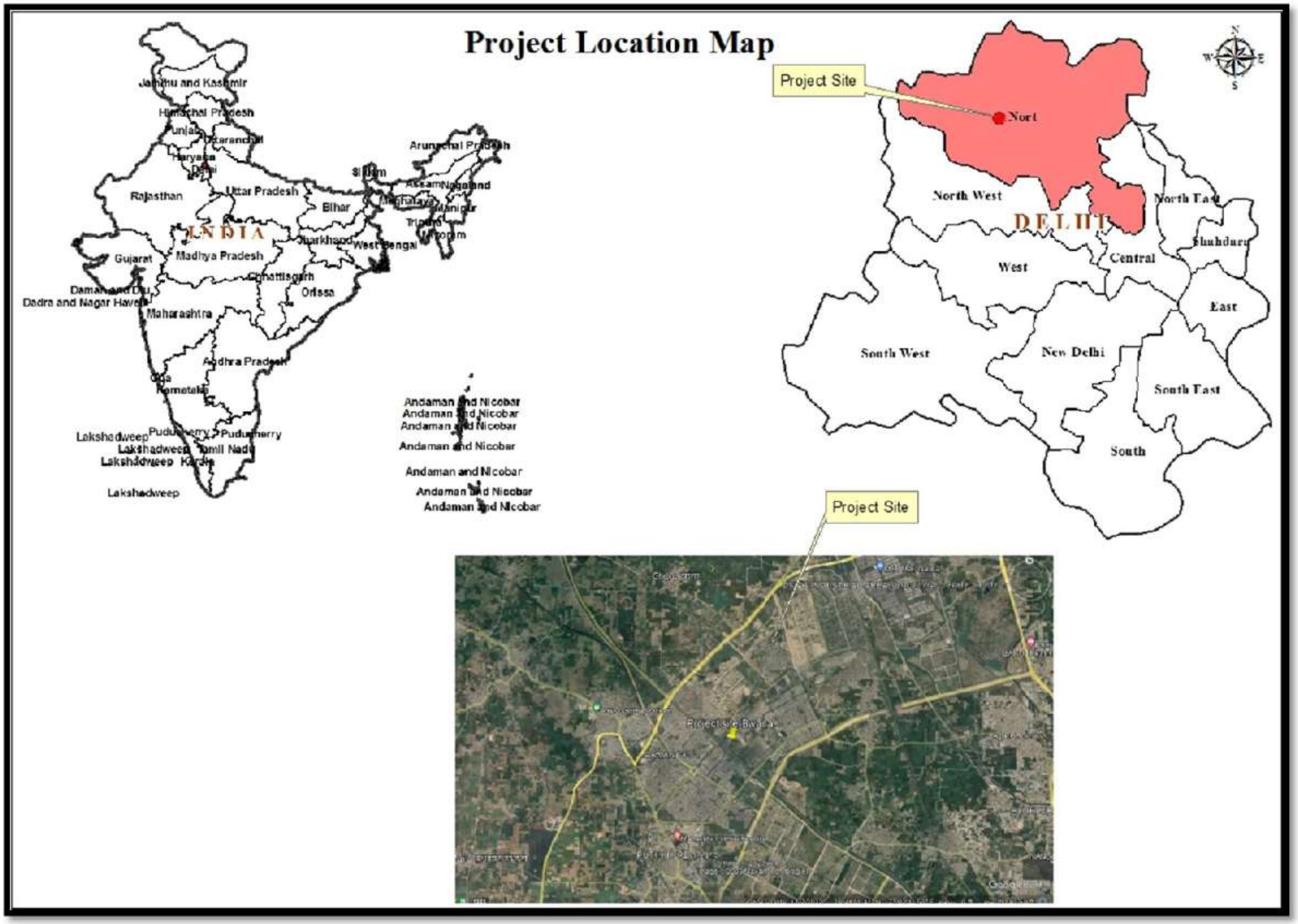


Figure 1.1: Google map showing project location for Waste to Energy Plant, Bawana

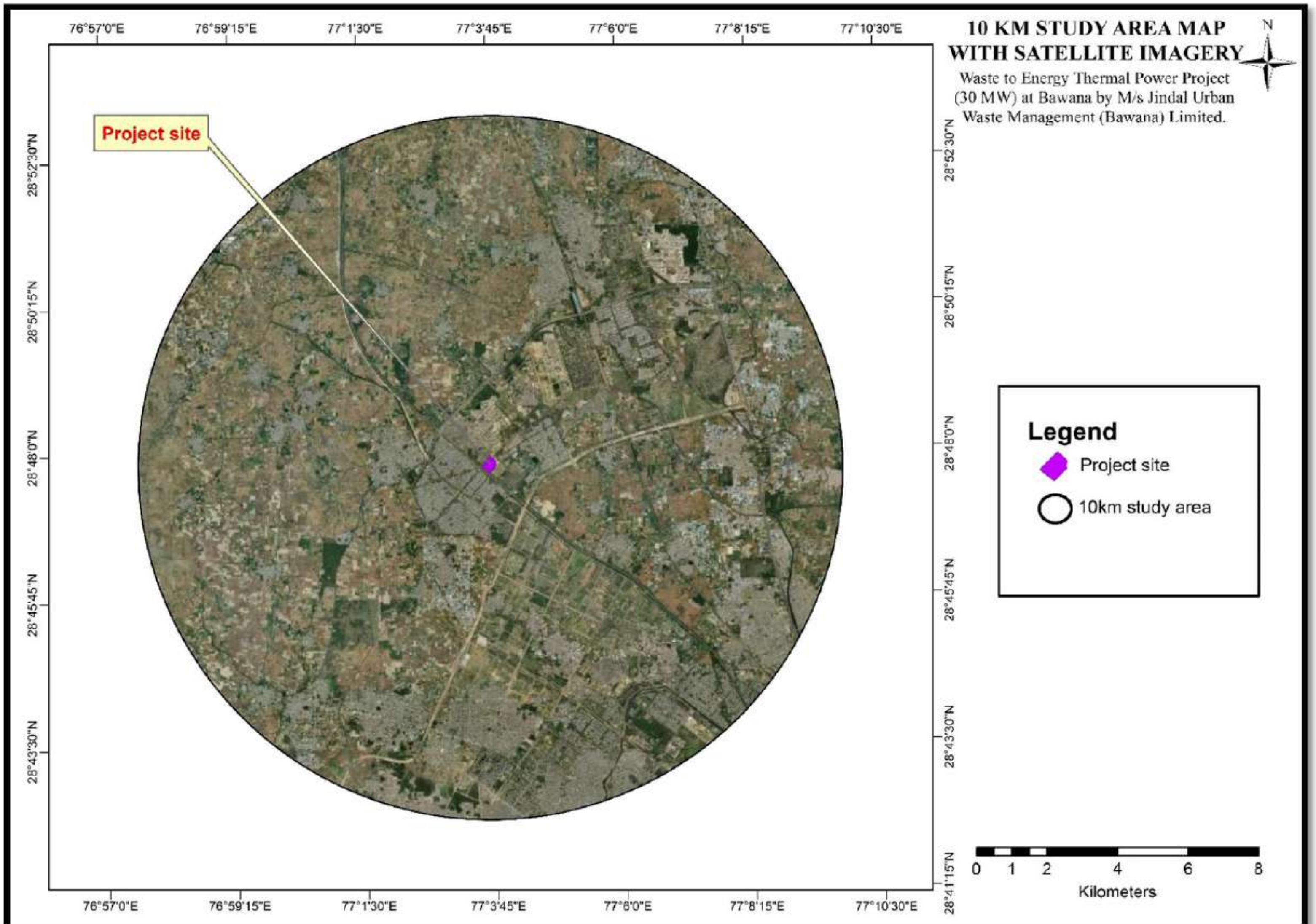


Figure 1.2: Google image showing project site and surrounding within 10km for Waste to Energy Plant, Bawana

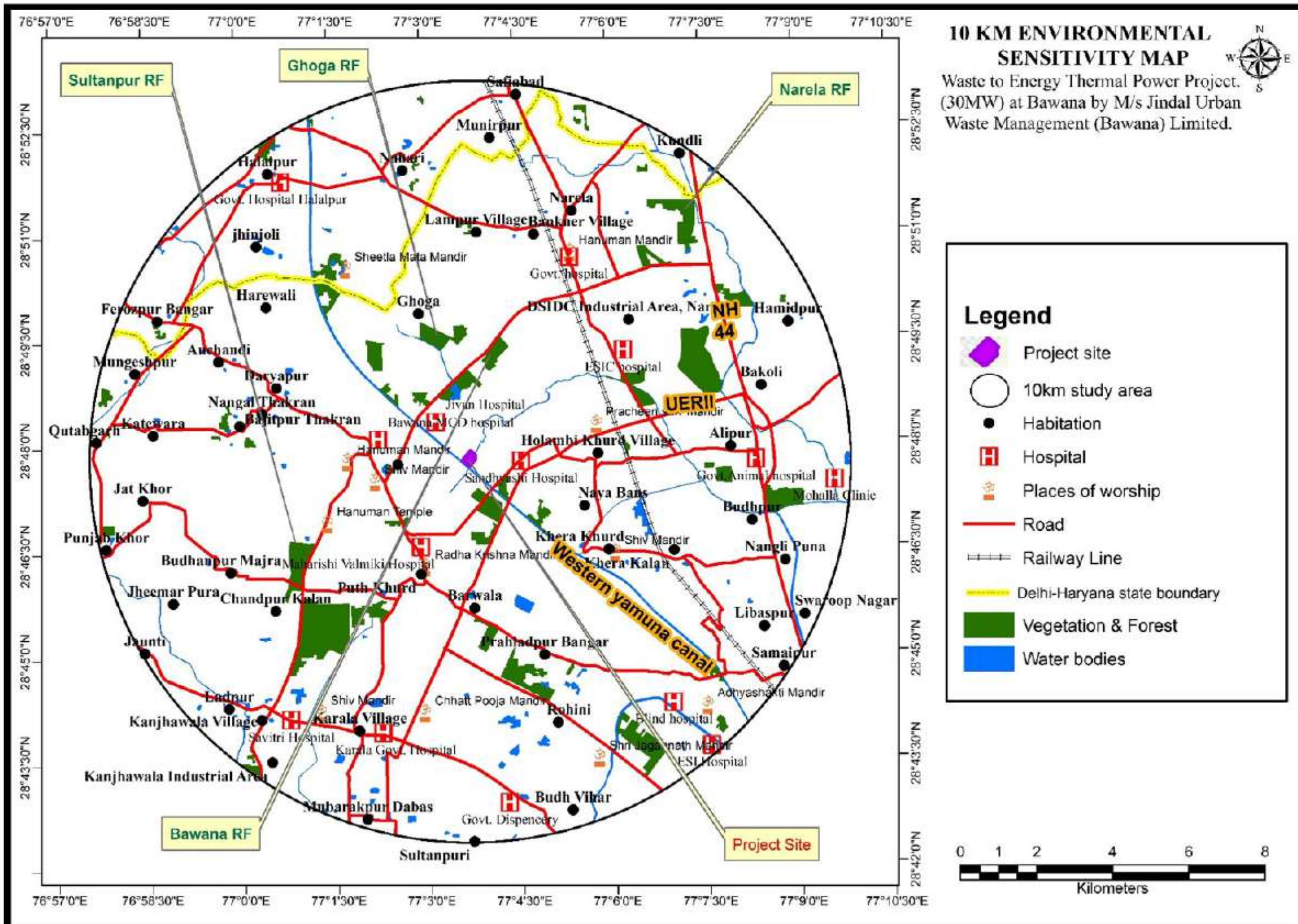


Figure 1.3: Sensitivity Map of 10km for Waste to Energy Plant, Bawana

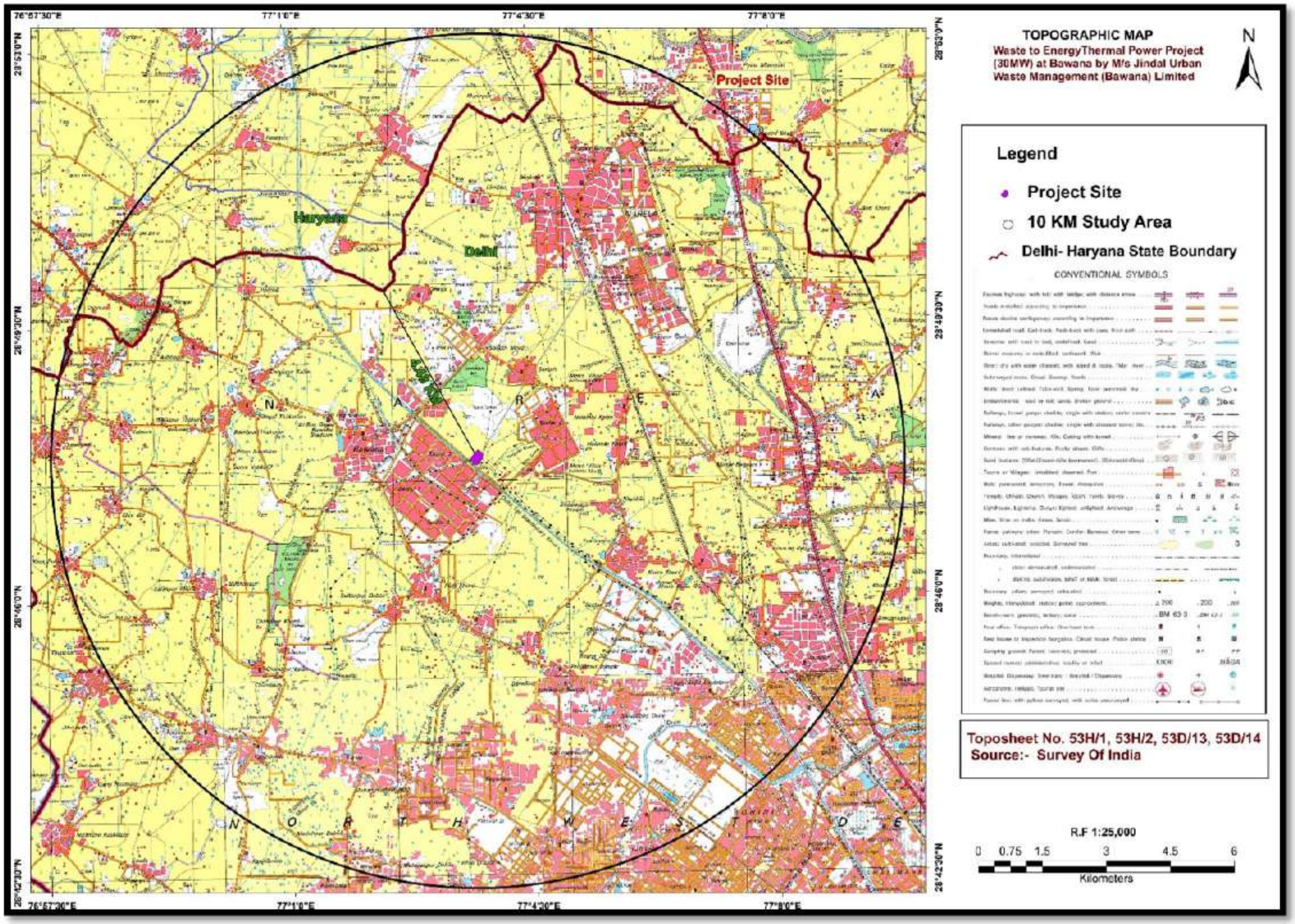


Figure 1.4: Topographical Map with Scale 1:25,000 showing distances of Delhi –Haryana Interstate Boundary from project site

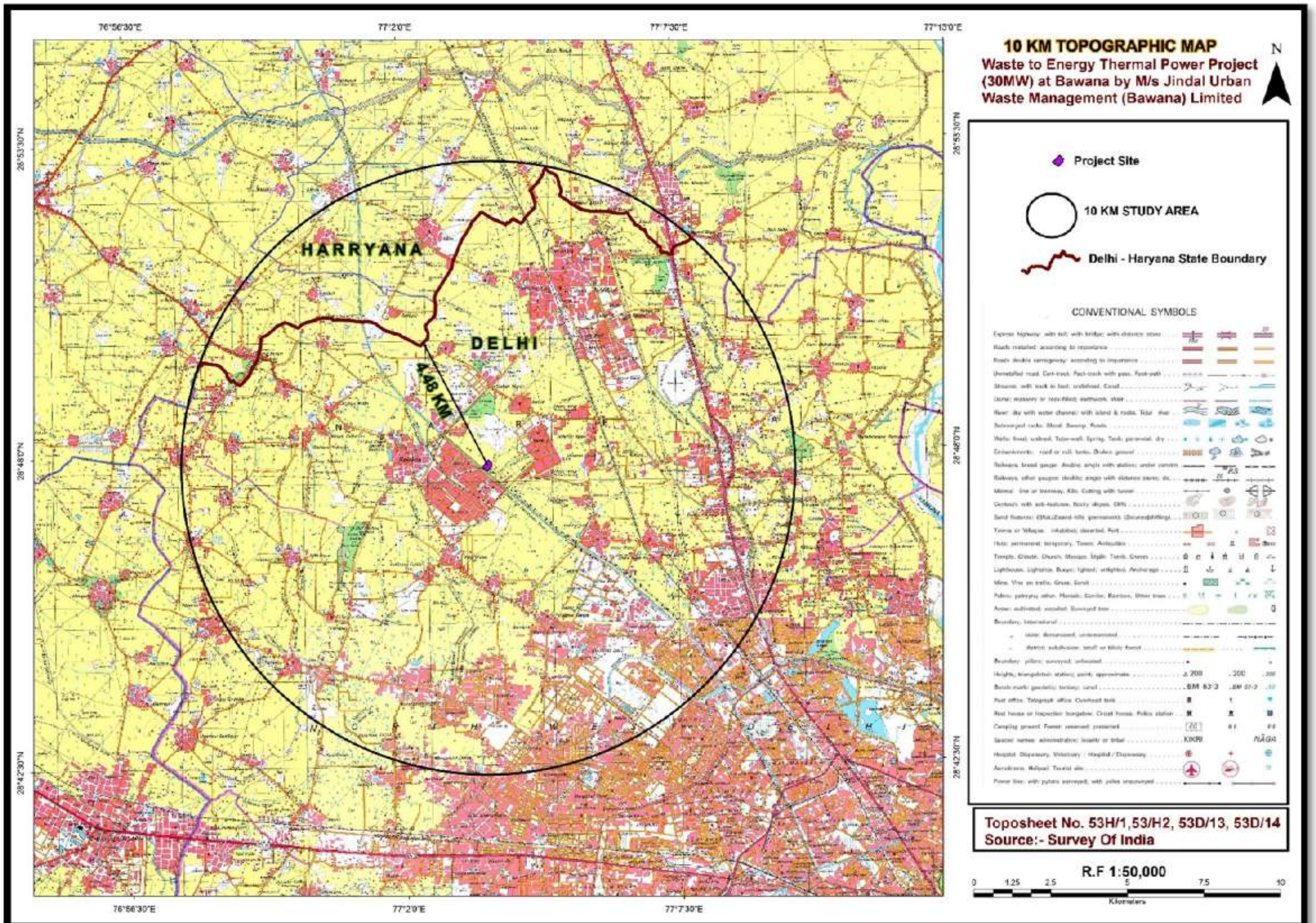


Figure 1.5: Topographical Map with Scale 1:50,000 showing distances of Delhi –Haryana Interstate Boundary from project site

1.5. Environmental Sensitivity and Surrounding Features

The brief of the Environmental Sensitivity and Surrounding Features including connectivity are given in the **Table 1.2.**

Table 1.2: Environmental Sensitivity around 10km Area.

PARTICULARS	DETAILS
Inter-State Boundary of Haryana	Delhi-Haryana border is 4.48 km in NNW direction.
Nearest State Highway/ National Highway	❖ NH-44~ 7.33 Km in East direction ❖ SH-18 ~ 4.64 Km in East direction ❖ UER-II~ 1.39 Km in SE direction
Seismic Zone	Zone-IV (As per IS 1893:2002)
Water Body	Western Yamuna Canal is located at approx. 32 meters from the project site in South West direction
Ecological Sensitive Areas (National Park, Wildlife Sanctuary, Biosphere Reserve, Reserve/ Protected Forest etc.) within 10 Km radius	❖ Ghoga RF: 3.12 Km in North direction ❖ Bawana RF: 1.70 km in North direction. ❖ Sultanpur RF: 4.29 km in SW direction ❖ Narela RF: 9.01km in NE direction. ❖ There is no National Park, Wildlife Sanctuary etc. within 10 km radius.
Areas occupied by sensitive manmade land uses (hospitals, schools, places of worship, community facilities	❖ Sandhyashi Hospital is located at a distance of 1.26 Km in East direction ❖ Jivan Hospital is located at a distance of 1.32 Km in NW direction ❖ Bawana MCD Hospital is located at a distance of 2.46 Km in WNW direction ❖ Siddhartha Hospital is located at a distance of 2.1 Km in W direction ❖ St. Omina Public School is located at a distance of 1.26 Km in East direction. ❖ Rana Public School is located at a distance of 7.35 Km in SE direction.

1.6. Brief details of the project

The brief details of the project are described in the **Table 1.3**:-

Table 1.3: Brief details of the project

S. No.	Information	Details
1	Project name	Proposed Waste to Energy Project (30 MW) at DSIIDC Industrial Area, Sector-5, Bawana, Delhi.
2	Name of project Proponent	M/s Jindal Urban Waste Management (Bawana) Limited.
3	Capacity	30 MW
4	General Conditions	Delhi-Haryana State boundary is located at the distance of 4.48 Km in NNW direction.
5	**Site Location**	
	Village	Bawana
	District	North Delhi
	State	Delhi
6	Land Requirement	15 Acres
7	Fuel (MSW)	3000TPD of MSW
8	Water Requirement	**During Construction phase**–40 KLD Industrial water will be met from Pragati Power Corporation Limited (PPCL)/Treated Sewage from Delhi Jal Board. **During operation phase-** 625 KLD Industrial water will be met from Pragati Power Corporation Limited (PPCL)/Treated Sewage from Delhi Jal Board. **Domestic water:** Approx. 10 KLD domestic water during construction and 7 KLD during operation phase will be required. This water will be supplied by DJB.
9	Construction Power Supply and its Source	The nearest construction power source is Tata Power Delhi Distribution Limited (TPDDL). No DG set will be used during construction phase. The 750 kVA DG set will be used during operation phase only in case of grid failure.
10	Employment opportunity	Employment potential: **During the construction phase** Employment (Contract): 570 Nos On Roll:60 Nos **Total (On Roll + Contract): 630 Nos.** **During the operational phase** Contract: 156 Nos On Roll: 86 Nos **Total (On Roll + Contract): 242 Nos.**
11	Nearest Railway Station	Narela Railway Station~6.06 Km in NE direction
12	Nearest Airport	Indira Gandhi Airport, ~ 26.81 Km in South direction.
13	Project Cost	Estimated Cost of the Project Rs 660.00 Crore.

Proposed Fuel: Refuse derived fuel prepared from Municipal Solid Waste.
Technology: Reverse reciprocating with forward feed inclined grate type boiler and steam turbo-generator for power generation (Rankine cycle).

Design capacity of MSW fuel preparation plant:

The Design capacity of MSW fuel preparation plant is 3000TPD.

Total Design Capacity of Waste to Energy plant: 30MW.

1.7. ENVIRONMENTAL REGULATIONS

Under the Environment Impact Assessment Notification, 2006, the project is required to obtain environmental clearance. The project shall abide by all applicable provisions of the Environment Protection Act, 1986 and Rules framed there under. Necessary clearances are required to be obtained for project. As per the Air (Prevention & Control of Pollution) Act 1981, Water (Prevention & Control of Pollution) Act 1974, Solid Waste Management Rules, 2016, Public Liability Insurance Act, 1991 and Hazardous and Other Wastes (Management and Tran's boundary Movement) Rules, 2016.

1.8. NEED OF THE EIA STUDY FOR THE PROJECT

As per EIA Notification, 2006 & its amendments, all electricity generating units of capacity >25MW (using municipal solid non-hazardous waste as fuel) will be treated as Category-A project and will require Environmental Clearance from MoEF&CC. Further, in the proposed project, general conditions are also applicable as the site is within 10 km radius of Delhi-Haryana border, approx. 5 km in NW direction. Therefore, project requires to obtain Environmental Clearance from the MoEF&CC. Draft Environment Impact Assessment Report is to be prepared mandatory for the Public Hearing. The EIA report would facilitate in obtaining Environmental Clearance (EC) from MoEF&CC for the project.
The ToR for preparation of EIA report has been accorded by the MoEF&CC vide letter J-13012/04/2023-IA.I (T) dated. 10/01/2024.

1.9. SCOPE OF THE EIA STUDY

The EIA report has been prepared as per approved ToR and following the generic structure of EIA report mentioned in the EIA Notification, 2006.
The EIA study includes: -

- Compilation of baseline environmental and social scenario of the study area within a radius of 10 km around the project site based on field studies and secondary data collected from the authorized source /Govt. agency.

- Identification, prediction and evaluation of potential environmental impacts expected during the construction and operation phase of the project.
- Preparation of mitigation measures, Environmental Management Plan (EMP) and Monitoring Program for implementation of suggested mitigation measures.

The work of the preparing Draft EIA report for conducting public hearing and Environmental clearance has been awarded to M/s Mantec Consultant, Noida which is a QCI/ NABET accredited company for preparing EIA report.

1.10. ENVIRONMENTAL CLEARANCE PROCESS

The project was presented for approval of ToR before the Expert Committee on 31.10.2023. This Draft EIA report has been prepared based on the ToR approved by the MoEF&CC and the environmental base-line study conducted by NABL Accredited Laboratory. The point wise compliance of the ToR issued by MoEF&CC is enclosed in the Draft EIA report.

The Draft EIA report will be submitted to DPCC, Delhi for conducting Public Hearing. The EIA report will be finalized by incorporating views expressed by public and reply given by the project proponent during Public Hearing. The final EIA report will be submitted to MoEF&CC for accord of Environmental Clearance by incorporating details of public hearing.

1.11. EIA METHODOLOGY

The objective of EIA is to predict and address potential environmental problems/concerns at an early stage of project planning and design. EIA/EMP assists in the decision making process by identifying the key impacts/ issues as a results of the activities and formulating mitigation measures, leading to an improvement in environmental quality.

In order to achieve these objectives, the following procedures have been adopted for the study:-

- Collection, collation and analysis of regional and local environmental status for various environmental attributes (like topography, geology, ambient air quality, meteorology, water quality, noise level, soil characteristics and land use, transport, settlement status and socio-economic aspects etc.) to assess base-line status of the project.

- Identification of environmental impacts leads to assessment of impact on the base-line status which will decide the feasibility of the project and suggests mitigation measures to control pollution with respect to standards applicable for the area.
- Evaluation of impacts leading to preparation of environmental management and monitoring plan.

This report is based on scientific principles and professional judgment with resultant subjective interpretation. Professional judgments expressed herein are based on the available data and information.

1.12. GENERIC STRUCTURE OF ENVIRONMENT IMPACT ASSESSMENT REPORT

The environmental impact assessment has been carried out to assess the impact of the project on various environmental components. The methodologies and findings of the study are detailed in the Draft EIA Report along with other relevant information under the different chapter headings as under:

1. Introduction
2. Project Description
3. Description of the Environment
4. Anticipated Environmental Impacts & Mitigation Measures
5. Analysis of Alternatives (Technology and site)
6. Environmental Monitoring Program
7. Additional Studies
8. Project Benefits
9. Environmental Cost & Benefit Analysis
10. Environment Management Plan
11. Summary & Conclusion
12. Disclosure of Consultants engaged

CHAPTER 2 : PROJECT DESCRIPTION

2.1 TYPES OF PROJECT

2.1.1 Need of the project

Rapid urbanization in the last few decades has led to significant increase in municipal solid waste generation in India. Municipal Solid Waste Management (MSWM) has always been a big challenge to the ULBs in India.

The problem of municipal solid waste management is a major economic burden on local Government & furthermore, open burning of MSW adversely affects the environment by emitting pollutants to the atmosphere. North-Delhi, a metropolitan city with an approximate population of about 4.69 million has experienced rapid urbanization over the past decade is facing a similar situation. The waste generation from this area is about 4500 TPD. For efficient management of the MSW, the JINDAL URBAN WASTE MANAGEMENT (BAWANA) LIMITED has proposed to set up 30 MW WtE Project at Bawana, Delhi which is a good step towards sustainable waste management program and most economical and environment friendly solution for Municipal Solid Waste problem. The proposed project will help to solve the ever-increasing municipal solid waste and it would meet the city's needs for the future.

The Waste to Energy project at Bawana has been planned to address the issue of municipal solid waste of Municipal Corporation of Delhi. Further, because of paucity of lands in the city and ever increasing amount of solid waste, it is imperative to process the MSW to the maximum extent possible to minimize dumping at the landfill sites.

2.1.2 Type of Project

The proposed Waste to Energy project is a green field project to generate power from MSW. There is no interlinked project. This project would help in reducing load on the existing landfill sites which have exhausted their capacity to manage the daily generated municipal solid waste in NW Delhi.

2.2 LAND DETAILS OF THE PROJECT

The project site is located in Bawana Industrial area about 15 Acre land is in physical position of MCD for setting up this project.

The land breakup of the proposed project for various purposes is given in **Table 2.1.** The layout map of the project is given as **Figure 2.1.**

Table 2.1: Breakup of Land Requirement

S. No.	Particulars	Proposed Project Area Details (in Acres)	Percentage (%)
1	**Total Plot Area**	**15.0**	**100**
2	TPP Site	7.84	52.27
3	Admin Office & Canteen	0.30	2.0
4	Greenbelt Area	6.0	40.0
5	Others	0.86	5.73

The CEA norm for land requirement for main plant of thermal power project using indigenous coal recommends 0.52 Acre/MW. CEA has not prescribed norm for land requirement for WtE project. Total land is 15 acres. In this project, the land requirement (including office building and canteen) for 30 MW comes to 0.50Acres/MW which is less than CEA norm for coal based plant.

Figure 2.1: Project Layout plan for Waste to Energy Plant, Bawana

2.3 EMPLOYMENT & POPULATION PROJECTION

Employment potential for the proposed project/plant is as follows:

<u>During the construction phase:</u>

Employment (On contract): 570 Nos

On Roll: 60Nos

Total (On Roll + On Contract): 630 Nos.

<u>During the operational phase:</u>

On contract: 156 Nos

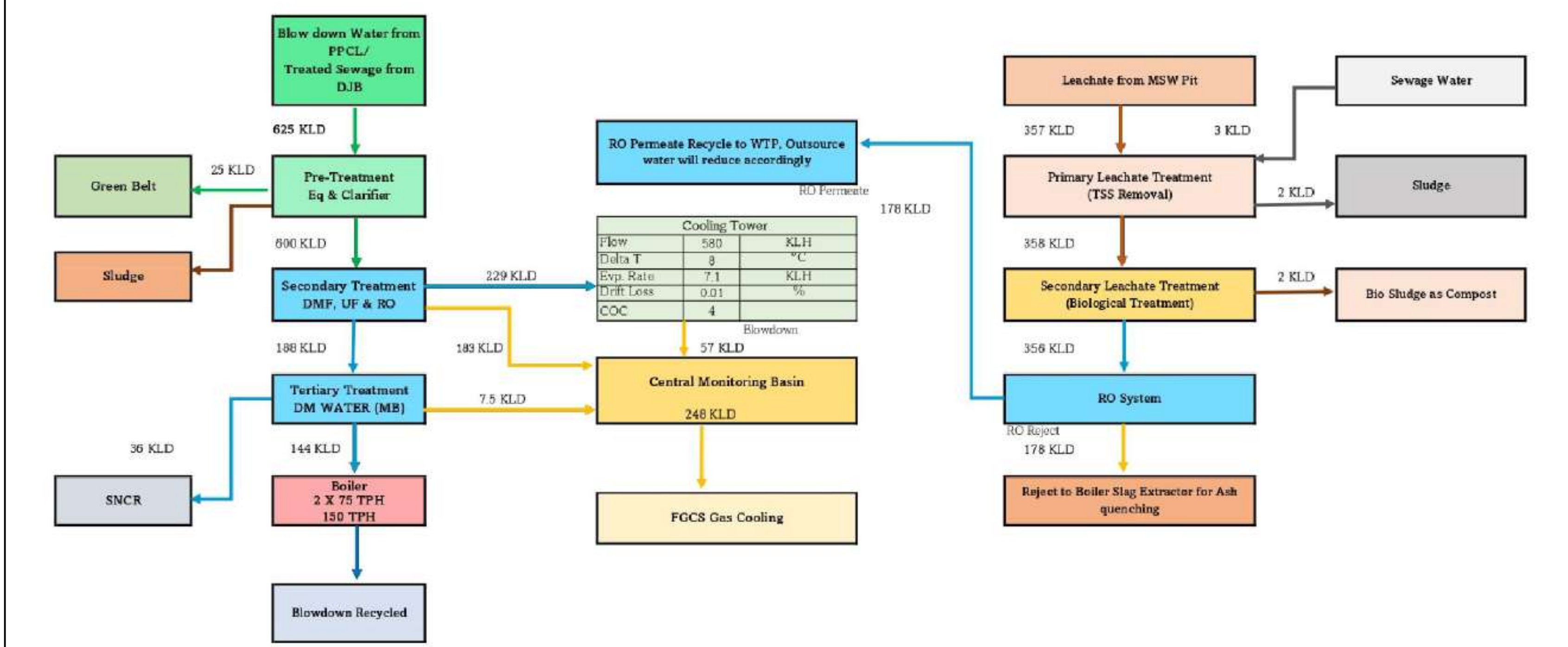
On Roll: 86 Nos

Total (On Roll + On Contract): 242 Nos.

2.4 WATER REQUIREMENT

Water requirement during construction phase is 40 KLD which will be met through reject blow down water from the PPCL/Treated Sewage from DJB. Approx. 10 KLD of water will be required for drinking purpose which will be supplied by DJB.

During the operational phase, water demand of 625 KLD will be met from PPCL/Treated Sewage from DJB for Industrial use whereas domestic water of 7 KLD will be supplied by DJB. The project will not use ground water source to save natural resource. Approx. 360 KLD of wastewater including sewage will be generated which will be treated in in-house Effluent Treatment Plant. The Water Balance of the project is given in **Figure 2.2.**



Water Requirement & Consumption Details

S.No.	Details	Quantity
1	Water from PPCL Blowdown /DJB Treated sewage	625 KLD
2	Treated Water Requirement (Boiler makeup + Cooling Tower makeup+Others)	377 KLD
3	Wastewater (Reject Water) recycled for Gas Cooling	248 KLD
4	Leachate Generation quantity	357 KLD
5	Treated Leachate water recovered from LTP (Recycled in WTP)	178 KLD
6	Reject water from LTP, Recycled for Ash quenching, except 6 KLD Sludge	178 KLD
7	Wastewater Discharge Quantity	0

Figure 2.2: Water-Balance Diagram

2.4.1 WATER SYSTEM

The water system of the project has been considered based upon reuse/recycle of wastewater, with Zero Liquid Discharge (ZLD) concept. The project will use reject blow down water from the PPCL or Treated Sewage from DJB. For reducing water requirement, air cooled condenser (ACC) has been proposed instead of water-cooled condenser. The proposed Cycle of Concentration (COC) for the project will be optimized for minimizing water requirement. Other effluents generated from DM plant and cooling system's blow down etc. will be brought to neutralization pit. After neutralization, it will be used for FGCS cooling and service water for floor washing, sprinkling on road and other general purposes. The treated water from Leachate treatment plant will be recycled to DM Plant and reject water for quenching of bottom ash. Thus, no effluent is proposed to be discharged outside the premises. Water requirement for proposed project is given in **Table 2.2.**

Table 2.2: Water requirement for proposed project

S. No.	Details	Water requirement & Consumption Details
1	Water from PPCL/Treated sewage from DJB	625 KLD
2	Process Water(Boiler make –up, Cooling Tower & SNCR) Requirement	377 KLD
3	Wastewater (reject water) recycled for gas cooling.	248 KLD
4	Leachate generation Qty.	357 KLD
5	Sewage generation quantity	3 KLD
6	Treated leachate water recovery from LTP. (Recycled in WTP)	178 KLD
7	Reject water from LTP, recycled for ash quenching except 6 KLD Sludge	178 KLD
8	Wastewater Discharge Qty.	0

2.5 OVERALL DESIGN CONSIDERATION

Rule No. 21.1 of SWM Rules, 2016 defines the Criteria for waste to energy process as: "Non-recyclable waste having calorific value of 1500 Kcal/kg or more shall not be disposed of on landfills and shall only be utilized for generating energy either or through refuse derived fuel or by giving away as feed stock for preparing refuse derived fuel."

Further, Chapter 3.3 of MSW Management Manual of CPHEEO states:

Waste to energy (WtE) refers to the process of generating energy in the form of heat or electricity from MSW. Energy from MSW can be achieved through:

1. Thermal processes like incineration or combustion of refuse derived fuel (RDF);
2. Biological processes like bio methanation and further conversion into electrical power or automotive fuel (compressed biogas).

In addition to the above, Gasification and Plasma technologies for recovery of energy from waste are also available. However, these are not fully mature and are also capital intensive.

All WtE facilities require some degree of pre-processing of MSW leading to what is commonly known as refuse derived fuel (RDF). For the project, technology to be selected needs to be in conformity with the SWM Rules as well as should be proven to provide stable operation of plant at rated capacity with maximum availability in all seasons.

To meet the requirements of SWM Rules, 2016 and MSW Management Manual of CPHEEO, following technological consideration are made: -

- Processing of mixed MSW in Material Recovery Facility using suitable technology for production of RDF, compost and separation of recyclables and inert for disposal.
- Selection of furnace which ensures stable and continuous operation and complete burnout of waste and flue gases using RDF as fuel.
- Flue gas emissions must meet the CPCB/MoEF&CC norms and standard referred in Schedule – II of SWM Rules-2016
- Leachate disposal and standards for compost produced incidental to the RDF production process should also meet the requirements of the SWM Rules.

Material recovery facility (MRF) will be installed at Bawana plant which will handle the segregation requirements for MSW. Flue gas cleaning system will be designed to take care of updated norms for emissions as prescribed by MoEF&CC and CPCB.

2.6 BRIEF DESCRIPTION OF TECHNOLOGY

The technology proposed to be employed for this WtE project is RDF combustion based reciprocating forward feed grate technology.

The power plant constitutes Material Recovery Facility (Pre-sorting), RDF fuel Pit, Incinerators, Boilers, and Steam Turbine Generators with power generation total capacity of 30 MW. The in-house consumption will be approx.15% of the generated power. Air cooled condensers (ACC) are to be used in lieu of water cooling condenser (WCC). The generated bottom ash will be processed in the bottom ash processing plant. After the processing materials which are not recyclable for further processing will be sent to Sanitary Landfill. Fly ash will be sent to the secured landfills site designated by MCD.

Air pollution control system will consist of Flue Gas Treatment System which includes Adsorption of acidic components and other pollutants by lime and Activated carbon in turbo reactor and filtration of dust particles through bag filters.

Wastewater & leachate generated from the WtE plant will be treated in the Leachate Treatment Plant. The treated wastewater will be recycled to DM plant and rejects for quenching of bottom ash. The green belt area will be developed around the plant which acts as pollutants sink. Further, plantation will be done on available vacant land after completion of construction of project.

2.7 ASH GENERATION AND ITS DISPOSAL & UTILIZATION

- The generated ash in the boiler would be in two forms-bottom ash and fly ash. Fly ash is formed by the fine inert and product of combustion carried away by the flue gas. The fly ash typically amounts to 2-3% of total waste feed of MSW in to the boiler. The rest of ash is called bottom ash (17% of the total feed of MSW). As the moisture content varies from season to season the amount of rejects generated and the ash produced varies from season to season.
- Through magnetic separators, ferrous metals are recovered from the bottom ash which will be sent to the recycler. Further, bottom ash will be used in road construction & paver block manufacturing and the remaining will be sent to the landfill. Fly ash will be sent to the secured landfills site designated by MCD.

The characteristics of fly ash and bottom ash **(Annexure-VIV)** of a waste to energy project has been analyzed and results are given in **Table 2.3** & **Table 2.4** respectively.

Table 2.3: Fly Ash results

Sl. No.	Parameter	Units of Measurements	Value	Protocol
1.	Texture	-	Sandy Clay Loam	IS 2720(Part-04):2020
2.	Sand	%	65	IS 2720(Part-04):2020
3.	Clay	%	29	IS 2720(Part-04):2020
4.	Silt	%	06	IS 2720(Part-04):2020
5.	CEC	mg/100gm	14.22	IS 2720(Part-24):2020
6.	Bulk Density	gm/cm^3	1.42	IS 2720(Part-28):2020
7.	Loss of Ignition	%	0.74	IS 3812 (Part-01)
8.	Organic Carbon	%	1.68	IS 2720(Part-22)

Table 2.4: Bottom Ash results

Sl. No.	Parameter	Units of Measurements	Value	Protocol
1.	Texture	-	Clay	IS 2720(Part-04):2020
2.	Sand	%	37	IS 2720(Part-04):2020
3.	Clay	%	55	IS 2720(Part-04):2020
4.	Silt	%	08	IS 2720(Part-04):2020
5.	CEC	mg/100gm	14.22	IS 2720(Part-24):2020
6.	Bulk Density	gm/cm^3	1.46	IS 2720(Part-28):2020
7.	Loss of Ignition	%	0.86	IS 3812 (Part-01)
8.	Organic Carbon	%	1.72	IS 2720(Part-22)

2.8 PREPARATION OF RDF

The various stages of MSW processing for preparation of RDF following this technology are as follows:

- Mixed MSW received at site will have high level of moisture content. It will be heterogeneous in terms of content and size. Raw waste will also contain metal and inert in various size in addition to finer organic matter.
- Municipal Solid Waste (MSW) arriving at the facility in trucks will be weighed at Weigh Bridge and unloaded into MSW storage pits near the Tipping floor facility. The tipping floor will have gates to enable dump MSW trucks to unload material in to storage pit.
- Initially, mesophilic bacteria will be added which oxidizes carbon to CO_2 and liberates large amount of heat. Temperature up to 50^{o}C will reach within 2 days leading to reduction in moisture content. Moisture reduction leads to free flow ability of waste and loosening of material for easy separation and shedding.

- Partially dried material will be fed to hopper for mechanical segregation for removal of inert and fines. Other undesirable materials will also be separated manually from the conveyor system.
- The processing of MSW will involve segregation of material into following components:
  - Inert material for disposal to landfills.
  - Recyclable including metals will send to recyclers vendor
  - Fine compostable material for conversion into stable compost for sale and
  - Processed MSW for use in boilers as fuel for energy generation.

The process flow diagram for processing plant is given in **Figure 2.3** and the project layout plan is given at **Figure 2.4.**

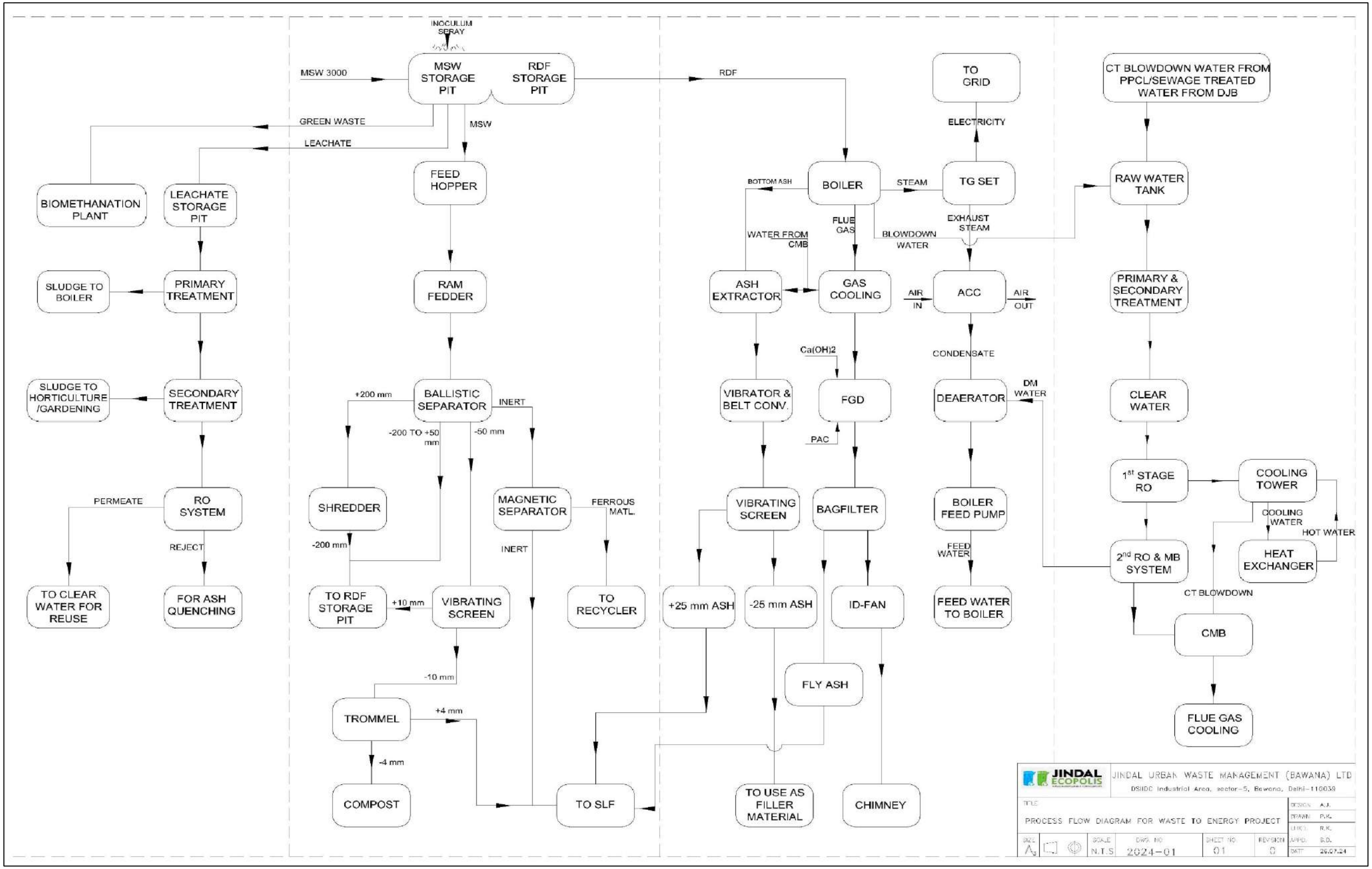
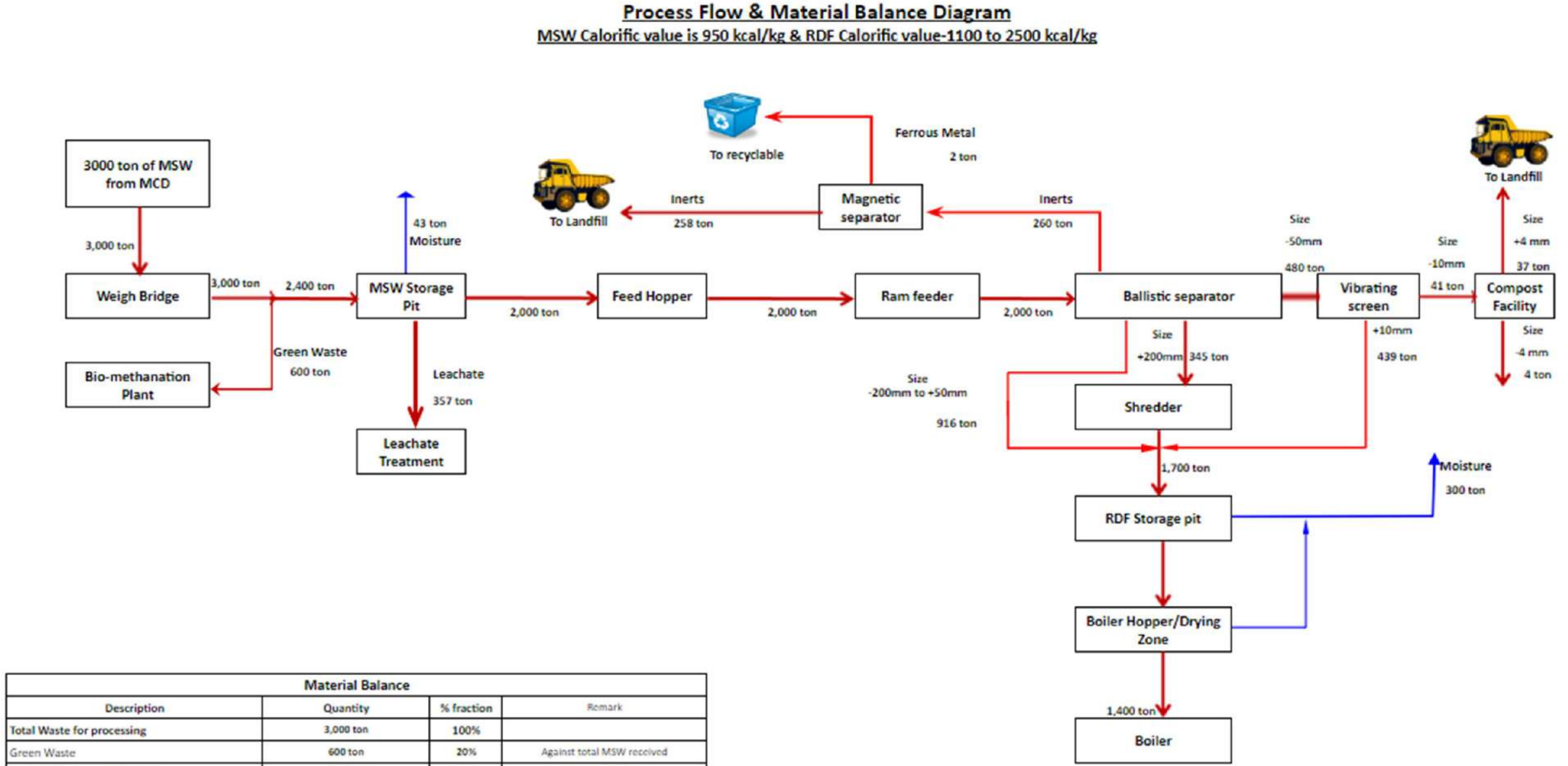


Figure 2.3:Process flow of processing plant

2.9 MATERIAL BALANCE OF THE PROJECT

Process Flow diagram & Material Balance diagram is given below in **Figure 2.4.**



Material Balance			
Description	Quantity	% fraction	Remark
Total Waste for processing	3,000 ton	100%	
Green Waste	600 ton	20%	Against total MSW received
Total MSW Processed for RDF	2,400 ton	80%	Against total MSW received
Total RDF to storage	1,400 ton	58%	Against total MSD processed for RDF
Inerts removal in processing	295 ton	12%	Against total MSD processed for RDF
Leachate recovered	357 ton	15%	Against total MSD processed for RDF
Moisture	343 ton	14%	Against total MSD processed for RDF
Compost	4 ton	0.17%	Against total MSD processed for RDF
Recyclables	2 ton	0.08%	Against total MSD processed for RDF

Figure 2.4: Process Flow diagram & Material Balance diagram

2.10 PROCESS DESCRIPTION

The description of process involved in the generation of electricity from municipal waste is given below:

- MSW receiving
- Pre Segregation and preparation of RDF
- Heat Recovery & Steam Generation in the boiler
- Power Generation & exporting to grid
- Flue Gas Cleaning System
- Leachate Treatment

2.10.1 COMPOSITION OF MSW:

Quality of the Municipal waste, i.e. calorific value is a vital consideration for power generation projects. Both actual and reported GCV values can vary widely due to various reasons such as:

- Seasonal variation due to climatic conditions.
- Zonal variation due to lifestyle impact-more GCV due to presence of more combustibles in wastes from affluent colonies.
- Mixing of sweepings, silts & C&D wastes.
- Sampling and analysis error.
- Absence of standardized methodology for preparation of waste samples for analysis (as received, air dried, oven dried).

Component wise weight and percentage of each component shows in **Table 2.5.**

Table 2.5: Composition of MSW

S. No.	Component	Weight of Component (Kg)	Percentage of Component (%)
1	Kitchen Waste	37.47	1.51
2	Vegetable Chhilka/ Maize Chhilka	814.86	32.86
3	Fruits/Lemon Chhilka	265.42	10.70
4	Dry Sugar Canes	16.39	0.66
5	Coconut Shell/hair	39.60	1.59
6	Straw/Hey	0.00	0.00
7	Flowers	0.00	0.000
8	Green leaves/Green Matter	85.10	3.43
9	Dry leaves/Dry Matter	95.54	3.85

S. No.	Component	Weight of Component (Kg)	Percentage of Component (%)
10	Wooden Pieces	86.31	3.48
11	Broom	1.65	0.07
12	Cardboard (wooden)	25.16	1.01
13	Paper/Cardboard	98.30	3.96
14	Textile/Cotton/Jute	165.62	6.68
15	Rubber/Leather/Tyre	11.92	0.48
16	**Plastic Waste**	**TOTAL = 342.98**	**13.83**
	Category-I	20.83	0.84
	Category-II	258.66	10.43
	Category-III	62.49	2.52
	Category-IV	0	0
	Non-Packaging/Other Plastic	1	0.04
17	Metals	12.43	0.50
18	Glass	11.90	0.48
19	Inert and other	167.52	6.75
20	Sand/soil/earth	45.10	1.82
21	Stones/brick/concrete	155.57	6.27
22	Ceramic and other	0.63	0.03
23	Human Hair	0.53	0.02
24	Batteries	0	0
25	Hazardous waste (if any)	0	0

(Source: MSW characterization is done by M/s Photron Laboratories Pvt. Ltd.)

2.10.2 MSW receiving

It consists of following systems:

Weigh Bridge two weigh bridges (1-input & 1-output) of minimum 60 tons weighing capacity for the proposed project. The platform scales have the capability of accurately measuring tare and net weights of range of vehicles. The scales have a minimum designated level of accuracy (i.e. ±5kg).

The weigh bridge is a permanent structure furnished with appropriate space to maintain and operate the computerized weight recording system, store historical records and have sufficient room for two weigh bridge operators.

The weigh bridge generates and maintains an electronic database for each delivery with time stamp and provide a print-out of the specifications and details for each consignment received at the Project Site.

2.10.3 Tipping floor

Proposed tipping floor will be sufficient to handle the entire MSW. Each truck carrying the municipal solid waste will be visually inspected. If the MSW vehicle contains a high percentage of unwanted materials, then it will not be accepted in the plant. To enhance efficiency, specialized training sessions will be conducted for truck drivers, focusing on the various materials found in Municipal Solid Waste (MSW) and their respective applications. The weighbridge operator will then instruct the drivers to proceed to the tipping floor, where the driver will unload the waste in the designated area only. This tipping floor is approx. 7.0 meter from bottom of the pits for effective unloading of waste. Sufficient quantity of sanitizer will be inoculated at this point with sprayer to reduce odor.

2.10.4 Natural drying section

In natural drying section, there will be drying pits and tipping floor equipped with EOT crane and grab bucket for MSW aeration and feeding to the hoppers for further segregation /processing. Tipping bay will be in the front side and MSW will be retained in the bay for one day, hence maximum leachate will be collected here. There will be adequately designed drying pits to reduce moisture from the waste. This area would be covered. The air required for the boilers would be drawn through ducts opening into the covered space thereby protecting the surrounding areas from the nuisance created by foul odour. Transparent sheets will be provided in the roof for sunlight. Pit area will be equipped with EOT (Electric Overhead Travel) cranes and grab. Drying pit will be designed to accommodate the adequate storage of MSW and size accordingly. Material will be disturbed with the help of grab crane for aeration and on 9th day, this material will be fed into the hopper for manual/ mechanical segregation. Thus, there will be 8 days' retention time for natural drying and moisture reduction. EOT grabs will be used to turn material for aeration and feed dried materiel in to the hoppers.

MSW will be stacked in the form of trapezoidal heaps and turned periodically to provide proper aeration and temperature control. It is the process of degradation of biodegradable material by certain micro-organisms in the presence of air, producing stabilized material. The process begins at an ambient temperature due to the activity of mesophilic bacteria which oxidize carbon to CO, thus liberating a large amount of heat. Usually, the temperature of the waste reaches 50 ^{0}C within two days, which is the upper limit of temperature tolerance of mesophilic organisms. At this point, the process is taken over by thermophilic bacteria and the temperature continues to rise. Biological digestion will be carried out by controlled aerobic process by successive populations of microorganisms (thermophilic enzymes) leading to development of stable temperature up to 65^0C to release carbon dioxide, minerals, organic substrate, energy and moisture. This technology is being recognized and is approved by the Central Public Health and Environmental Engineering Organization (CPHEEO), Ministry of Urban Development, Government of India. Most of the thermophilic phase, which lasts about two weeks, takes place in the temperature range of 55- 65^0C.

The process is dependent, of course, on the provision of a suitable environment for the microbes, in addition to the nutrients provided by the waste material. The main requirements are adequate supply of air and moisture. Compared to an anaerobic process, an aerobic conversion process is preferable as it is fast, exothermic and free from odour. The aerobic process also helps in eliminating pathogenic bacteria weed seeds, larva, etc. as a result of high temperature developed during the process. This system is much better than surface drying through hot air; it also works out cost effective. Moisture reduction (up to 20%) leading to free flow ability of waste and loosening of material for easy shredding will be achieved.

2.10.5 Material processing and compost recovery facility

Mixed MSW received at WtE facility has high level of moisture content and composition is also heterogeneous in terms of content and size. Material processing and compost recovery facility consists of MSW unloading, manual/mechanical segregation, RDF preparation and compost section. Processing of waste will be done in 3 shifts and two-hours/shift will be for maintenance and cleaning of processing section. Equipment sizing will be done accordingly to handle the waste in this stipulated time. Proper redundancy will be designed for critical equipment to reduce the breakdown time.

2.10.6 SEGREGATION

2.10.6.1 Manual and Mechanical segregation and RDF preparation

- The Municipal Corporation of Delhi is responsible for collecting waste from residential areas, and it is the primary duty of citizens to follow waste segregation guidelines outlined in the Municipal Solid Waste (MSW) Rules, 2016. The process begins with waste segregation at the source, involving rag pickers in the separation of valuable materials, hard plastics, and thermocol. Subsequently, the waste will be transported in covered vehicles to the Waste-to-Energy (WtE) facility, preventing littering and minimizing odors during transit.

Upon arrival at the facility, MSW trucks will be weighed at the weighbridge and unloaded into MSW storage pits located near the Tipping floor. The Tipping floor will be equipped with gates to facilitate the unloading of MSW trucks into storage pits with a negative draft, preventing odors from spreading outside.

Magnetic separator will be installed to remove the ferrous scrap before feeding. Ballistic separator performs screening action as well as gravity separation segregates the waste into following fractions:

- Fines below 10 mm Size: - these contain digested organic matter and are sent to compost section for further curing and completion of composting process.
- A material above 200 mm size is retained on top screen and is sent to shredder for size reduction.
- Middle fraction (50 to 200 mm) is feed for the boiler which is transported to boiler feed storage. EOT crane with grab will make separate heap and also feed the stored material in to feed hoppers of boilers.
- Heavy inert material is separated by gravity/inertia separation and is fed to inert material conveyor for disposal.

On 9th day, semi decomposed material will be fed to hopper for manual segregation and removal of large size materials like boulders, stones, synthetic fabrics, mats, tires, hard boards, woods, etc. This would ensure mechanical safer operation of the subsequent for the pre-processing equipment. Stones and boulders will be collected on the inert conveyor and transported for landfill. Combustibles will be collected and conveyed for further processing including shredding. Next step is mechanical Segregation. In this section the partially dried material feed to pre-processing section hopper for mechanical segregation to remove inert and fines. Through a ram feeder, the material will then be fed to a ballistic separator, where components are separated based on their sizes. The ballistic separator isolates material sizes above 200 mm, which will be sent to a shredder for breaking down larger components into smaller sizes. The shredded material is then directed to the Refuse-Derived Fuel (RDF) storage pit, while the -50 mm size will be sent to a vibrating screen for further screening to -10 mm. The -10 mm fraction, and the +10 mm portion will be sent to the RDF storage pit. Material ranging from -200 mm to +50 mm will also be directed to the RDF storage pit, with the remaining portion being inert. Ferrous materials in the inert fraction are segregated using a magnetic separator and sent to recyclers. RDF will be stored in a pit for 6 to 7 days before being fed into the boiler hopper for burning. The Flow diagram of Segregation Process is shown in the **Figure: 2.5.**

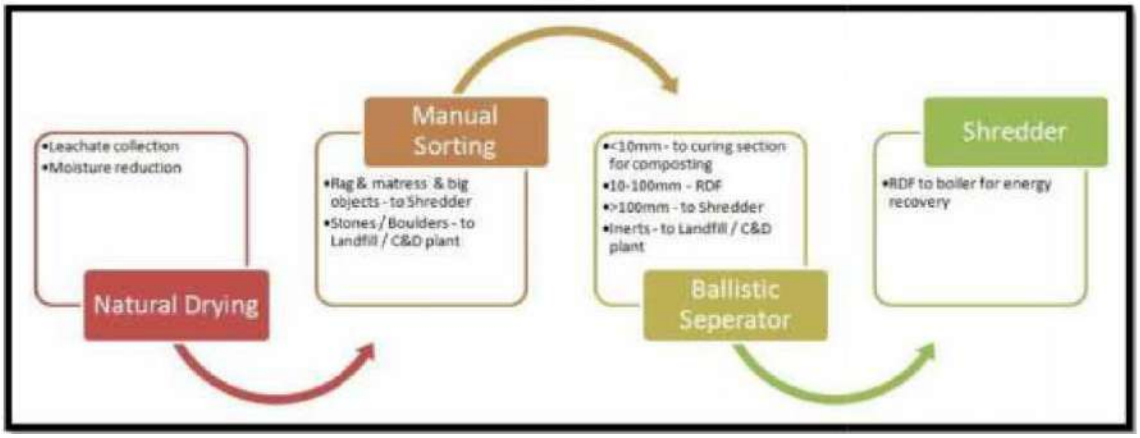


Figure 2.5: Flow Diagram of Segregation Process

2.10.6.2 Curing and refinement section

Material will be distributed with the help of grab crane for further curing. The compost will have the activity of micro-organisms and the slow process of digestion will be taking place. To stabilize the compost, it will be cured by adding water and providing gentle turning for a period of 15-20 days for further stabilization and moisture control.

Cured material from the curing section will be fed to a moving bed feeder conveyor using EOT grab crane. The feeder conveyor will feed the material at a controlled rate to the rotary trommel, which contains a sieve size of 4mm. The screened material coming out of the rotary trommel will be passed through a permanent magnet and will then be sent to the gravity separator, which will remove heavy impurities such as glass, metals, sand, silica etc. from the organic manure. If the moisture will be excess, the cured material will be dried before sieving and then be sieved. The final product coming out of the gravity separator is transferred to a storage space. The refined compost will be stored in the compost storage area and the same will be bagged in a semi-automated packing unit.

2.10.6.3 RDF Storage & feeding

Prepared RDF will be stored in the RDF storage area. Capacity of RDF storage will be for buffer storage only. This area will be covered with roof and equipped with EOTs cranes and grab to feed in boiler.

2.10.6.4 Disposal of rejected material

All rejected materials will be sent to landfill sites through vehicles. The weighbridge operator weighs the tare vehicle as well as loaded vehicle after the rejected material is loaded.

2.10.6.5 Combustion & Steam Generation in boilers:

- Processed MSW will be used for steam generation by incineration in boilers.
- Reverse reciprocating with forward feed inclined grate has performed most successfully in WtE projects under different fuel conditions all over the world. MSW is slowly propelled through the combustion chamber (furnace) by a hydro-mechanically actuated grate. Fuel continuously enters one end of the furnace and ash is continuously discharged at the other after going through several to and fro movements within the chamber. The plant is configured to enable complete combustion as MSW moves through the furnace.
- Primary combustion air is preheated to dry the fuel and then allow complete combustion. Combustion conditions are controlled to optimize the feed moisture by steam heated air pre-heater and control the residence time of the fuel in the furnace for complete combustion. Boilers will be provided with sophisticated instruments, control and monitoring and temperature gauge for the various sections in the boiler.

2.10.6.6 Boilers Including Auxiliaries

Steam requirement has been computed by developing heat and mass balance tool specifically developed for the project. Two boilers with RDF throughput equivalent of 700TPD each has been considered. This would help to improve operational reliability taking into account the periodic stoppages required for cleaning of boilers operating on such fuels. The following three parameters have been taken into account while carrying out basic engineering design of the boilers:

- Air temperature for combustion
- GCV of the fuel
- Exit flue gas temperature

Boiler combustion system would be designed to operate on RDF of GCV range 1100-2500 kcal/kg. This would ensure operation sustainability even under uneven drying conditions, fire safety of the RDF plant and storage bin and safety of technology selected.

Incineration is a thermal process for MSW where raw (unprocessed waste) and processed waste (RDF) can be used as boiler feedstock. Incineration is the most popular MSW treatment method that transforms waste materials into useful energy. Fuel is combusted in the temperature above 950ºC and is converted in to flue gas and non-combustible materials with solid residue state called bottom ash. Incinerators reduce the solid mass of the original waste by 80–85% and the volume by 90-95%. This means that while incineration does not completely replace land filling, it significantly reduces the necessary volume for disposal.

For the proposed project reciprocating grate incinerator is used and same technology will be used for proposed project. Specifications of Boiler details are given in **Table 2.6.**

Table 2.6: Specifications of Boiler and TG Set

Particulars	Unit	Value/Description
Boiler grate	-	Reciprocating forward feed-air cooled
Boiler type	-	Vertical
Boiler steam capacity (MCR)	TPH	78 (Excluding steam for SCAPH)
Superheated steam pressure	$Kgf/cm^2(a)$	42
Superheated steam temperature	°C	400
Feed water temperature economizer inlet	°C	130
Fuel Rate (RDF)	TPD	700
MSW processed fuel GCV limit-Operational stability & safety	Kcal/kg	1100-2500
Excess air	%	30%-70%
Primary air temperature	°C	220-240
Secondary air temperature	°C	150
Efficiency	%	80-83
Exit flue gas temperature economizer	°C	190
Peak Capacity	%	110MCR
Main steam Conductivity	µS/cm	<0.2
Main steam Silica as SiO_2	ppm	<0.02
Main steam Hardness as $CaCO_3$	ppm	Nil
Bottom ash (Grate ash, Bank, Economizer)	-	Water cooled
Fly ash	-	Dense Phase Pneumatic Conveyor

2.10.6.7 Reciprocating Grate Incinerator

In this project Reciprocating Grate incinerator is used and requires that the grate be able to move the waste from the combustion chamber to allow for an effective and complete combustion. The grate has three sections, first one for drying, followed by combustion & the last for conveyance of ash. Provision has been made for supply of preheated air to take care of flame stability under varying moisture content in the RDF fuel. This would ensure maintenance of appropriate furnace condition, efficiency and environment at performance all the time.

The movement of the MSW particles in a grate would be influenced by:

- Properties of waste-particle size, shape, density and bulk density impacting angle of repose of the mass under different conditions.
- Geometry of the grate-ratio of length to width, inclination of grate, angle of fixed & reciprocating.
- Operating parameters such as feed rate, reciprocation speed, point of ignition and combustion conditions (air fuel mixing).

The main advantages of reciprocating Grate Incinerator are as follows:

- The technology is widely used and thoroughly tested for waste incineration and meets the demands for technical performance.
- It can accommodate large variations in waste composition and calorific value.
- Allows for an overall thermal efficiency of up to 80~83%.
- System is able to operate 8,000 hours per year.

2.10.6.8 Auxiliary fuel and firing System:

There will be a dedicated oil firing system for each boiler, these burner system comprises set of start-up and auxiliary burners. The main purposes of these burners are:

Start-up burner, it will support during refractory dry out for gradually heat up the furnace during start-up for drying and baking of the refractory lining preheating (if necessary) of the furnace during normal start up procedure of the furnace.

Auxiliary burner.

- The auxiliary burners have been designed to maintain the required temperature and retention time.

- These burners are used during startup and shutdown conditions to achieve certain combustion temperature in controlled way when there is no fuel so as to avoid any damage in installation due to sudden temperature variations.

There is limit of flue gas exit temperature from the perspective of reaction in SNCR. This limits the waste heat recovery potential in the air pre-heater. Further, it is very difficult to control the temperature of pre-heated air in an air pre-heater. It has therefore, been considered necessary to install steam heated air pre-heater (SCAPH). Two-stage SCAPH-the 1st one based on low pressure steam from bleed of STG and the 2nd one from high pressure saturated steam from steam drum, with appropriate control system would be used. This would help in regulating the final temperature of air as per requirement of the boiler corresponding to the moisture level in the RDF and at the same time optimize the overall thermo-dynamic efficiency of the system along with sustainable environment performance.

Power Generation: - Process of generation of electricity from turbo-generator is described below **Figure 2.6.**

Turbo-generator

- Rankine cycle is used for power generation. Efficiency of the Rankine cycle depends upon the pressure and temperature of the superheated steam and condenser. With a view to contain the corrosion impact at higher temperatures, MSW power plants is maintained at around 400^{o}C and consequently the pressure at around 42Kgf/cm^{2} (a).
- Air cooled condensers will be used for condensing steam exhaust from the turbine. Power will be generated in Alternator at 11 kV. Additional switch yard will be installed for export of power to grid through DISCOM.

Turbo-generators convert the thermal energy of steam into mechanical work (Turbine) & then convert the mechanical energy to the electricity (Alternator). Depending upon the size of the machine and operating parameters, the alternator can be either directly coupled with the turbine or mechanically connected through a gear box in between; latter is mostly in case of smaller capacity machines such as the ones for “WtE” projects.

High pressure steam is admitted into chamber of the turbine and then expanded in fixed and moving nozzles depending upon the turbine configuration. During working of the nozzles/blades thermal energy is converted into mechanical work. Low pressure steam at the end can be either extracted for processes and/or preheating of feed water for improving the overall thermodynamic efficiency of the plant or condensed directly at lowest possible pressure (related to the absolute atmospheric pressure) for generating maximum power from the available steam. Steam is required in the "WtE" plant for the LP-heater as well as feed water de-aerator & SCAPH. This steam can be extracted from the turbine under different modes.

2.10.6.9 Condensing plant

High pressure steam is expanded in the turbine and condensed in the condenser at the lowest possible pressure for extracting maximum possible work from the thermal energy contained in the steam. Generally, the water-cooled condensers are most favorable for condensing steam. Hot water is cooled by the cooling tower & heat is rejected to atmosphere by evaporation of water. Thus, over a time span the concentration of the salt level in the cooling tower sump increases. This requires periodic blow down to maintain the concentration of total dissolved solids (TDS) within limit. Higher concentration of the TDS in circulating water will lead to the scaling on the surface of condenser thus decreasing the performance. TDS in the circulating water is normally not allowed to exceed the range of 2,500-3,000 ppm for circulating water. The amount of blow down is governed by the concentration of the dissolved salts in the make-up water. It is proposed to use the sewage water for the power generation. It has been studied in the projects that treatment cost of the sewage water for use in the cooling tower becomes non-techno viable.

In the projects, it has been studied that the life cycle costing for similar type of water properties yields more attractive for air cooled condenser than water cooled condenser. It is, therefore, proposed to deploy ACC for the project. As per the MoEF&CC notification dated 16th October, 2017, new plants to be installed shall have meet specific water consumption up to maximum of 2.5m^3/MWh and achieve zero water discharge" which would be meet through ACC. The flow diagram of power generation technology is described below **Figure 2.6.**

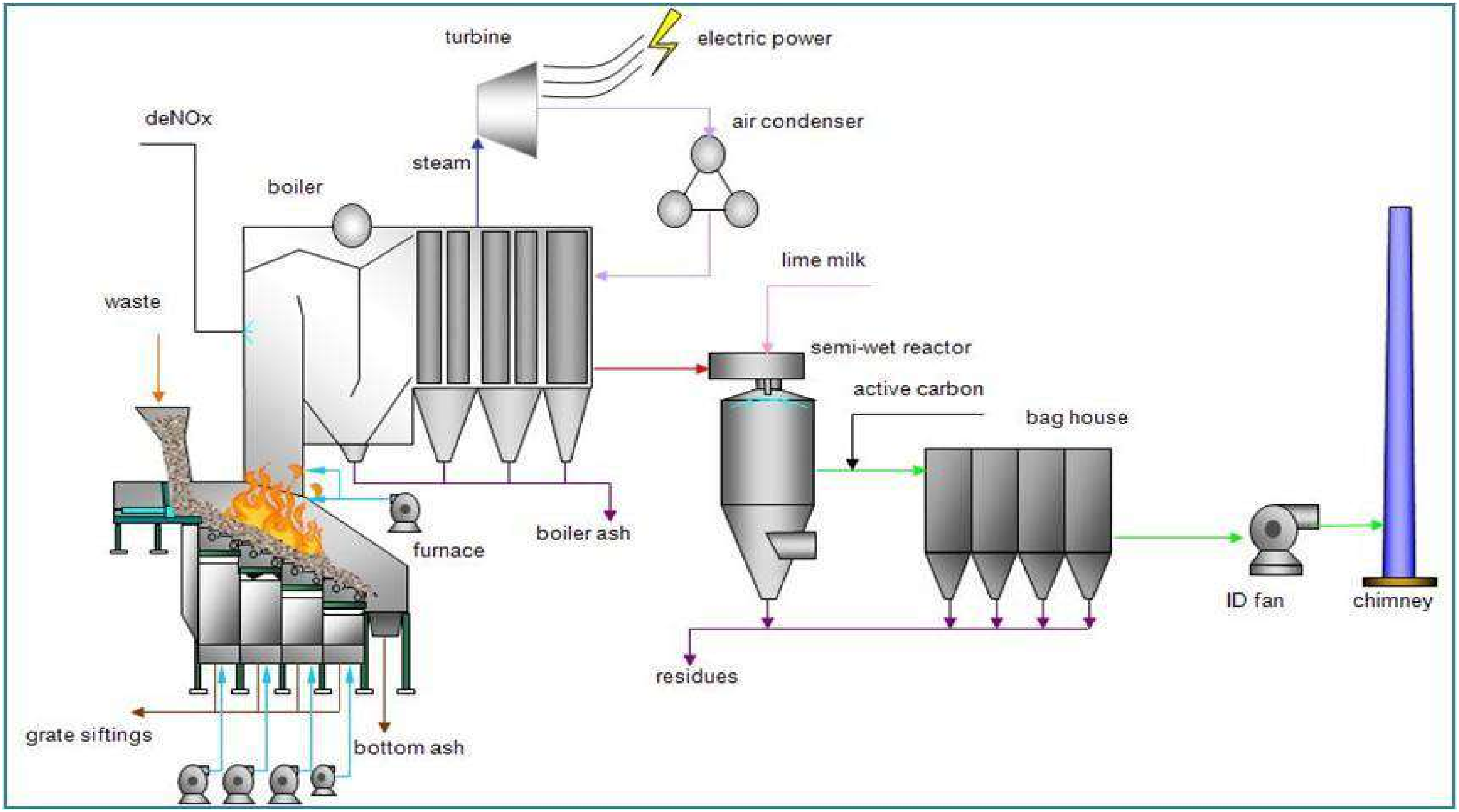


Figure 2.6: Flow Diagram of Power Generation

2.10.6.10 Electrical system

The plant electrical system comprises the main generator unit, step up sub-station for power evacuation and plant auxiliary system. Power would be generated at 11 kV and would be stepped up to 66 kV for transmission to the grid sub-station. Four step down transformers each of 11/0.433 kV, would be installed for supply of power to the plant auxiliary system and equipment. The nearest DISCOM is Tata Power Delhi Distribution Limited (TPDDL). The Power required during construction for the proposed project will be provided by the nearest source of energy. During operation, part of the energy produced by the project will be used. The 750 kVA DG set will be used during operation phase only in case of grid failure.

2.10.6.11 Power evacuation

Power evacuation is an important aspect of a power project that allows generated power to be immediately evacuated from the power plant to the grid for distribution or further transmission. Major components of the system are as follows:

- Power transformer
- Circuit breaker (CB)
- Current transformer (CT)
- Potential transformer (PT)
- Lightning arrestor (LA)
- Cables &conductors
- Isolator
- Energy meter
- Transmission lines or cables

During operation, part of the energy produced by the project will be used. No DG set will be used during construction phase. The 750 kVA DG set will be used during operation phase only in case of grid failure.Evacuation of power would be carried out by installing a 66/11 kV switchyard in the plant and laying 66 kV transmission cables (underground) between plant and the nearest grid sub-station.

2.10.7 Flue Gas Cleaning System

The MSW used for power generation contains various components like carbon, hydrogen, nitrogen, oxygen, volatile matter, ash, chlorine, silica, etc. Combustion of this waste or waste derived fuels results in generation of mixture of gases termed as flue gas consisting of water vapour, carbon dioxide and excess air which includes acid gases like HCl, HF, HI, SO_2, NO, organic substances, dioxins, furans, heavy metals and fly ash particles.

In order to achieve the emission norms as per MoEF&CC, the flue gas generated is to be treated by using suitable flue gas cleaning system before releasing into the atmosphere. Flue gas cleaning system (FGCS) involves removal of the following pollutants from flue gas.

- Gaseous contaminants removal
- Removal of toxic substance dioxin and mercury
- Particle Removal

The Flue Gas Cleaning System is designed to treat the flue gas stream being discharged from boiler. The flue gas cleaning process is a dry sorption system using hydrated lime and activated carbon as reagents. It consists essentially of the following major components:

- Turbo-reactor
- Bag house Filter
- Sorbent Handling System
- End Product Handling System

- **Turbo Reactor:**

  The flue gases from boiler are led directly to the lower part of the Turbo Reactor where the flue gas comes into intimate contact with hydrated lime and activated carbon which absorb and neutralize the SO_2 and other acid compounds, heavy metals and dioxins/furans contained in the flue gas stream. In turbo-reactor flue gas is conditioned with water to an optimized operating temperature. At the head of the turbo-reactor a considerable part of the solids is precipitated and flows downwards, mainly along the reactor walls. The remaining dust leaves the reactor with the flue gases and enters into the downstream fabric bag house filter.

- **Bag house Filter:**

  The high dust loaded flue gas from the turbo-reactor enters the Fabric Filter via a central raw gas channel and from there through raw gas nozzles into the dust chambers. The filter consists of six chambers with separation in independent chambers. Each bag house consists of total 2520 nos. PTFE bags with PTFE membrane. The raw gas flows through the filter medium from the outside to the inside, while solids carried over by the gas are trapped on the outside of the filter bag. These particles form a layer which aids in filtration (filtration-aiding layer / filter cake).

- **Sorbent Handling System**

  As a sorbent slaked lime [hydrated lime, $Ca(OH)_2$] and open-hearth furnace coke (HOC) are transported out of the sorbent silos and injected by dilute phase conveying into the fluidized bed in the turbo-reactor.

- **End Product Handling System:**

  The product will be discharged via rotary vane feeders from bag house filter to the fluidizing conveyors upstream of the dosage rollers into an intermediate product silo. From there it is transported via dense phase conveying into the product silos. From product silo fly ash will be transported by closed vehicle to SLF.

2.10.7.1 Air Pollution Control

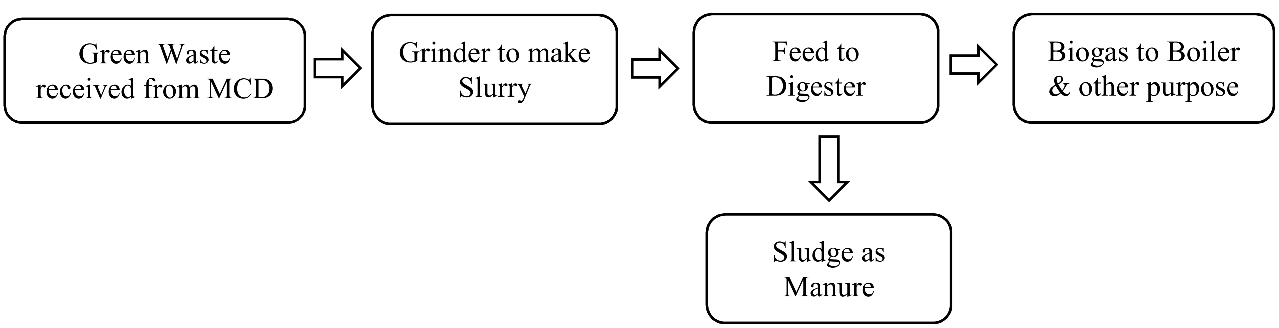
Air pollution control technology has been developed to take care of all concerns through elaborate arrangement of multistage treatment and control and monitoring system. The flue gas treatment system consisting of lime and activated carbon injection system, quenching chamber and reaction tower followed by bag filters ensures total compliance with the regulatory requirement. Process control for the flue gas treatment facility consists of three loops, in which the first loop, continuously controls the flow of re-circulated absorbent to the reactor by continuously monitoring the quantity of flue gas. The second loop is controlled by a temperature measurement of the outlet gas which ensures that the flue gas is cooled down by controlling the quantity of water sprayed.

Water required to cool down flue gases is very less and get evaporated in system itself. The third loop is used to control the adding quantity of lime and activated carbon for removal of acid gases (HCl, SO_2). The activated carbon adsorbs heavy metals. Flue gas flowing out from the reactor then goes into the bag filter for removal of micro particles including hazardous substances. The purified flue gas is discharged by ID fan and vented into the atmosphere. Online stack monitoring and display system for the unit.

2.10.8 Bio-Methanation Plant:

Green Waste received from MCD shall be used for bio-methanation by biodegradation of the organic materials. After collection of the green waste, slurry will be made by grinder and feed into the digester where the microorganisms in an anaerobic environment decompose organic material into methane and carbon dioxide gases, which produces biogas.

Biogas production from organic waste helps in waste management by diverting organic materials from landfills and reducing greenhouse gas emissions. The nutrient-rich digested sludge from the anaerobic digestion process shall be used as compost.



2.11 WATER POLLUTION CONTROL

Liquid effluent is generated from following sources:

a) Leachates from the municipal waste.

b) Waste water from various source including boiler blow down water, cooling water blow down, Waste water from DM water plant.

c) Domestic waste water.

2.11.1 LEACHATE TREATMENT PLANT (LTP)

2.11.1.1 Introduction:

The LTP will comprise of Primary (Chemical Treatment), Secondary (Biological Treatment) & Tertiary (Membrane Filtration) treatment. The details of LTP are as follows:

- 3000 TPD MSW (Fuel) will be received for process in which water known as leachate will percolate from MSW and will be collected into a pit for treatment.
- Leachate is highly contaminated with pollutants such as organic and inorganic compounds, heavy metals, and other harmful substances.
- 357 KLD leachate and 3 KLD domestic sewage will be routed to Leachate Treatment Plant to achieve the treated leachate quality parameter.
- Treated leachate will be recycled in WTP to reduce raw water intake from STP of DJB. Biogas from digester will be routed to flare and boiler, can be utilized for making CNG.
- LTP reject water will be used in ash quenching, and sludge as manure.
- All water will be utilized and recycled in the process and there will be no any liquid discharge from the plant, Henceforth, the project will adhere to the Zero Liquid Discharge (ZLD) concept.

2.11.1.2 Quality Parameters:

Different quality parameters of Raw Leachate, After Pretreatment & after Tertiary Treatment (RO) process and LTP Process Flow Diagram is given in the below **Table 2.7** and **Figure: 2.7.**

Table: 2.7 Quality Parameters

Sr. No.	PARAMETERS	UOM	RAW LEACHATE	AFTER PRIMARY & SECONDARY TREATMENT	AFTER TERTIARY (RO) TREATMENT
1	COD	ppm	40000- 75000	<1000	50-100
2	BOD	ppm	30000-50000	<600	20-50
3	Oil & Grease	ppm	2000- 5000	NIL	NIL
4	pH	-	4.5 - 7.5	7.0 - 8.0	7.0 - 8.0
5	TDS	ppm	42000 - 70000	<30000	600- 950

6	Colloidal Silica	ppm	800	200	NIL
7	Reactive Silica	ppm	200	200	10
8	Ca Hardness	ppm	12000	6000	100
9	Mg Hardness	ppm	8000	4000	40
10	Chloride	ppm	17000-20000	<10000	100-200
11	TSS	ppm	150-3200	<100	NIL
12	Turbidity	NTU	3000- 4000	<100 ppm (slightly reddish).	NIL
13	Ammonical Nitrogen	ppm	2000	<20	-
14	Nitrogen	ppm	3000	<30	-

2.11.1.3 Toxicity Characteristic Leachate Procedure (TCLP)

The TCLP Characteristic of a waste to energy plant is given as **Annexure - IV** and the proximate and ultimate analysis, Calorific value of municipal waste is given as **Annexure -V.** The regulatory norms is given in the **Table 2.8.**

Table 2.8: Regulatory norms for Leachate Characteristics

Substance	TCLP Regulatory Level
Arsenic	5.0 mg/l
Barium	100.0 mg/l
Benzene	0.5 mg/l
Cadmium	1.0 mg/l
Carbon tetrachloride	0.5 mg/l
Chlordane	0.03 mg/l
Chloro benzene	100.0 mg/l
chloroform	6.0 mg/l
chromium	5.0 mg/l
o-cresol	200.0 mg/l
m-cresol	200.0 mg/l
p-cresol	200.0 mg/l
cresol	200.0 mg/l
2,4-D	10.0 mg/l
1,4-dichlorobenzene	7.5 mg/l
1,2-dichloroethane	0.5 mg/l

1,1-dichloroethylene	0.7 mg/l
2,4-dinitrotoluene	0.13 mg/l
Endrin	0.02 mg/l
heptachlor (and its epoxide)	0.008 mg/l
Hexachlorobenzene	0.13 mg/l
Hexachlorobutadiene	0.5 mg/l
Hexachloroethane	3.0 mg/l
Lead	5.0 mg/l
Lindane	0.4 mg/l
Mercury	0.2 mg/l
Methoxychlor	10.0 mg/l
Methyl ethyl ketone	200.0 mg/l
Nitrobenzene	2.0 mg/l
Pentachlorophenol	100.0 mg/l
Pyridine	5.0 mg/l
Selenium	1.0 mg/l
Silver	5.0 mg/l
Tetrachloroethylene	0.7 mg/l
Toxaphene	0.5 mg/l
Trichloroethylene	0.5 mg/l
2,4,5-Trichlorophenol	400.0 mg/l
2,4,6-Trichlorophenol	2.0 mg/l
2,4,5-TP (Silvex)	1.0 mg/l
Vinyl Chloride	0.2 mg/l

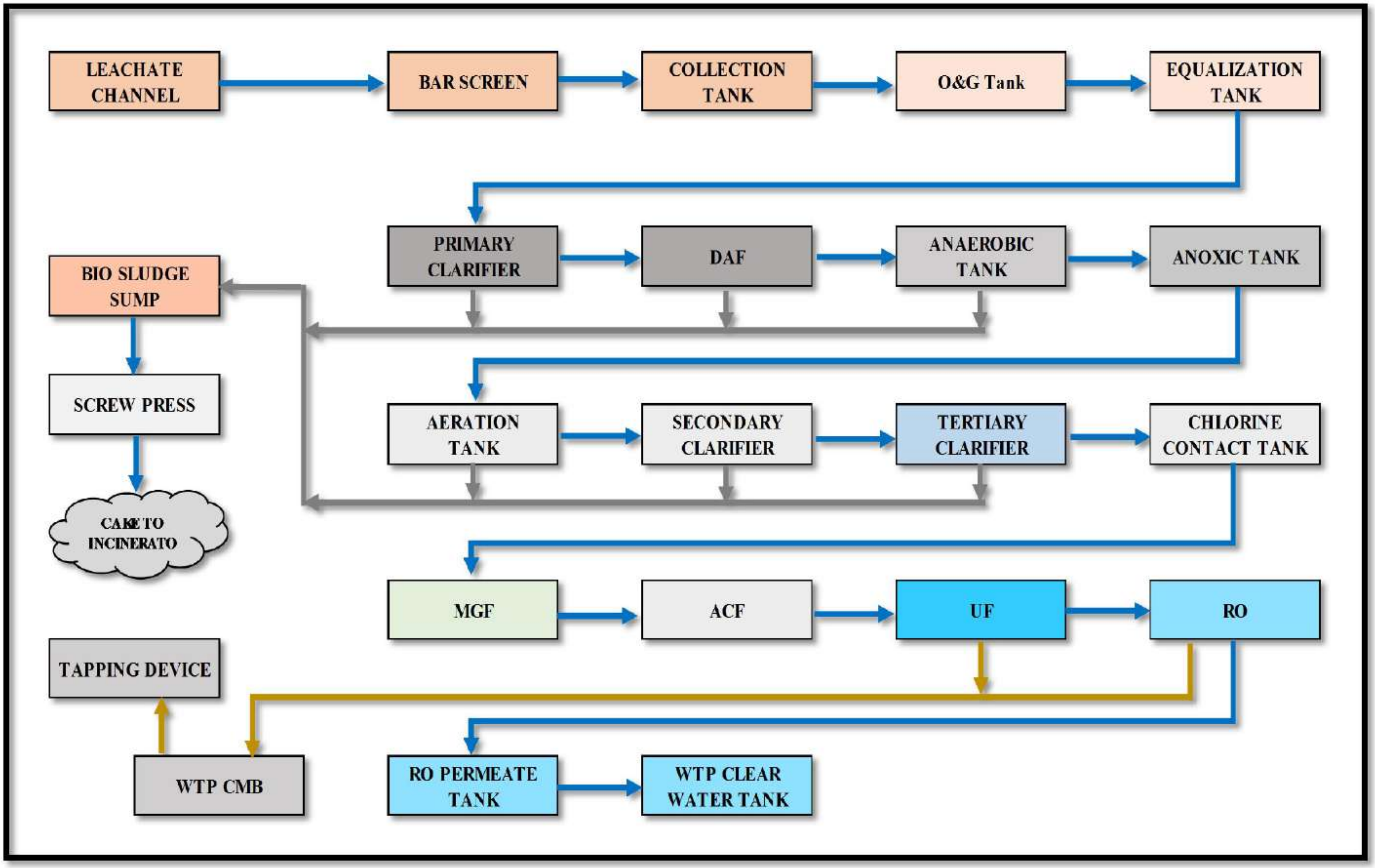


Figure 2.7: LTP Process Flow Diagram

2.11.1.4 Process Details

2.11.1.4.1 Oil & Grease Tank:

- Leachate from collection pit will be fed to O&G tank.
- O&G tank use to remove the free oil, which float on surface.
- Floating oil will be removed manually from manhole.
- O&G tank outlet water will be moved to Equalization tank.

2.11.1.4.2 Equalization Tank:

Equalization tank having 222 KL storage capacity with bottom air grid system and acid dosing Equalization tank will consist of bottom air grid system and acid/alkali dosing system for pH neutralization. Blower will provide air supply in equalization tank bottom air grid.

Purpose of Aeration:

- Homogenation of feed water.
- Maintain alkali pH.
- Reduce hydraulic fluctuation load on upstream units.
- Reduction in carbon dioxide
- Oxidation of Iron & Manganese

2.11.1.4.3 Primary Clarifier:

- There will be chemical dosing of coagulation & flocculation and remove suspended solids by settling to bottom and drain out by pump to sludge holding tank.
- Remove 50-70% TSS.
- Remove 25-35% BOD

2.11.1.4.4 Dissolved Air Floatation (DAF) Unit:

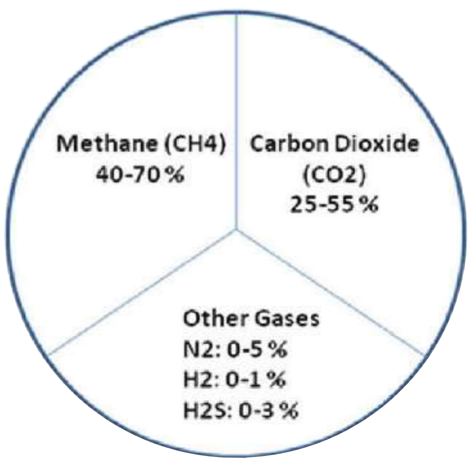
- DAF will remove emulsified oil coming to surface by skimmer.
- Air & chemical feed together with leachate into DAF.
- Remove Suspended Solids settled to bottom then to sludge holding tank.
- DAF outlet below upper surface will be routed to digester.
- Retention Time >30 min.
- Remove 90-95% O&G.

- Remove 25-35% TSS.

2.11.1.4.5 Anaerobic Treatment (Digester):

- Anaerobic (without oxygen) biological process will be used to break down organic materials and release biogas.
- The Digestion of takes place for about 20 days in the mesophilic temperature (30˚C-35˚C) with approximately 50-60% of methane gas production.
- Anaerobic digestion includes four major steps- Hydrolysis, Acidogenesis, Acetogenesis & Methanogenesis, to decompose the organic matter and produce biogas as below.
- Digested Sludge from the bottom will be utilized as manure.

2.11.1.4.6 Biogas Composition:



2.11.1.4.7 Anoxic Treatment:

- Anoxic conditions involve environments in which molecular or free oxygen (O_2) is absent, though bound oxygen may be present.
- Anoxic zones is useful for Nitrogen Removal.
- In anoxic zones, when bacteria break down the nitrogen products, the separation of the molecule's releases oxygen, which the bacteria need to thrive.
- Because the biodegradation of nitrogen products naturally releases oxygen, the bacteria in anoxic tanks like denitrification basins/Sec Clarifier do not require supplemental oxygen from air diffusers.

2.11.1.4.8 Aerobic Treatment:

- After Anoxic tank leachate will be routed to Aerobic treatment, which involves oxygen-dependent microorganisms to break down organic matter and converting them into carbon dioxide, water, and biomass.
- The diffuser given in the bottom of tank will provide oxygen to the microorganisms and mix biomass with feed water to consume BOD. Mixed Biomass in aeration tank known as Mixed Liquor Suspended Solid (MLSS).
- MLSS settled down in Secondary Clarifier and again recycle to Aeration tank, excess biomass sends to sludge holding tank for dewatering through Screw Press. Dewatered Sludge (Cake) use as manure.
- Secondary Clarifier overflow with reduced organic load (90-92%) route to Tertiary Clarifier (like primary clarifier) for further TSS removal.

2.11.1.4.9 Chlorine Contact Tank (CCT):

- CCT will have sufficient time for chlorine reaction to effectively disinfect and deactivate pathogens present in the water.
- Sodium Hypo Chloride chemical dosing will be given for disinfection.
- Hypochlorous Acid (HOCl) will be generated as disinfectant which removes or inactivate microorganisms (pathogens) present in water to reduce their growth in upward units.

2.11.1.4.10 MGF ACF:

- MGF primarily addresses physical impurities (TSS).
- ACF targeting chemical contaminants through adsorption and remove organic compounds, chlorine, volatile organic compounds (VOCs)
- MGF will have different layers of Pebbles, Gravels, Silex & Sand.
- ACF will have Activated Carbon with bottom support of Pebbles, Gravels, Silex & Sand.
- Backwash in 24 hours operation or as per differential pressure (0.5 kg/cm^2), to remove the particle deposited on bed. Backwash water route to drain pit and then equalization tank.

2.11.1.5 Reverse Osmosis:

OSMOSIS:

When fresh water and a salt solution are separated by semi permeable membrane, water will migrate from the freshwater side into the salt solution (i.e., Low concentrate to high concentrate side). This phenomenon is called "Osmosis".

REVERSE OSMOSIS:

When a pressure greater than the osmotic pressure is applied to the concentrated solution, water flows from the concentrated to the dilute solution side through semi-permeable membrane.

Plate and Tube Reverse Osmosis (PTRO)

- ACF outlet will be fed to Plate type RO.
- PTRO is upgraded type of RO membranes which are designed to operate with high quality influent and at high pressure up to 90 bar, incorporates Plate and Tube Reverse Osmosis technology.
- The module with multiple circular membrane cushions within the structure of ABS plastic plates forms a sandwich with a permeate carrier passage for the purified water.
- The feed flows over each subsequent membrane cushion contained within the hydraulic plate structure and exits the last chamber as concentrate.
- The purified water or permeate is collected from each membrane cushion. Hence there will be two final outlets from each individual module – one is recyclable permeate and the other being RO reject or the concentrate.

2.11.1.6 Industrial Wastewater

Wastewater generated from cooling water blow down and DM plant will be brought to neutralization pit through drains, and will be neutralized by acid/alkali dosing. The neutralized water will be used for ash quenching etc. The boiler blow down will be recycled to the DM plant. The wastewater system will be based on zero liquid discharge concept for the project.

2.11.1.7 Domestic Sewage

Sewage generated in the plant will be routed to the Leachate treatment plant for chemical and biological treatment.

2.12 SOLID WASTE

2.12.1 Domestic Waste:

During operational phase, domestic waste approx. 121 Kg will be generated which will be handled properly, as proposed project is itself Municipal Solid Waste Management based Waste to Energy project.

2.12.2 Ash Generation:

Approx. 12 % of ash will be generated as Solid Waste from the Power Plant. The ash generated will be utilized for various purposes and the unutilized ash will be sent to secured landfills site designated by MCD.

2.12.3 Inert waste from pre-processing

The inert wastes will be segregated during the preprocessing of municipal solid waste out of which recyclables will be sent to the recycling agencies and left over will be sent to the landfill site.

2.13 Hard plastic waste

The Municipal Solid Waste (MSW) received at the waste-to-energy facility is largely devoid of hard plastic due to prior manual segregation by rag pickers. These individuals undergo training to identify various types of hard plastics through visual inspection, ensuring precise segregation from other materials.

2.14 ODOUR CONTROL

Odour pollution will be well controlled in this project. The MSW storage pit will be in an enclosed area with a negative pressure with the airflow being routed through the boiler which prevents unpleasant odour from escaping into the atmosphere. To make the odour system more effective bio inoculum i.e. consortium of microorganism called EM culture will be mixed with the raw MSW. Additionally, odour control fragrance will also be used.

2.15 RAINWATER HARVESTING

Considering the climatic conditions and the scarce surface as well as groundwater availability in the region, state of the art rainwater harvesting system will be followed by M/s Jindal Urban Waste Management (Bawana) Limited. To facilitate rainwater harvesting, collection and storage, the rainwater storage system will be located at an appropriate locations on the site keeping in view the slope contours and collection point.

Guidelines issued by the Delhi Jal Board (DJB), if any, will be adhered for finalization of appropriate rainwater harvesting system.

2.16 HARNESSING SOLAR POWER

A rooftop solar power, or rooftop PV, is a photovoltaic (PV) system that has its electricity-generating solar panels mounted on the suitable rooftops. Solar PV modules shall be placed on top of our building's certain roofs to generate electricity. In this case, grid-connected mechanism using rooftop PV shall allow us to first consume the electricity generated from the solar system, to meet our unit auxiliary demand, and then export the surplus energy, if any, into the grid.

The various components of such system shall include PV panels, module mounting structures, cables, wires, solar inverters, and other electrical accessories, e.g., safety, monitoring, and metering equipment, etc.

- Solar Panels produce carbon free electricity when irradiated with sunlight. Solar panels shall be made of smaller Silicon solar cells. Multiple solar panels shall be strung together to make up a solar array. Solar panels shall be protected by tempered glass and secured within an aluminium /metal frame.
- Mounting clamps shall consist of aluminium brackets and SS bolts that shall secure solar panels to one another on the roof and on to the rails.
- Racking or rails shall be made of metal and shall lie in a parallel configuration on the roof, level enough for the panels to be evenly mounted.
- Mounts shall attach the rails and the entire array to the surface of the roof.
- DC /AC wiring shall connect between panels and micro or string inverter.
- Micro inverters shall be mounted to the bottom of the panel and convert DC power from the panels into AC power.

A conceptual diagram of Harnessing Solar Power at JUWMBL is given in **Figure 2.8**.

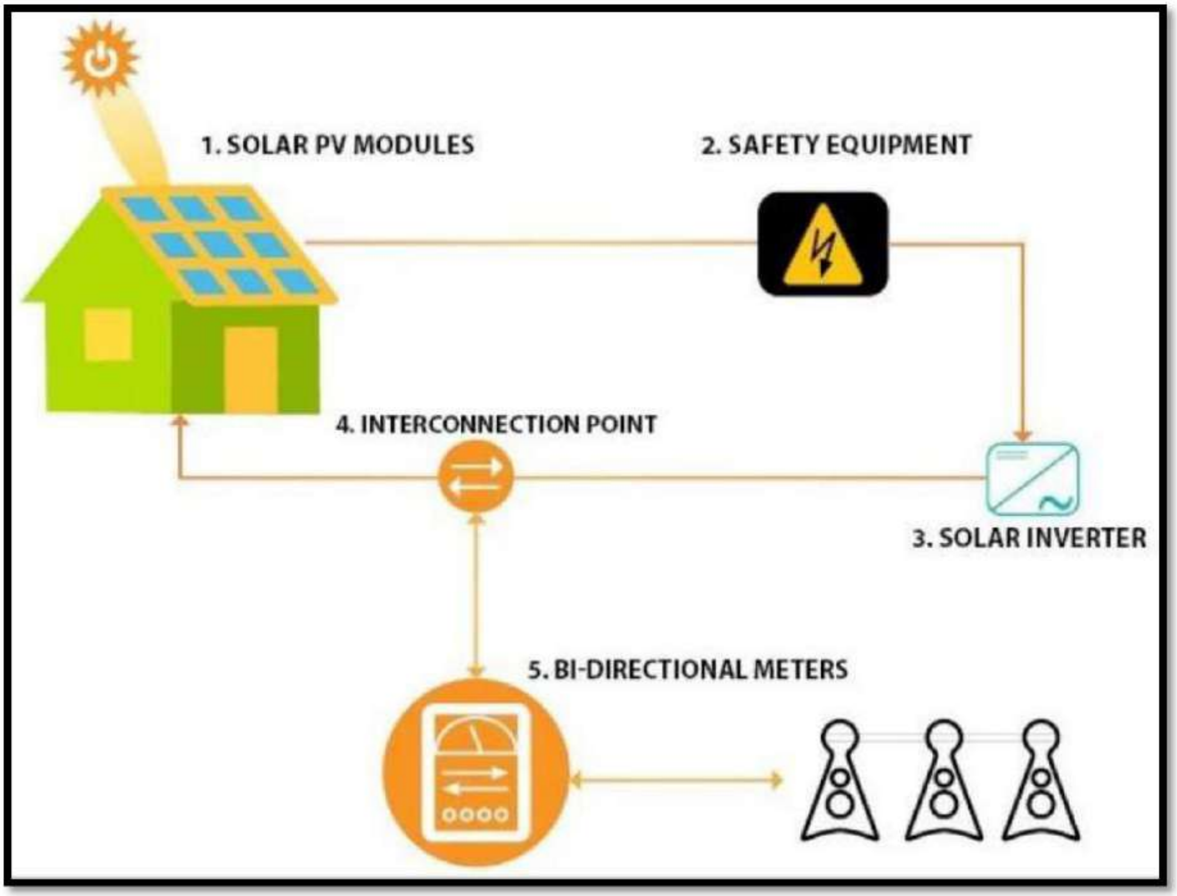


Figure 2.8: Harnessing Solar Power at JUWMBL

- Total estimated rooftop area available here in our case is approx. 5,860 m². The same, subjected to the usability factor, post the results of shadow and other relevant analysis later shall, may reduce to 3,500 m².
- This area could house, peak solar power installation of nearly 700 kWp, i.e., roughly 25% of the total unit auxiliary power demand and may thereafter would generate the annual electricity up to 1 MU's.
- It shall draw the capital investment to the tune of about ₹ 3.5 – 4.0 Cr.

2.17 ESTIMATED PROJECT COST

Estimated development cost of the project is Rs. 660.00 Crores.

The cost projections for the WTE project are listed in **Table 2.9.**

Table 2.9: Cost projections for the WTE project

S No.	Particulars	Capex including contingency
1	Civil & Structures	150.00 Crores
2	Processing Equipment's.	320.00 Crores
3	Utility, Electrical, Instrument, & Others	190.00 Crores
	Total	**660.00 Crores.**

2.18 PROPOSED SCHEDULE FOR APPROVAL AND IMPLEMENTATION

M/s Jindal Urban Waste Management (Bawana) Limited will initiate the Construction work for the project after grant of EC from MoEF&CC.

2.19 CORPORATE ENVIRONMENTAL POLICY

The Jindal Saw Company has a corporate Environment, Health and Safety policy which is duly approved by the board. The proposed project will be constructed by M/s Jindal Urban Waste Management (Bawana) Limited**,** a subsidiary of Jindal Saw. The corporate environment policy is given as **Annexure X.**

A separate EHS policy will be prepared for M/s Jindal Urban Waste Management (Bawana) Limited.

2.20 CORPORATE SOCIAL RESPONSIBILITY (CSR) POLICY

The proposed green field project will be implemented by M/s Jindal Urban Waste Management (Bawana) Limited, subsidiary company of Jindal Saw Limited. The Jindal Saw Limited is having a Corporate Social Responsibility (CSR) Policy **(Annexure XI)** and same will be adopted by M/s Jindal Urban Waste Management (Bawana) Limited. The Corporate Social Responsibility is strongly connected with the principles of sustainability. Therefore, it is the core corporate responsibility of Jindal SAW Limited to practice its corporate values through its commitment to grow in a socially and environmentally responsible way. The company is committed to undertake activities such as free medical check-up camps for nearby local population, Vocational training

(Skill Development) to women, local villagers &rag pickers on Developing packaging & other products from recyclables/reusable, Books/Stationary distribution in nearby schools, plantation of Medicinal and Fragrance Trees in Nearby Localities in the surrounding areas. The CSR activities will be dovetailed with government schemes. The CSR activities will be monitored by an independent cell comprising of higher officials after project completion.

2.21 Court Cases for the project

There is no court case against the proposed project.

2.22 VISION & CORE VALUES

Our Vision:

To be the most preferred and reliable provider of value in all our businesses.

Core Values:

- **Integrity**

  Conduct all business dealings along transparent lines.

- **Respect for Individual**

  Recognize individual's contribution in the growth and development of the Company. Treat all Jindalites with respect and dignity.

- **Dynamic Thinking**

  Demonstrate a winner's attitude with a crystal-clear focus to deliver sustained value for all Stakeholders.

- **Creativity & Innovation**

  Encourage creative experimentation, embrace new ideas and institutionalize continuous improvement in all aspects of business and performance.

- **Social Responsibility**

  Dedicate efforts to social and environmental issues to enrich the quality of life of the communities we serve.

CHAPTER 3. DESCRIPTION OF ENVIRONMENT

3.1 INTRODUCTION

This chapter presents baseline data which will help in better appreciation of various environmental and ecological attributes of the study area. The baseline status of the environment is described section wise for better understanding of the broad spectrum of environmental conditions.

Field monitoring studies to evaluate the baseline status of the project study area were carried out as per MoEF&CC and CPCB guidelines. Environmental data has been described with reference to proposed project site for following attributes:

a) Geology & Hydrogeology
b) Land Environment
c) Soil Environment
d) Water Environment
e) Air Environment
f) Noise Environment
g) Biological Environment
h) Socio-economic Environment

3.2 STUDY AREA

The study area comprises of project site and area in 10 km radius around the project site. (Figure 2.1, Chapter-2).

3.3 STUDY PERIOD

Baseline environmental data generation for environmental attributes was carried out from March, 2023 to May, 2023.

3.4 METHODOLOGY

The guiding factors for the present baseline study are the requirements laid down by the MoEF&CC guidelines as per the Environmental Impact Assessment notification, 2006.

The studies were conducted by considering the following:

- The various environmental attributes were divided into primary and secondary studies. Primary environmental attributes such as micro-meteorology, air, water, soil, noise, demographic and socio economic, flora and fauna were assessed by conducting field studies and on-site monitoring and review of the past studies conducted, for the purpose of comparison.

- Data and information for land use, geology, geo-hydrological and socio-economic environment have been collected from secondary sources such as various government publications and literature reviews.
- Site visits and reconnaissance survey of the study area were carried out for fixing the monitoring locations for the primary data collection. Various Government, Semi-Government departments were approached for getting information for the secondary data generation.

Sampling locations were decided based on the prominent wind direction along with considering the sensitive areas around the site. The brief description of methodology adopted are as follows:

* A meteorological station was installed at the project site.
* In order to assess the Ambient Air Quality (AAQ), samples of ambient air were collected by installation of Respirable Dust Sampler and Fine Particulate Sampler with gas samplers at different locations from the study area during study period and analyzed for primary air pollutants to assess the ambient air quality as per CPCB norms.
* Samples for ground water were collected during the study period from the existing hand-pumps, while surface water was collected from Western Yamuna Canal and nallah passing through the project site. Analysis was done for parameters to determine water quality as per standard methods for examination of water and wastewater.
* Samples for soil were collected and analyzed for relevant physical and chemical characteristics.
* The noise level measurements were made at 8 locations with the help of sound level meter to establish the baseline noise levels of study area.

Ecological and biological baseline was established through primary survey and secondary sources. Socio-economic data was collected from field studies and secondary sources like Census Book of India, 2011 etc.

3.5 PHYSIOGRAPHY OF THE STUDY AREA

The physiography of Delhi is dominated by the river Yamuna and the Aravalli range, and the plains in between, formed by alluvium deposits of recent formation. The Yamuna River and terminal part of the Aravalli hill range are the two main geographical features of the city. The Aravalli hill ranges are covered with forest and are called the Ridges. They are the city's lung space and help maintain its environment. The Delhi Ridge and its four sections, the northern, the central, the south central and the southern constitute the farthest extension of the Aravalli range.

Its spurs meet the Yamuna at two points, in the north and the east. This acts as barrier between the desert and the plains and slows down the movement of dust and wind from the desert. The natural forest of ridge has a moderating influence on temperature, besides bestowing other known benefits. The Yamuna River is a sacred river for most of the inhabitants and Delhi's source of drinking water.

The plain land is mostly fertile. The Yamuna River is the only perennial river in the area and is flowing in the North-East direction from the project site.

Source: *https://www.cgwb.gov.in/cgwbpnm/public/uploads/documents/1708414374816562110file.pdf*

3.6 TOPOGRAPHY

3.6.1 TOPOGRAPHY OF THE DELHI

Delhi is bounded by the Indo-Gangetic alluvial plains in the North and East and Aravalli hill ranges in the South. The terrain of Delhi is flat in general except for a low from North- Northeast to South-Southwest trending ridge. The project site elevation varies from 248 m to 236 m above mean sea level (msl) with gentle slope towards SE direction of the site.

Source:*https://www.cgwb.gov.in/cgwbpnm/public/uploads/documents/1708414374816562110file.pdf*

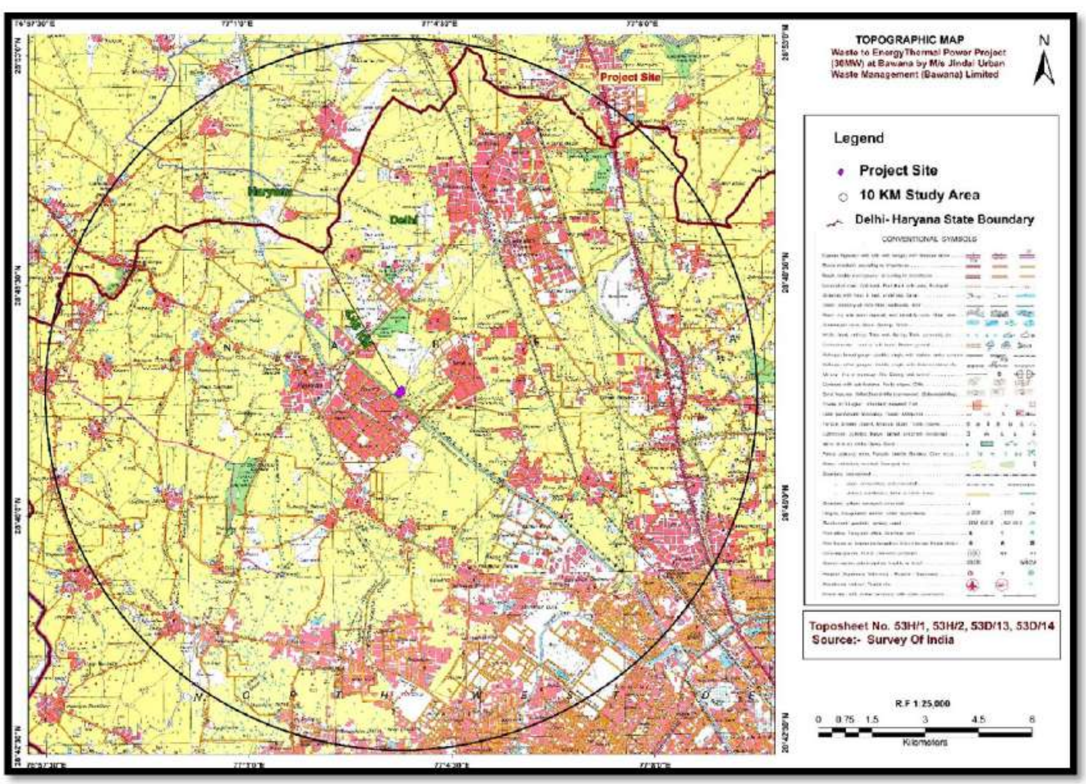


Figure 3.1: Topographic Map Study Area within 10km for Waste to Energy Plant, Bawana

3.6.2 GEOLOGY & HYDROGEOLOGY

3.6.2.1 GEOLOGY

The rock formations exposed in the National Capital Territory of Delhi are mainly quartzite Interbedded with thin bands of micaceous schist. These Proterozoic age rocks occur along the ridge, extending from Harchandpur (Haryana) in the South to Wazirabad (Delhi) in the North. Quaternary sediments consisting alluvium deposit directly overlie the Proterozoic rocks. Systematic geological and geomorphologic studies carried out by the Geologists of Geological Survey of India has revealed three Stratigraphic horizons and underlying three distinct litho-stratigraphic units of NCT Delhi. The highest of these is the erosional surface forming the top of denudational hills. The second surface is Older Alluvial plain and the third is depositional Younger Alluvial plain (Yamuna). All three litho stratigraphic units corresponding to them have undergone changes due to widespread and uncontrolled urban activity over the period.

(Source: *https://www.cgwb.gov.in/cgwbpnm/public/uploads/documents/1708414374816562110file.pdf)*

3.6.3 HYDROGEOLOGY (AQUIFERS)

The Stratigraphic Succession of Delhi are presented in **Table 3.1** and shown in **Figure. 3.2**.

Table 3.1: Stratigraphic Succession of Delhi

Period	Formation	Description
Alluvium	Newer Alluvium	Unconsolidated, inter-bedded lenses of sand, silt gravel and clay confined to narrow flood plains of Yamuna River and Aeolian deposit of South Delhi
	Older Alluvium	Unconsolidated thickness varies upto 300m. Interbedded, inter-Fingering deposits of sand, clay and kankar, poor to moderately sorted.
Delhi Super Group	Alwar Quartzite	Well stratified, thick bedded, brown to buff colour, hard and compact, intruded locally by pegmatite and quartz veins interbedded with mica schist.

(Source: https://www.cgwb.gov.in/cgwbpnm/public/uploads/documents/1708414374816562110file.pdf)

3.6.4 Aquifer details of Bawana area

Bawana's aquifer systems predominantly consist of shallow alluvial aquifers. These aquifers are essential in an area characterized by brackish water aquifers, serving as the primary source of drinking water for local communities. The hydrogeological setup includes unconfined to semi-confined aquifers, primarily composed of sand, silty sand, and kankar horizons. These geological formations influence groundwater occurrence, quality, and vulnerability to contamination. In the

National Capital Territory (NCT) of Delhi, the geological landscape, including Bawana, is shaped significantly by the Delhi Quartzite ridge, a critical recharge zone for the region's subsurface aquifer system. Predominantly comprised of Quaternary deposits, younger alluvial sediments merged with older alluvium, these formations constitute the principal repository of groundwater in the area. The varying thickness of unconsolidated sediments influence groundwater dynamics and recharge processes across the region.

(Source: https://www.cgwb.gov.in/cgwbpnm/public/uploads/documents/1708414374816562110file.pdf)

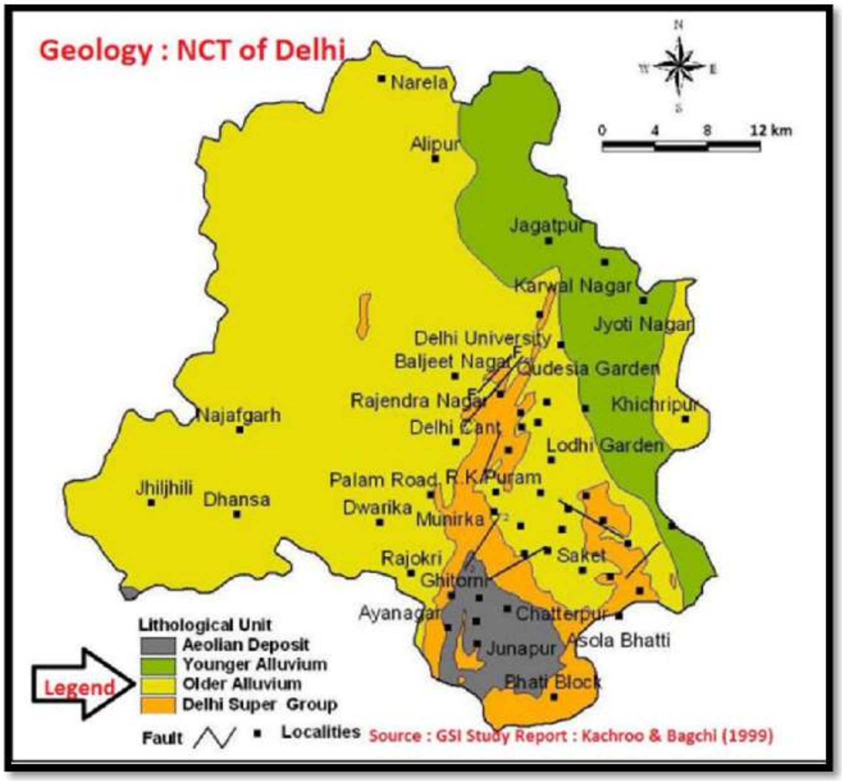


Figure 3.2:- Stratigraphic Succession of Delhi

3.7 DEPTH OF WATER LEVEL OF DELHI

The 10 km study area covers three different water level depth zone area: 0-5 mbgl (meter below ground level), 5-10 mbgl, and 10-20 mbgl. The exact location of the project falls under the 5-10 mbgl water level class. This strategic positioning allows for targeted interventions to manage and improve groundwater resources effectively. As this water level rises as per the season by 0-2 mbgl.

(Source: https://www.cgwb.gov.in/cgwbpnm/public/uploads/documents/1708414374816562110file.pdf)

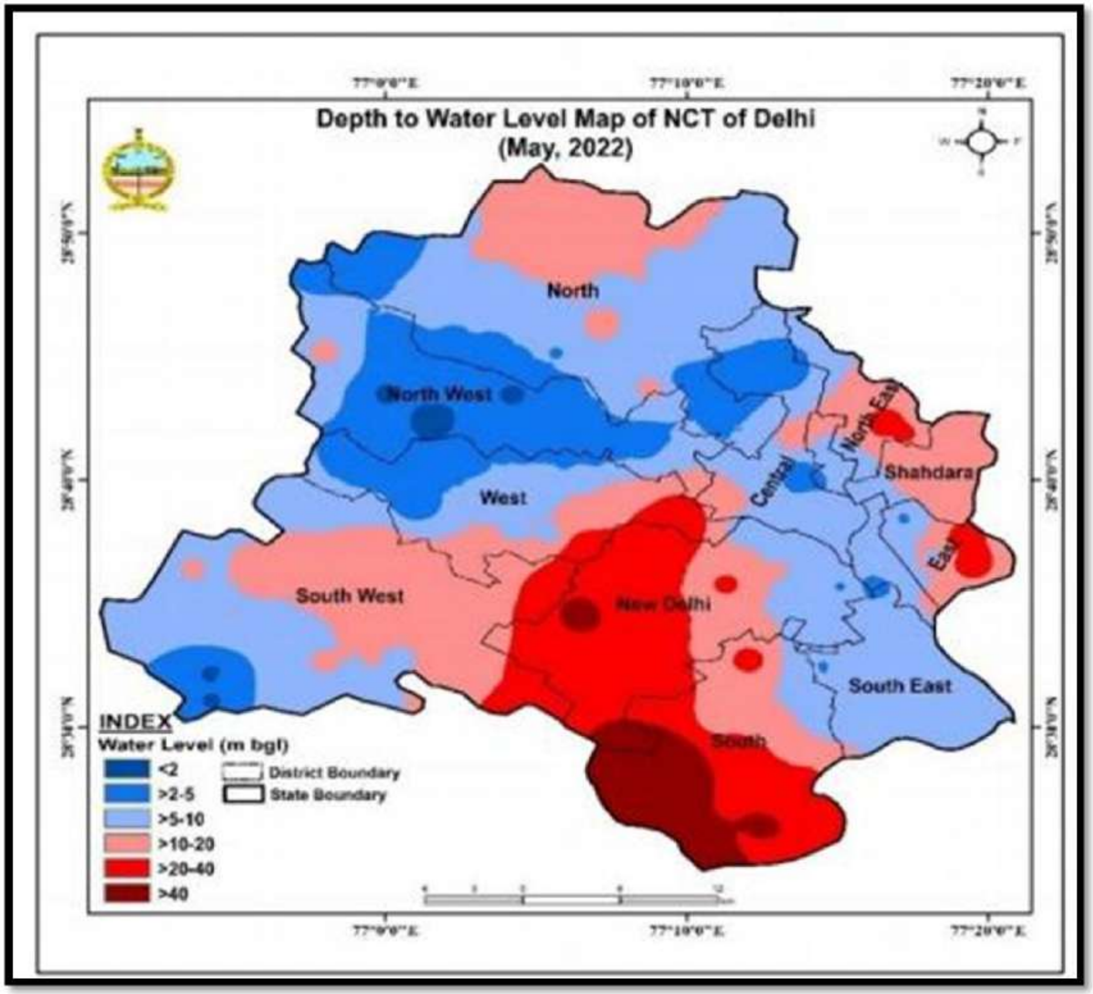


Figure 3.3:- Depth of water level of Delhi

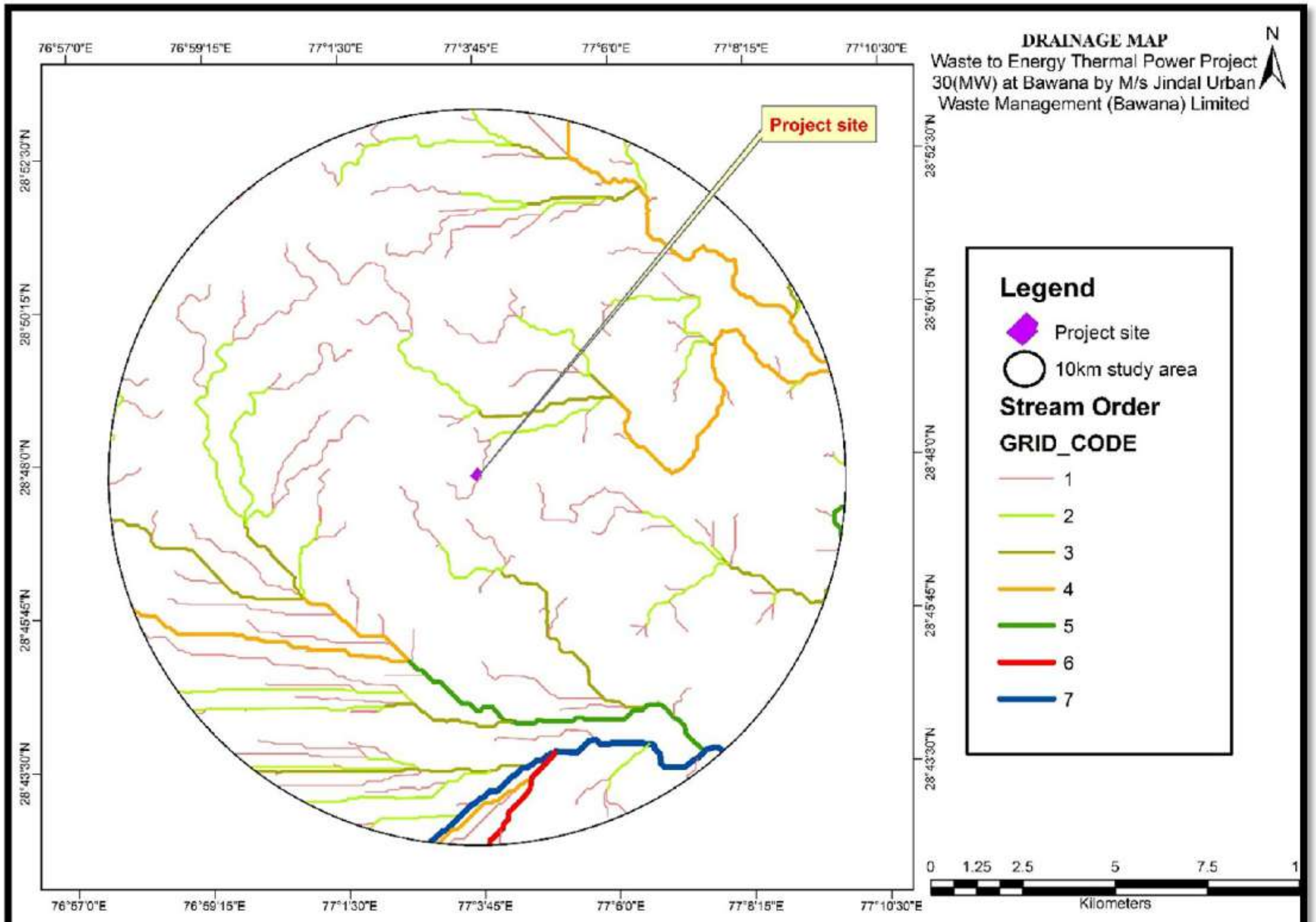


Figure 3.4: Drainage Pattern in the Study area

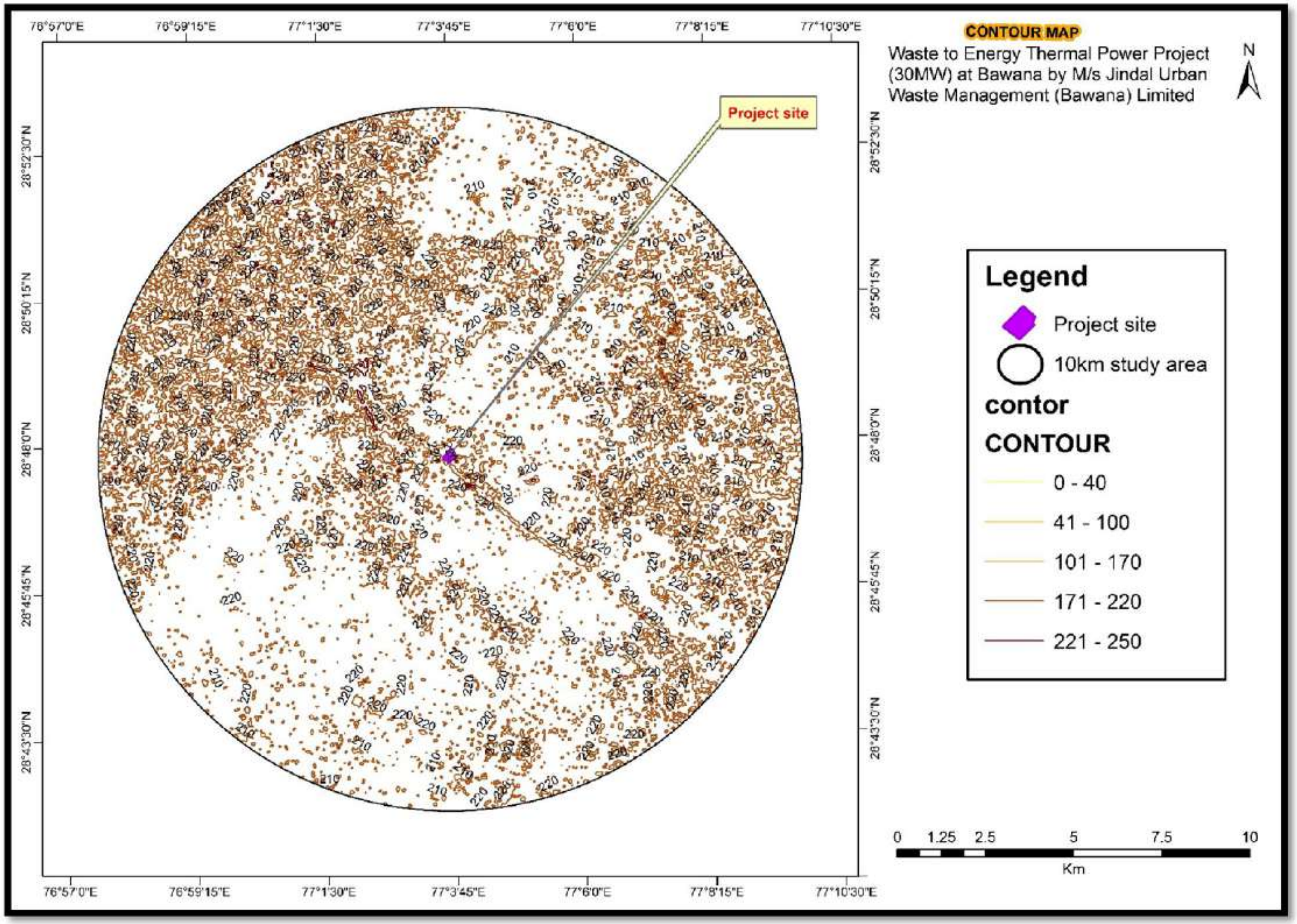


Figure 3.5: Contour Map of the Study Area

3.8 LAND-USE /LAND COVER PATTERN OF THE STUDY AREA

The Land use pattern based on satellite imagery are shown in **Figure 3.6** and **Table 3.2.**

Table 3.2: Landuse pattern based upon the Satellite imagery within 10 km radius

S. No.	Class Name	Area (Ha.)	Percentage
1	Agricultural Area	16977.593	53.208
2	Built-up	13375.821	41.92
3	Natural Vegetation	293.553	0.92
4	Water Body	220.803	0.692
5	Barren Land	1040.200	3.26
Total		**31907.97**	**100**

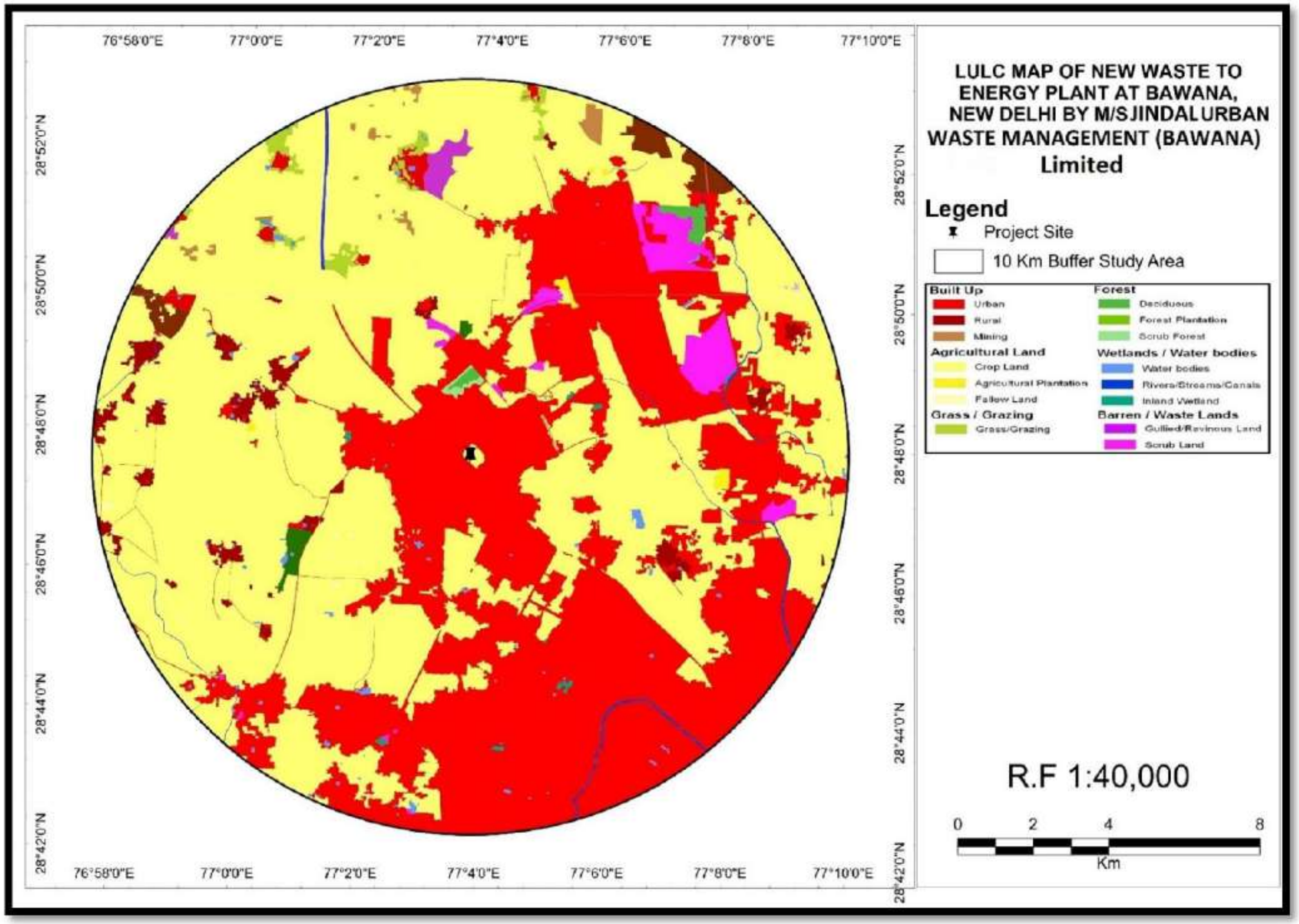


Figure 3.6: Landuse Map of 10 km Study Area

3.9 CLIMATE

The climate of NCT Delhi is mainly influenced by its inland position and the prevalence of air of the continental type during major part of the year. Extreme dryness with the intensely hot summer and cold winter are the characteristics of the climate. Only during the three-monsoon months July, August, and September does air of oceanic origin penetrate to this state and causes increased humidity, cloudiness, and precipitation. The year can broadly be divided into four seasons. The cold season starts in late November and extends up to the beginning of March. This is followed by the hot season, which lasts till the end of June when the monsoon arrives over the state. The monsoon continues to the last week of September. The post monsoon months October and November constitute a transition period from the monsoon to winter condition. The details of climatological data of IMD (Safdarjung) are given in **Table 3.3**.

(Source: *Government of India Ministry of Earth Sciences India Meteorological Department)*

Table 3.3: Details of Climatological Data of IMD (Safdarjung)

जलवायवी सारणी
CLIMATOLOGICAL TABLE

BACK

स्टेशन : नई दिल्ली (सफदरजंग) अक्षांश देशांतर समुद्री तल माध्य से ऊंचाई मीटर प्रक्षणों पर आधारित
STATION : New Delhi (Safdarjang) LAT. 28°35' LONG. 77°12' HEIGHT ABOVE M.S.L. 216 METRES BASED ON OBSERVATIONS 1971-2000

माह MONTH		स्टेशन का सतह दाब STATION LEVEL PRESSURE	वायु तापमान AIR TEMPERATURE — माध्य MEAN: शुष्क बल्ब DRY BULB	नम बल्ब WET BULB	दैनिक अधिकतम DAILY MAX	दैनिक न्यूनतम DAILY MIN	माह में उच्चतम HIGHEST IN THE MONTH	माह में निम्नतम LOWEST IN THE MONTH	चरम EXTREMES: उच्चतम HIGHEST	दिनांक और वर्ष DATE AND YEAR	निम्नतम LOWEST	दिनांक और वर्ष DATE AND YEAR	आर्द्रता HUMIDITY: सापेक्ष आर्द्रता RELATIVE HUMIDITY	वाष्प दाब VAPOUR PRESSURE	मेघ की मात्रा CLOUD AMOUNTS: समस्त मेघ ALL CLOUDS	निम्न मेघ LOW CLOUDS	वर्षा RAINFALL: मासिक योग MONTHLY TOTAL	वर्षा के दिनों की संख्या NO. OF RAINY DAYS	वर्षसहित सबसे नम महीने का योग TOTAL IN WETTEST MONTH WITH YEAR	वर्षसहित शुष्कतम महीने का योग TOTAL IN DRIEST MONTH WITH YEAR	24 घंटों में सबसे भारी वर्षा HEAVIEST FALL IN 24 HOURS	दिनांक और वर्ष DATE AND YEAR	माध्य पवन गति MEAN WIND SPEED
		एच.पी.ए hPa	डि. से °C	डि. से °C	डि. से °C	डि. से °C	डि. से °C	डि. से °C	डि. से °C		डि. से °C		प्रतिशत %	एच.पी.ए hPa	आकाश के अष्टमांश Oktas of sky		मि.मि. mm		मि.मि. mm	मि.मि. mm	मि.मि. mm		कि.मी. प्र. घं. Kmph
जनवरी JAN	I	992.2	9.7	8.1	20.8	7.6	25.3	4.2	30.0	29	-0.6	16	80	9.8	2.7	1.1	20.8	1.4	173.2	0.0	116.8	28	7.3
	II	989.9	18.7	12.8						1991		1935	47	10.2	2.5	0.7			1885			1885	
फरवरी FEB	I	990.1	12.7	10.4	23.6	10.2	29.0	5.6	33.9	17	1.6	9	74	11.0	2.3	0.8	19.7	1.6	153.4	0.0	104.1	21	8.6
	II	987.7	21.8	14.3						1993		1982	39	10.3	2.6	0.7			1915			1942	
मार्च MAR	I	987.3	18.9	14.8	29.2	15.3	35.0	10.1	40.6	31	4.4	6	62	13.6	2.3	0.5	13.5	1.4	78.2	0.0	62.2	11	9.6
	II	984.7	27.4	17.3						1945		1945	33	11.8	2.9	0.8			1915			1915	
अप्रैल APR	I	983.2	26.2	18.3	36.0	21.3	40.9	15.9	45.6	29	10.7	2	44	14.8	1.7	0.4	11.4	1.3	183.5	0.0	134.0	16	9.7
	II	979.7	34.6	20.1						1941		1965	22	11.8	2.3	0.8			1983			1983	
मई MAY	I	979.3	30.6	21.1	39.5	25.9	43.4	21.1	47.2	29	15.2	2	41	17.6	1.4	0.4	22.7	1.8	75.4	0.0	60.0	24	10.3
	II	975.5	37.9	22.4						1944		1969	23	14.6	2.1	1.1			1982			1976	
जून JUN	I	975.4	31.4	24.2	39.0	27.9	43.8	22.4	46.7	17	18.9	23	55	24.6	2.6	1.2	77.4	4.4	414.8	0.0	235.5	28	10.5
	II	971.7	36.9	25.0						1945		1932	38	22.1	3.0	1.8			1936			1936	
जुलाई JUL	I	974.9	29.4	25.9	34.9	27.0	39.5	23.6	45.0	1	20.3	1	75	30.6	5.1	2.9	214.2	10.5	538.2	4.1	266.2	21	8.6
	II	971.9	32.6	26.7						1931		1986	63	30.1	5.5	3.3			1964	1941		1958	
अगस्त AUG	I	976.9	28.5	25.7	33.6	26.4	37.2	23.7	42.0	12	21.2	23	79	30.7	5.1	2.9	253.4	10.9	583.3	0.0	184.0	2	7.7
	II	974.0	31.6	26.5						1987		1965	67	30.5	5.5	3.3			1961			1961	
सितम्बर SEP	I	981.5	27.5	23.9	34.1	24.8	37.0	21.7	40.6	16	17.3	26	72	26.8	2.8	1.5	120.9	4.9	492.3	0.0	176.5	16	7.7
	II	978.3	32.0	24.8						1938		1964	55	25.6	3.1	2.1			1900			1904	
अक्तूबर OCT	I	987.0	23.3	19.0	32.9	19.4	36.0	15.0	39.4	17	9.4	31	65	18.8	1.0	0.4	17.3	1.2	238.3	0.0	172.7	1	5.0
	II	984.0	30.0	20.9						1951		1937	42	17.6	1.2	0.6			1954			1954	
नवम्बर NOV	I	990.9	16.6	13.5	28.2	13.0	32.1	9.0	35.0	1	3.9	28	69	13.2	0.9	0.2	3.7	0.4	100.1	0.0	93.4	27	4.9
	II	988.1	24.4	17.0						1999		1938	44	13.5	1.1	0.3			1972			1972	
दिसम्बर DEC	I	992.9	10.9	9.0	22.9	8.4	26.8	4.9	29.3	3	1.1	26	77	10.1	2.1	0.7	9.4	1.1	134.4	0.0	75.7	3	6.0
	II	990.5	19.5	13.8						1987		1945	50	11.3	1.9	0.3			1884			1923	
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	984.3	22.1	17.8	31.2	18.9	44.2	3.5	47.2	29	-0.6	16	66	18.5	2.5	1.1	784.4	41.1	1533.1	262.9	266.2	21	8.0
	II	981.3	29.0	20.1					5	1944	1	1935	44	17.5	2.8	1.3			1933	1929	7	1958	
वर्षों की संख्या NUMBER OF YEARS	I II	30	30	30	30	30	30	30	100		100		30	30	30	30	29	29	99	99	99		30

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जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : नई दिल्ली (सफदरजंग)
STAION : New Delhi (Safdarjang)

Weather Phenomena (No. of days with) and Wind (No. of days with wind speed, Km. p. h.)

Month		PPT 0.3 mm or more	Hail	Thunder	Fog	Dust storm	Squall	62 or more	20-61	1-19	0
जनवरी JAN	I	2.5	0.2	1.5	12.1	0.1	0.1	0	0	22	9
	II							0	1	27	3
फरवरी FEB	I	3.2	0.2	2.4	5.0	0.1	0.1	0	1	21	6
	II							0	3	24	1
मार्च MAR	I	3.4	0.3	3.5	1.4	0.1	1.0	0	1	25	5
	II							0	6	24	1
अप्रैल APR	I	2.3	0.1	2.9	0.0	0.7	1.6	0	2	25	3
	II							0	4	24	2
मई MAY	I	3.5	0.2	5.1	0.0	2.2	2.9	0	3	24	4
	II							0	4	23	4
जून JUN	I	6.5	0.2	6.3	0.0	1.6	1.9	0	4	23	3
	II							0	2	24	4
जुलाई JUL	I	14.7	0.2	8.7	0.1	0.2	1.9	0	3	24	4
	II							0	2	24	5
अगस्त AUG	I	13.9	0.1	7.7	0.1	0.0	0.8	0	3	23	5
	II							0	1	24	6
सितम्बर SEP	I	6.6	0.0	3.6	0.2	0.1	0.9	0	2	22	6
	II							0	1	24	5
अक्तूबर OCT	I	2.1	0.1	1.3	1.5	0.2	0.5	0	0	21	10
	II							0	0	22	9
नवम्बर NOV	I	0.8	0.0	0.5	4.6	0.0	0.1	0	0	19	11
	II							0	0	18	12
दिसम्बर DEC	I	1.5	0.0	0.7	11.2	0.0	0.0	0	0	20	11
	II							0	0	22	9
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	60.9	1.6	44.3	36.2	5.2	11.8	0	18	270	77
	II							0	25	280	60
वर्षों की संख्या NUMBER OF YEARS	I, II	30						30			

Wind – Percentage No. of days wind from

Month		N	NE	E	SE	S	SW	W	NW	CALM
JAN	I	1	2	5	5	2	6	31	18	30
	II	12	4	9	8	2	0	11	44	10
FEB	I	2	2	5	7	3	7	31	22	21
	II	13	5	8	9	3	1	10	47	4
MAR	I	4	3	6	7	4	6	29	26	15
	II	16	7	8	7	2	2	6	49	3
APR	I	5	3	7	7	4	9	28	26	11
	II	18	6	7	4	1	2	9	47	6
MAY	I	4	2	14	13	4	7	27	17	12
	II	13	7	9	5	1	3	9	40	13
JUN	I	3	4	15	17	5	6	22	16	12
	II	11	10	15	9	3	3	11	25	13
JUL	I	2	2	23	20	6	5	17	11	14
	II	7	7	22	14	5	6	7	17	15
AUG	I	2	4	19	15	5	6	22	11	16
	II	8	7	20	11	3	5	8	19	19
SEP	I	2	3	15	11	3	5	26	16	19
	II	15	8	13	8	2	2	6	29	17
OCT	I	3	2	8	8	2	6	25	14	32
	II	22	8	8	3	1	1	2	26	29
NOV	I	1	1	4	3	1	8	31	12	39
	II	13	4	5	2	1	1	6	29	39
DEC	I	1	1	2	4	1	6	34	15	36
	II	10	3	4	5	1	1	10	36	30
ANNUAL TOTAL OR MEAN	I	2	2	10	10	3	6	29	17	21
	II	13	6	11	7	2	2	8	34	17
NUMBER OF YEARS	I, II	30								

Cloud (Oktas) and Visibility

Month		All clouds 0	All clouds T-2	All clouds 3-5	All clouds 6-7	All clouds 8	Low cloud 0	Low cloud T-2	Low cloud 3-5	Low cloud 6-7	Low cloud 8	FOG 8	Visibility up to 1 Km.	1-4 Kms.	4-10 Kms.	10-20 Kms.	Over 20 Kms.
JAN	I	14	5	5	4	3	22	3	3	1	2	0	10.2	16.8	4.0	0.0	0.0
	II	11	8	6	5	1	23	3	4	1	0	0	1.3	11.3	18.1	0.2	0.0
FEB	I	12	5	5	4	2	21	3	3	0	1	0	3.9	16.5	7.5	0.1	0.0
	II	10	6	6	5	1	20	5	3	0	0	0	0.1	5.7	20.0	2.2	0.0
MAR	I	11	7	7	5	1	25	3	3	0	0	0	0.9	15.9	14.1	0.0	0.0
	II	9	7	8	6	1	20	6	4	1	0	0	0.0	3.1	23.9	3.9	0.0
APR	I	15	7	5	3	0	26	2	2	0	0	0	0.2	11.8	17.7	0.3	0.0
	II	11	7	7	4	1	19	7	4	0	0	0	0.0	2.7	23.3	4.0	0.0
MAY	I	18	6	4	2	1	26	3	2	0	0	0	0.2	11.0	19.6	0.2	0.0
	II	14	7	5	4	1	18	7	5	1	0	0	0.2	5.3	24.0	1.5	0.0
JUN	I	13	5	5	5	2	19	4	6	1	0	0	0.5	10.5	18.8	0.2	0.0
	II	7	7	8	6	2	11	9	9	1	0	0	0.1	8.1	20.3	1.4	0.0
JUL	I	3	4	6	11	7	7	6	14	4	0	0	0.2	8.6	21.5	0.7	0.0
	II	1	3	8	14	5	2	7	20	2	0	0	0.0	7.4	21.9	1.6	0.0
AUG	I	2	4	8	11	6	7	7	13	4	0	0	0.0	8.8	21.3	0.9	0.0
	II	0	3	9	15	4	1	8	19	3	0	0	0.1	6.2	22.9	1.8	0.0
SEP	I	12	6	5	5	2	16	5	7	2	0	0	0.0	9.3	19.2	1.5	0.0
	II	6	10	7	6	1	8	11	10	1	0	0	0.1	4.9	22.4	2.6	0.0
OCT	I	22	4	2	2	1	27	2	2	0	0	0	1.0	17.2	12.5	0.3	0.0
	II	21	5	3	2	0	23	5	3	0	0	0	0.3	9.8	20.3	0.6	0.0
NOV	I	21	4	2	2	1	28	1	1	0	0	0	4.0	19.6	6.5	0.0	0.0
	II	19	6	3	2	0	27	2	1	0	0	0	0.6	15.1	14.2	0.0	0.0
DEC	I	15	6	5	3	2	26	1	2	0	2	0	9.2	16.6	5.1	0.0	0.0
	II	13	8	6	3	1	27	2	2	0	0	0	1.9	15.9	13.2	0.0	0.0
ANNUAL TOTAL OR MEAN	I	162	61	58	57	27	249	40	58	13	5	0	30.2	161.3	169.2	4.2	0.0
	II	124	75	74	74	18	200	72	83	10	0	0	4.7	95.1	245.4	19.8	0.0
NUMBER OF YEARS	I, II	30					30						30				

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The mean maximum annual temperature is 44.2°C and lowest mean temp is 3.5°C. The average annual mean humidity is 64 %. The mean maximum wind Speed is 25km/h and the mean minimum wind speed is 18km/h. The Maximum relative humidity is 66% and the minimum relative humidity is 18.5%.

3.10 METEOROLOGY OF THE SITE

A weather station was installed at the site for monthly monitoring of temperature, wind velocity, etc. to collect meteorological data. **Table 3.4** gives summarized monitored meteorological data of the project site. **Figure 3.7** depicts the wind-rose diagram based on monitoring data.

Table 3.4: Summarized Monitored Meteorological Data

Month	Wind Speed (m/s)		Temperature ^{0}C		Relative Humidity (%)	
	Max	Min	Max	Min	Max	Min
March	10.41	0.01	32.35	12.65	100	21
April	6.04	0.03	38.35	12.95	99	12
May	8.82	0.01	41.85	17.05	97	13
Range	0.01-10.41		12.65-41.85		12-100	

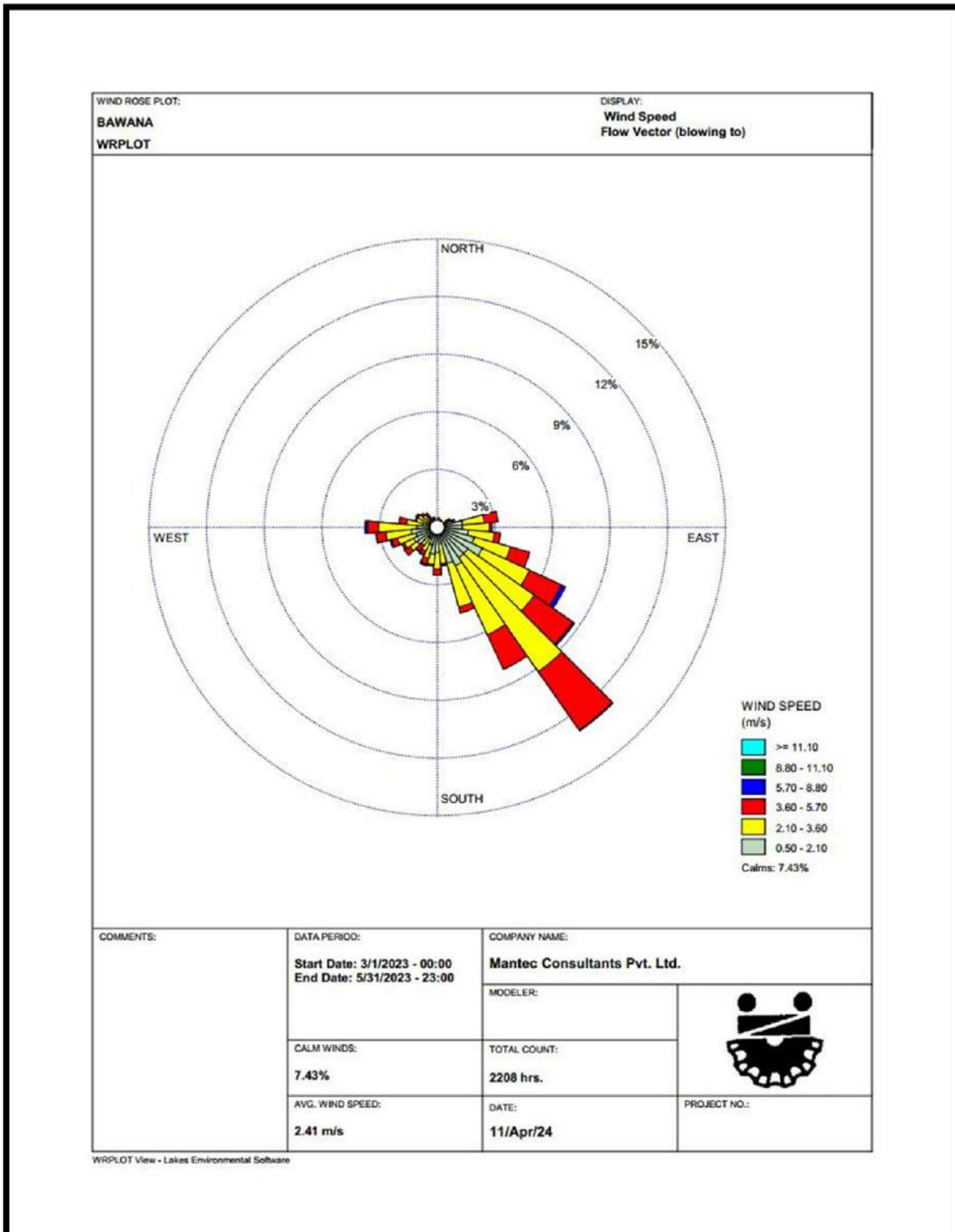

Figure 3.7: Wind-Rose Diagram of Project Site

3.11 NOISE ENVIRONMENT

Noise levels were recorded during the day and night time to compute the equivalent noise levels. The noise level was recorded continuously for 24 hours at an interval of 1 hour. The noise level was monitored once during the study period at each monitoring location. The noise level was recorded in dB (A).

3.11.1 Instrument used for sampling

Automated sound level meter (SLM 100) was used for measuring the noise level.

3.11.2 Ambient noise standard

Ministry of Environment & Forests & Climate Change (MoEF&CC) has notified the noise standards vide. Gazette notification dated February 14, 2000, for different zones under the Environment Protection Act (1986). These standards are given in **Table 3.5.**

Table 3.5: Ambient Noise Quality Standards

Area Code	Category of Area	Noise dB(A) L_{eq}	
		Day time*	Night time*
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

**Note: Daytime is from 6.00am to 10.00 pm and Nighttime is from 10.00 pm to 6.00 am*

3.11.3 Sampling Locations

Noise monitoring was carried out at 8 locations near residential areas, industrial areas and silence zone located within 10 km radius in the study area. Details of monitoring locations & Noise Monitoring Photographs are given in **Table 3.6** & **Figure 3.8 & Figure 3.9.**

Table 3.6: Ambient Noise sampling locations

Sr. No	Sampling Location	Land Use Type	Distance from Site	Direction from Site	Latitude	Longitude
NQ 1	Near TamilNadu Waste Management Limited Sector 5 Bawana, Delhi	Industrial Area	0.51km	NE	28°47'50.216" N	77° 4' 1.206" E
NQ 2	Near CISF camp Rohini sector 34 Delhi	Residential Area	2.42km	SE	28° 46' 41.414" N	77° 4' 37.345" E
NQ 3	Near Vaishno Devi Mandir Khera Kalan, Delhi	Residential Area	5.73km	SE	28° 46' 26.866" N	77° 6' 55.200" E
NQ 4	Near Brilliant Tution Centre, Mahatma Gandhi Chowk Sonipat	Residential Area	4.1km	NW	28° 49' 48.036" N	77° 2' 54.922" E
NQ 5	Near Park, DSIIDC Industrial Area, Sector 1, Bawana	Industrial Area	2.02km	SW	28° 47' 6.543" N	77° 2' 43.355" E
NQ 6	Near Jai Kuber Plast Co Polymers DSIDC Industrial Area, Narela	Industrial Area	5.27km	NE	28° 49' 36.151" N	77° 6' 8.860" E
NQ 7	Shri Balaji Mandir Sec-11 Rohni, Delhi	Residential Area	8.62km	SE	28° 43' 45.877" N	77° 6' 34.745" E
NQ 8	Near Government Animal Hospital Ferozpur Bangar Village Haryana	Silence Zone	8.61km	NW	28° 49' 44.007" N	76° 58' 58.095" E

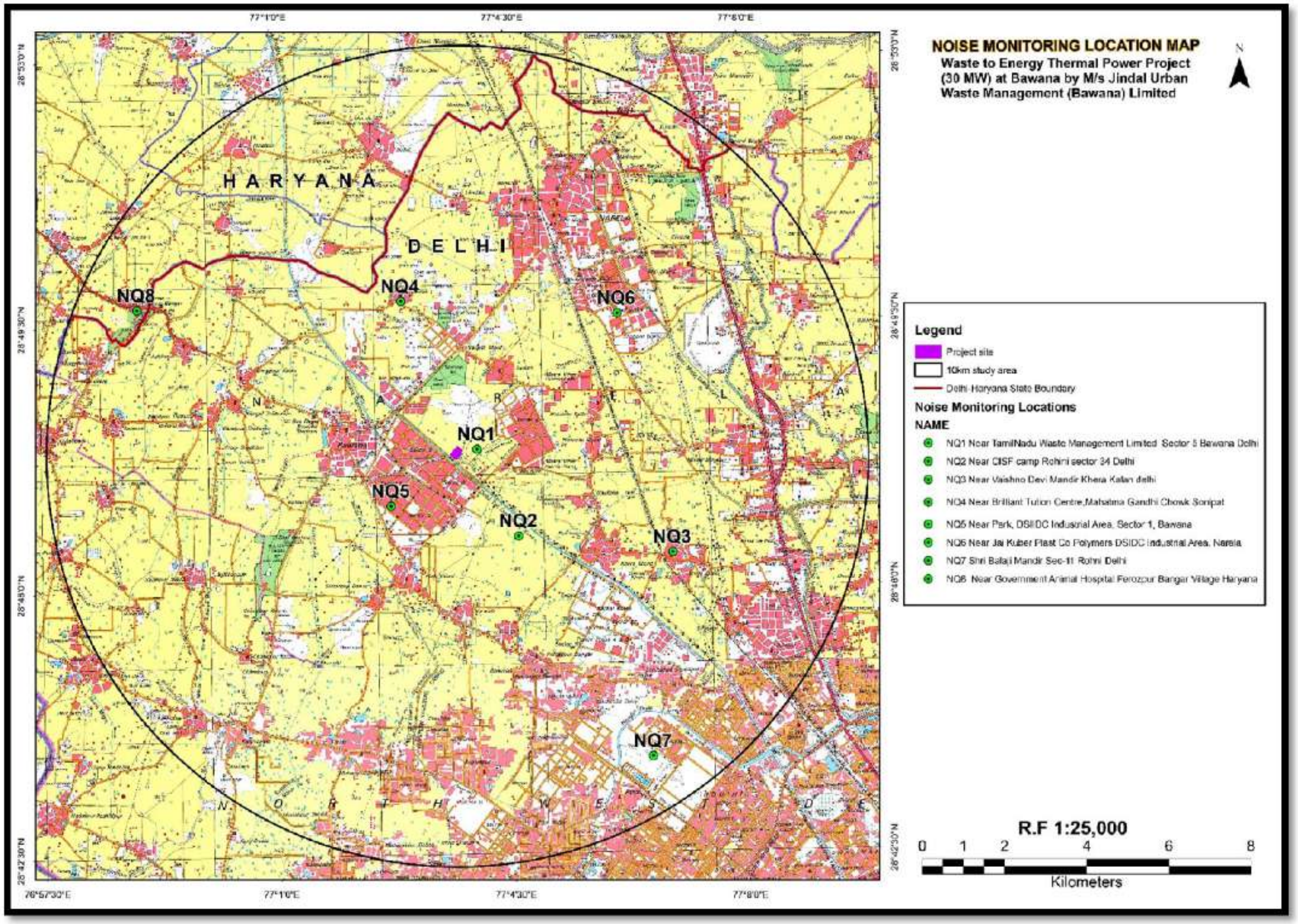

Figure 3.8:- Map Showing Ambient Noise Monitoring Stations


Delhi, Delhi, India
Google


GPS Map Camera
Ghoga, Delhi, India
R2JX+FM8, Ghoga, Delhi 110039, India
Lat 28.831167°
Long 77.048981°
28/04/23 01:40 PM GMT +05:30
Google


Delhi, Delhi, India
G8 pkt 3 narela, near j j colony, Sector 5, Bawana,
Delhi, 110040, India
Lat 28.798402°
Long 77.062143°
30/03/23 01:48 PM GMT +05:30
Google


Delhi, Delhi, India
G8 pkt 3 narela, near j j colony, Sector 5, Bawana,
Delhi, 110040, India
Lat 28.798536°
Long 77.062159°
30/03/23 01:50 PM GMT +05:30
Google

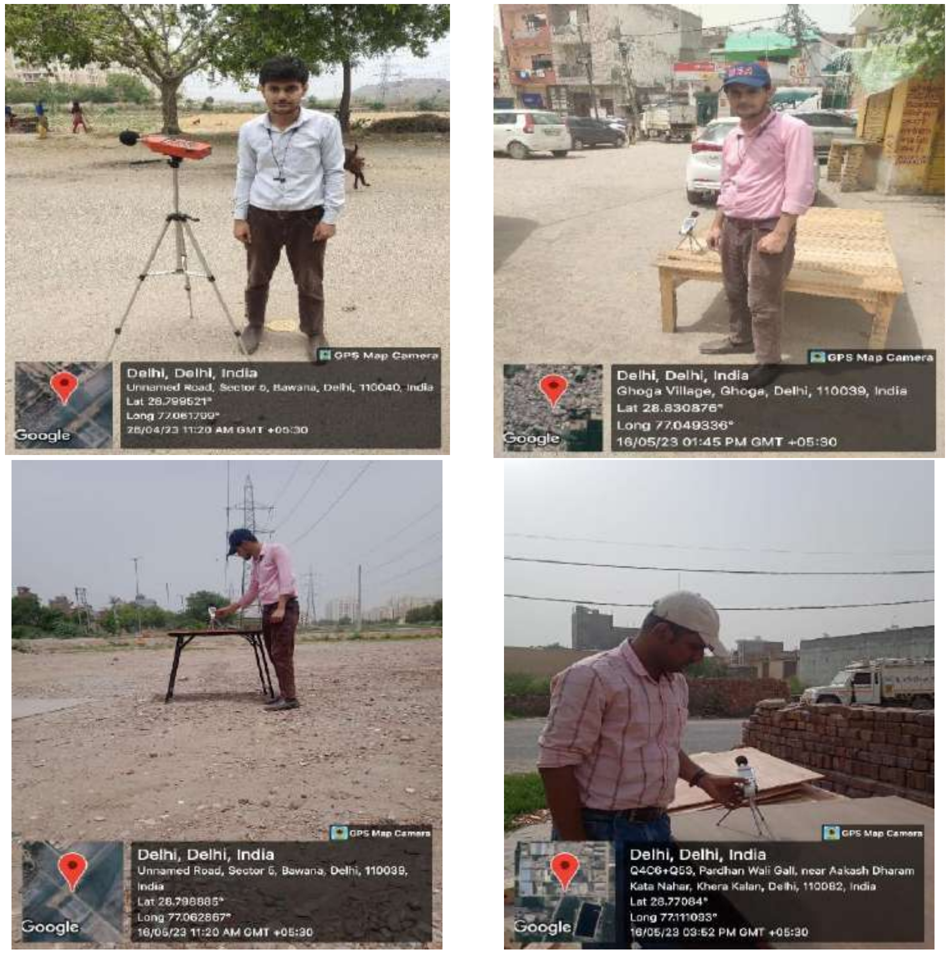

Figure 3.9:- Noise Monitoring Photographs

3.11.4 Interpretation

All measured noise levels at various locations are given **Table 3.7**. National Ambient Air Quality Standards (NAAQS) for noise.

Table 3.7: Noise Quality Data

Sr. No.	Sampling Locations	Standards of Noise Level			Measured Noise Level db(A)	
	Location	Category of Area	Day dB (A)	Night dB (A)	Day (L_d)	Night (L_n)
NQ 1	Near Tamil Nadu Waste Management Limited Sector- 5 Bawana, Delhi	Industrial	75	70	54.8	42.6
NQ 2	Near CISF Camp Rohini Sector-34, Delhi	Residential	55	45	42.6	39.2
NQ 3	Near Vaishno Devi Mandir Khera Kalan, Delhi	Silence Zone	50	40	45.2	36.8
NQ 4	Near Brilliant Tuition Centre, Mahatma Gandhi Chowk, Sonipat	Commercial	65	55	50.4	40.5
NQ 5	Near Park, DSIIDC Industrial Area, Sector 1, Bawana	Industrial	75	70	52.6	41.5
NQ 6	Near Jai Kuber Plast Co Polymers DSIDC Industrial Area, Narela	Industrial	75	70	46.5	40.6
NQ 7	Near Shri Balaji Mandir Sec-11, Rohini	Silence Zone	50	40	43.8	37.8
NQ 8	Near Government Animal Hospital Ferozpur Bangar Village, Haryana.	Silence Zone	50	40	46.5	36.2

The noise levels at a project site are discussed in relation to daytime and nighttime measurements. Daytime noise ranges from 42.6 to 54.8 decibels (dB), while nighttime noise falls between 36.2 to 42.6 dB. The higher daytime levels are attributed to construction operations and vehicular activities, which are more active during the day. Conversely, nighttime noise is lower due to reduced activity during those hours.

3.12 WATER ENVIRONMENT

3.12.1 Frequency and Parameters

Water samples were collected once during the study period and analyzed for selected physio-chemical and biological parameters. Water Quality Criteria as per Central Pollution Control Board is given in **Table 3.8.**

Table 3.8: Water Quality Criteria as per Central Pollution Control Board

Designated-best-use	Class	Criteria
Drinking water source without conventional treatment but after disinfection	A	Total Coliform Organism MPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6mg/l or more Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organized)	B	Total Coliform Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5; Dissolved Oxygen 5mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	Total Coliform Organism MPN/100ml shall be 5000 or less pH between 6 to 9; Dissolved Oxygen 4mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wildlife and Fisheries	D	pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH between 6.0 to 8.5 Electrical Conductivity at 25°C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/l
	Below-E	Not Meeting A, B, C, D & E Criteria

3.12.2 Sampling and Analysis Technique

The parameters like pH, temperature and DO were analyzed at the site, whereas other parameters were analyzed in the laboratory after preserving the samples. All the parameters were analyzed as per Standard Methods for the Examination of Water and Wastewater.

3.12.3 Sampling Locations for 10km study area

Water sampling was carried out at 16 locations, 8 for Ground water and 8 for Surface water. Details of monitoring locations of 10 Km study area are given in **Table 3.9** and exhibited in **Figure 3.10.**

Table 3.9: Water sampling locations for 10 km Study area

Sr. No.	Location	Land Use Type	Distance	Direction	Latitude	Longitude
GW1	Near Sanskar public school Swatantra Nagar, Narela, Delhi	Residential Area	5.41km	NE	28° 50' 30.029" N	77° 4' 47.896" E
GW2	Near Bawana 5 CNG Pump Sector-5 Holambi Khurd, Delhi	Industrial Area	1.33km	NE	28° 48' 13.504" N	77° 4' 20.400" E
GW3	Near IOCL Coco Bawana sec 3 - Petrol Pump Puth Khurd, Delhi	Industrial Area	1.82km	SW	28° 47' 2.753" N	77° 2' 55.486" E
GW4	MCD Primary school Sector-24, Rohini, Delhi	Residential Area	8.65km	SE	28° 43' 19.761" N	77° 5' 40.384" E
GW5	M.C.D. BOYS PRIMARY SCHOOL KANJHAWALA	Residential Area	8.66km	SW	28° 44' 11.002" N	77° 0' 13.727" E
GW6	Near Rajiv Gandhi Stadium Bawana Village, Delhi	Residential Area	3.17km	NW	28° 48' 7.056" N	77° 1' 49.773" E
GW7	Near Lord Shiv Temple Alipur, New Delhi	Residential Area	7.19km	NE	28° 47' 56.946" N	77° 8' 7.047" E
GW8	Near G. D convent school Khera Khurd, Delhi	Residential Area	3.97km	SE	28° 46' 35.890" N	77° 5' 46.881" E

Sr. No.	Location	Land Use Type	Distance	Direction	Latitude	Longitude
SW1	Near Deen Dayal Upadhyay Park Prahladpur, Rohini Delhi	Pond	6.37km	SE	28° 44' 33.640" N	77° 5' 14.399" E
SW2	Near Hanuman mandir Begam Vihar, Sector 33 Delhi	Pond	6.80km	S	28° 44' 5.829" N	77° 4' 15.580" E
SW3	Near Shiv Mandir, Khera Kalan Village, Delhi	Pond	6.27km	SE	28° 46' 14.245" N	77° 7' 10.798" E
SW4	Near Icon Tech Machinery Pvt Ltd Bawana Industrial Area Delhi	Western Yamuna Canal	1.19km	NE	28° 48' 20.092" N	77° 3' 59.620" E
SW5	Near Bharat Plastic DSIIDC Industrial Area, Sector 4, Bawana	Nallah	0.31km	SW	28°47'39.12"N	77° 3'41.34"E
SW6	Near Madarsa shamsul huda, Bawana, Delhi	Western Yamuna Canal	1.41km	NW	28° 48' 11.565" N	77° 3' 1.073" E
SW7	Near Delhi Jal Board Iradat Nagar, Delhi	Western Yamuna Canal	1.78km	SE	28° 47' 2.212" N	77° 4' 30.457" E
SW8	Near Dada Maldev Sports Ground Darayapur Kalan Village, Delhi	Pond	5.35km	NW	28° 49' 4.265" N	77° 0' 48.733" E

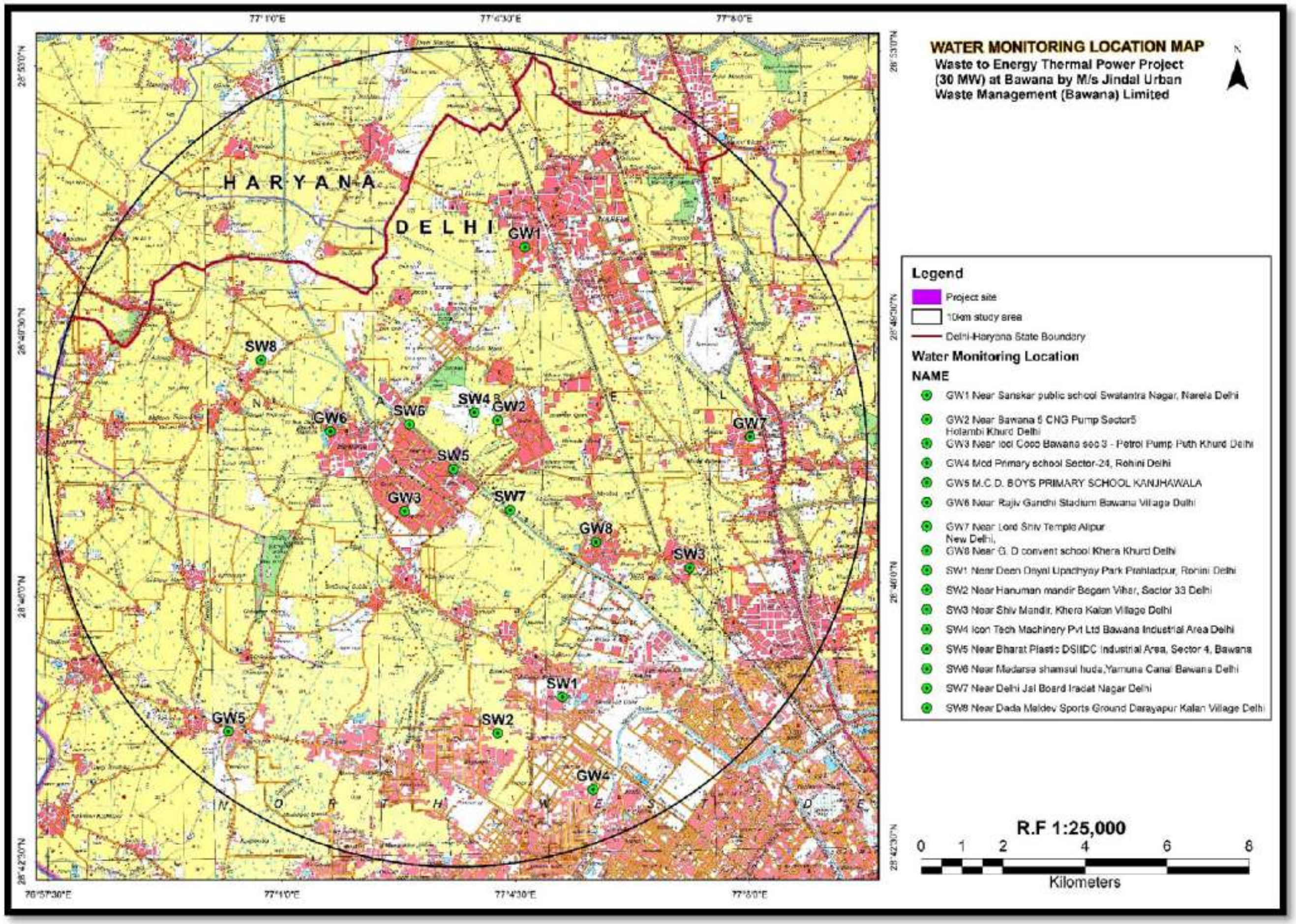

Figure 3.10:- Ground Water & Surface Water Sampling Stations

3.12.3.1 Results and Interpretation of Ground water Quality

The monitored results of ground water samples have been depicted in **Table 3.10.**

Table 3.10: Ground Water Results

Locations					GW1	GW2	GW3	GW4	GW-5	GW6	GW7	GW8
SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement	Near Sanskar Public School Swatantra Nagar, Narela delhi	Near Bawana 5 CNG Pump sector 5 Holambi Khurd Delhi	Near IOCL CoCo Bawana Sec 3 -Petrol Pump Puth Khurd Khedi Delhi	MCD Primary School Sec. 24 Rohini	MCD Boys Primary School Kanjhawala	Near Rajiv Gandhi Stadium Bawana Village Delhi	Near Lord Shiv Temple Alipur New Delhi	Near G.D Convent School Khera Khurd Delhi
1	Colour	5	15	Hazen Units	<5	<5	<5	<5	<5	<5	<5	<5
2	Odour	Agreeable	Agreeable	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Taste	Agreeable	Agreeable	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	pH	-	-	-	6.94	7.11	7.44	7.58	7.36	7.28	7.45	7.35
5	Temperature	-	-	°C	21	20	22	20	19	22	21	22
6	Turbidity	1	5	NTU	1.3	1.6	1.4	1.0	1.1	1.4	1.3	1.2
7	Conductivity	-	-	µmhos/cm	621	636	691	666	696	680	683	648
8	Alkalinity as $CaCO_3$	200	600	mg/l	194	188	220	210	228	218	232	204

Locations					GW1	GW2	GW3	GW4	GW-5	GW6	GW7	GW8
					Near Sanskar Public School Swatantra Nagar, Narela delhi	Near Bawana 5 CNG Pump sector 5 Holambi Khurd Delhi	Near IOCL CoCo Bawana Sec 3 -Petrol Pump Puth Khurd Khedi Delhi	MCD Primary School Sec. 24 Rohini	MCD Boys Primary School Kanjhawala	Near Rajiv Gandhi Stadium Bawana Village Delhi	Near Lord Shiv Temple Alipur New Delhi	Near G.D Convent School Khera Khurd Delhi
SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement								
9	Total Dissolved Solids	500	2000	mg/l	404	414	449	433	452	698	444	232
10	Total Hardness as $CaCO_3$	200	600	mg/l	176	181	198	222	244	250	236	134
11	Calcium as Ca	200	100	mg/l	52.8	56.2	60.0	62.0	72.0	68.0	69.6	64.0
12	Magnesium as Mg	30	100	mg/l	10.7	9.8	11.6	16.3	15.6	19.4	15.1	18.0
13	Chloride as Cl	250	1000	mg/l	70	76	84	78	66	82	62	65
14	Total Phosphorus	-	-	mg/l	0.73	0.78	0.72	0.83	0.66	0.73	0.69	0.57
15	Nitrate as NO_3	45	No relaxation	mg/l	11.4	11.8	11.9	10.2	13.8	12.7	13.4	11.7
16	Sulphate as SO_4	200	400	mg/l	45	49	44	52	55	58	53	46
17	Fluoride as F	1	1.5	mg/l	0.66	0.62	0.74	0.59	0.67	0.81	0.69	0.57
18	Ammonia as total ammonia-N	0.5	No relaxation	mg/l	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
19	Anionic detergents (as MBAS)	0.2	1.00	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Locations					GW1	GW2	GW3	GW4	GW-5	GW6	GW7	GW8
SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement	Near Sanskar Public School Swatantra Nagar, Narela delhi	Near Bawana 5 CNG Pump sector 5 Holambi Khurd Delhi	Near IOCL CoCo Bawana Sec 3 -Petrol Pump Puth Khurd Khedi Delhi	MCD Primary School Sec. 24 Rohini	MCD Boys Primary School Kanjhawala	Near Rajiv Gandhi Stadium Bawana Village Delhi	Near Lord Shiv Temple Alipur New Delhi	Near G.D Convent School Khera Khurd Delhi
20	Chloramines as Cl_2	4.0	No relaxation	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
21	Free residual chlorine	0.2	1.0	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
22	Mineral oil	0.5	No relaxation	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
23	Phenolic compounds as C_6H_5OH	0.001	0.002	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
24	Cyanide as CN	0.05	No relaxation	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
25	Aluminium as Al	0.03	0.2	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
26	Barium as Ba	0.7	No relaxation	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
27	Boron as B	0.5	1.0	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Locations					GW1	GW2	GW3	GW4	GW-5	GW6	GW7	GW8
					Near Sanskar Public School Swatantra Nagar, Narela delhi	Near Bawana 5 CNG Pump sector 5 Holambi Khurd Delhi	Near IOCL CoCo Bawana Sec 3 -Petrol Pump Puth Khurd Khedi Delhi	MCD Primary School Sec. 24 Rohini	MCD Boys Primary School Kanjhawala	Near Rajiv Gandhi Stadium Bawana Village Delhi	Near Lord Shiv Temple Alipur New Delhi	Near G.D Convent School Khera Khurd Delhi
SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement								
28	Cadmium as Cd	0.003	No relaxation	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
29	Copper as Cu	0.05	1.5	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
30	Iron as Fe	0.3	No relaxation	mg/l	0.013	0.01	0.003	0.002	0.005	0.014	<0.3	0.006
31	Lead as Pb	0.01	No relaxation	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
32	Manganese as Mn	0.1	0.3	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
33	Mercury as Hg	0.001	No relaxation	mg/l	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
34	Molybdenum as Mo	0.07	No relaxation	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Locations					GW1	GW2	GW3	GW4	GW-5	GW6	GW7	GW8
SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement	Near Sanskar Public School Swatantra Nagar, Narela delhi	Near Bawana 5 CNG Pump sector 5 Holambi Khurd Delhi	Near IOCL CoCo Bawana Sec 3 -Petrol Pump Puth Khurd Khedi Delhi	MCD Primary School Sec. 24 Rohini	MCD Boys Primary School Kanjhawala	Near Rajiv Gandhi Stadium Bawana Village Delhi	Near Lord Shiv Temple Alipur New Delhi	Near G.D Convent School Khera Khurd Delhi
35	Nickel as Ni	0.02	No relaxation	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
36	Selenium as Se	0.01	No relaxation	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
37	Silver as Ag	0.1	No relaxation	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
38	Total Arsenic as As	0.01	0.05	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
39	Total Chromium as Cr	0.05	No relaxation	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
40	Zinc as Zn	5	15	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
41	Sodium as Na	-	-	mg/l	62	62	66	52	54	45	54	48
42	Potassium as K	-	-	mg/l	6	6	7	5	6	5	5	5

Locations					GW1	GW2	GW3	GW4	GW-5	GW6	GW7	GW8
SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement	Near Sanskar Public School Swatantra Nagar, Narela delhi	Near Bawana 5 CNG Pump sector 5 Holambi Khurd Delhi	Near IOCL CoCo Bawana Sec 3 -Petrol Pump Puth Khurd Khedi Delhi	MCD Primary School Sec. 24 Rohini	MCD Boys Primary School Kanjhawala	Near Rajiv Gandhi Stadium Bawana Village Delhi	Near Lord Shiv Temple Alipur New Delhi	Near G.D Convent School Khera Khurd Delhi
43	Pesticides	No relaxation	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
44	Polychlorinated biphenyls	0.0005	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
45	Polynuclear aromatic hydrocarbons as PAH	0.0005	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
46	Bromoform	0.1	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
47	Dibromochloromethane	0.1	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
48	Bromodichloromethane	0.06	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND

Locations					GW1	GW2	GW3	GW4	GW-5	GW6	GW7	GW8
SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement	Near Sanskar Public School Swatantra Nagar, Narela delhi	Near Bawana 5 CNG Pump sector 5 Holambi Khurd Delhi	Near IOCL CoCo Bawana Sec 3 -Petrol Pump Puth Khurd Khedi Delhi	MCD Primary School Sec. 24 Rohini	MCD Boys Primary School Kanjhawala	Near Rajiv Gandhi Stadium Bawana Village Delhi	Near Lord Shiv Temple Alipur New Delhi	Near G.D Convent School Khera Khurd Delhi
49	Chloroform	0.2	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
50	Total Coliform	Shall not be detectable in any 100 ml sample		MPN/100ml	<2	<2	<2	<2	<2	<2	<2	<2
51	Faecal Coliform	Shall not be detectable in any 100 ml sample		MPN/100ml	<2	<2	<2	<2	<2	<2	<2	<2
52	E. coli	Shall not be detectable in any 100 ml sample		MPN/100ml	<2	<2	<2	<2	<2	<2	<2	<2

Based on the analysis conducted on water samples collected from various locations within the study area, several key parameters were evaluated to assess water quality. The pH values ranged from 6.94 to 7.58, indicating a neutral to slightly alkaline nature of the water. This range falls within the recommended standard of 6.5 to 8.5, ensuring the water's suitability for various uses without posing acidity or alkalinity concerns.

Total Dissolved Solids (TDS) levels in the samples varied between 232 to 698 mg/L, reflecting the concentration of dissolved substances present in the water. While TDS levels influence the water's taste and may impact its suitability for certain applications, the observed range remains within acceptable limits for drinking water quality.

Chloride concentrations were found between 62 to 84 mg/L, indicating moderate levels within the samples. Chlorides, which can stem from natural sources or anthropogenic activities, play a role in water salinity and taste perception but were found at levels consistent with health standards.

Sulfate concentrations ranged from 44 to 58 mg/L across the samples, indicating a moderate presence of sulfates in the water. This parameter, while typically not a health concern at these concentrations, can affect taste and odor and is monitored to ensure compliance with regulatory standards.

Total hardness, representing the concentration of calcium and magnesium salts in the water, varied from 134 to 250 mg/L (expressed as $CaCO_3$ equivalents). This parameter influences the water's suitability for domestic and industrial purposes, with the observed range falling within acceptable limits.

In terms of metal content, iron was found at a very low concentration of <0.03 mg/L, suggesting minimal presence and indicating good overall water quality with regards to metal contamination.

Overall, the analysis underscores that the water samples from the study area meet the required standards for pH, TDS, chlorides, sulfates, total hardness, and metals, affirming their suitability for various uses including drinking, agriculture, and industrial applications. Continued monitoring and periodic assessments will be essential to ensure sustained water quality and to address any emerging concerns proactively.

3.12.3.2 Results and Interpretation of Surface Water

The monitored results of surface water samples have been depicted in **Table 3.11.**

Table 3.11: Surface Water Results

Sl. No.	Parameters	Locations / Unit of Measurement	SW1 Near Deen Dayal Upadhayay Park Prahladpur, Rohini Delhi	SW2 Near Hanuman Mandir Begam Vihar, Sector 33 delhi	SW3 Near Shiv Mandir Khera Kalan Village Delhi	SW4 Icon Tech Machinery Pvt Ltd Bawana Sec 3 Industrial Area Delhi	SW5 Near Bharat Plastic DSIIDC Industrial Area, Sector 4 Bawana	SW6 Near Madarsa Shamsul Huda Yamuna Canal Bawana delhi	SW7 Near Delhi Jal Board Iradat Nagar Delhi	SW8 Near Dada Maldev Sports Ground Darayapur kalan Village Delhi
1	Colour	Hazen	<5	<5	<5	<5	<5	<5	<5	<5
2	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Taste	-	Not done	Not done	Not done	Not done	Not done	Not done	Not done	Not done
4	pH	-	7.22	7.02	7.24	7.06	7.21	7.28	7.14	7.34
5	Temperature	°C	19	20	21	21	20	21	20	21
6	Turbidity	NTU	1.2	2.3	2.6	2.0	2.7	2.5	1.8	2.5
7	Conductivity	µmhos/cm	447	428	359	441	456	463	459	478
8	Alkalinity as $CaCO_3$	mg/l	164	166	115	148	146	158	132	148
9	Total Dissolved Solids	mg/l	290	278	233	287	296	301	298	311

Sl. No.	Parameters	Locations	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
		Unit of Measurement	Near Deen Dayal Upadhayay Park Prahladpur, Rohini Delhi	Near Hanuman Mandir Begam Vihar, Sector 33 delhi	Near Shiv Mandir Khera Kalan Village Delhi	Icon Tech Machinery Pvt Ltd Bawana Sec 3 Industrial Area Delhi	Near Bharat Plastic DSIIDC Industrial Area, Sector 4 Bawana	Near Madarsa Shamsul Huda Yamuna Canal Bawana delhi	Near Delhi Jal Board Iradat Nagar Delhi	Near Dada Maldev Sports Ground Darayapur kalan Village Delhi
10	Total Suspended Solids	mg/l	2	3	4	6	3	4	4	4
11	Total Hardness as $CaCO_3$	mg/l	156	187	130	130	152	196	182	180
12	Calcium as $CaCO_3$	mg/l	112	142	102	124	122	140	138	136
13	Magnesium as $CaCO_3$	mg/l	44	45	28	30	30	56	44	44
14	Chloride as Cl	mg/l	42	28	60	34	42	43	51	46
15	Total Phosphorus	mg/l	0.44	0.42	0.58	0.48	0.63	0.71	0.39	0.52
16	Nitrate as NO_3	mg/l	7.2	9.5	8.5	9.9	10.2	8.4	11.5	10.5
17	Sulphate as SO_4	mg/l	28	30	26	46	34	27	32	40
18	Fluoride as F	mg/l	0.33	0.41	0.67	0.50	0.49	0.52	0.40	0.54
19	Ammonia as total ammonia-N	mg/l	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
20	Anionic detergents (as MBAS)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
21	Chloramines as Cl_2	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
22	Free residual chlorine	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Sl. No.	Parameters	Locations	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
		Unit of Measurement	Near Deen Dayal Upadhayay Park Prahladpur, Rohini Delhi	Near Hanuman Mandir Begam Vihar, Sector 33 delhi	Near Shiv Mandir Khera Kalan Village Delhi	Icon Tech Machinery Pvt Ltd Bawana Sec 3 Industrial Area Delhi	Near Bharat Plastic DSIIDC Industrial Area, Sector 4 Bawana	Near Madarsa Shamsul Huda Yamuna Canal Bawana delhi	Near Delhi Jal Board Iradat Nagar Delhi	Near Dada Maldev Sports Ground Darayapur kalan Village Delhi
23	Mineral oil	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
24	Phenolic compounds as C_6H_5OH	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
25	Cyanide as CN	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Aluminium as Al	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
27	Barium as Ba	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
28	Boron as B	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
29	Cadmium as Cd	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
30	Copper as Cu	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
31	Iron as Fe	mg/l	0.02	0.018	0.016	0.015	0.019	0.011	0.011	0.011
32	Lead as Pb	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
33	Manganese as Mn	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
34	Mercury as Hg	mg/l	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
35	Molybdenum as Mo	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
36	Nickel as Ni	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
37	Selenium as Se	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
38	Silver as Ag	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
39	Total Arsenic as As	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Sl. No.	Parameters	Locations / Unit of Measurement	SW1 Near Deen Dayal Upadhayay Park Prahladpur, Rohini Delhi	SW2 Near Hanuman Mandir Begam Vihar, Sector 33 delhi	SW3 Near Shiv Mandir Khera Kalan Village Delhi	SW4 Icon Tech Machinery Pvt Ltd Bawana Sec 3 Industrial Area Delhi	SW5 Near Bharat Plastic DSIIDC Industrial Area, Sector 4 Bawana	SW6 Near Madarsa Shamsul Huda Yamuna Canal Bawana delhi	SW7 Near Delhi Jal Board Iradat Nagar Delhi	SW8 Near Dada Maldev Sports Ground Darayapur kalan Village Delhi
40	Total Chromium as Cr	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
41	Zinc as Zn	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
42	Sodium as Na	mg/l	34	20	30	32	40	32	33	32
43	Potassium as K	mg/l	4	3	3	4	5	4	4	6
44	Pesticides	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
45	Polychlorinated biphenyls	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
46	Polynuclear aromatic hydrocarbons as PAH	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
47	Bromoform	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
48	Dibromochloromethane	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
49	Bromodichloromethane	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
50	Chloroform	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
51	Dissolved Oxygen	mg/l	5.6	6.0	5.5	5.6	6.4	6.2	5.9	6.3
52	BOD	mg/l	16	14	16	20	12	10	12	10

Sl. No.	Parameters	Locations	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
		Unit of Measurement	Near Deen Dayal Upadhayay Park Prahladpur, Rohini Delhi	Near Hanuman Mandir Begam Vihar, Sector 33 delhi	Near Shiv Mandir Khera Kalan Village Delhi	Icon Tech Machinery Pvt Ltd Bawana Sec 3 Industrial Area Delhi	Near Bharat Plastic DSIIDC Industrial Area, Sector 4 Bawana	Near Madarsa Shamsul Huda Yamuna Canal Bawana delhi	Near Delhi Jal Board Iradat Nagar Delhi	Near Dada Maldev Sports Ground Darayapur kalan Village Delhi
53	COD	mg/l	48	46	72	84	40	42	46	42
54	Total Coliform	MPN/100ml	1410	940	1200	1770	1300	1480	1090	1410
55	Fecal Coliform	MPN/100ml	630	490	700	840	790	700	580	760
56	E. coli	MPN/100ml	580	410	630	760	490	630	430	700

The analysis of water samples from various locations within the study area reveals consistent findings across several critical parameters. The pH values measured range from 7.02 to 7.34, indicating a neutral to slightly alkaline nature of the water. This falls comfortably within the recommended standard pH range, ensuring the water's compatibility for diverse uses without concerns of acidity or alkalinity.

Total Dissolved Solids (TDS) in the samples were observed to range from 278 to 311 mg/L. TDS reflects the concentration of dissolved substances in the water and impacts its taste and suitability for consumption and other applications. The observed levels are moderate and generally within acceptable limits for potable water quality.

Sulfate concentrations ranged between 26 to 46 mg/L in the samples. Sulfates, which can originate from natural geological sources or human activities, are essential to monitor due to their potential impact on taste and health considerations. The measured concentrations are within standard permissible levels, indicating no significant concerns regarding sulfate contamination.

Total hardness, which denotes the concentration of calcium and magnesium salts, varied from 130 to 196 mg/L (expressed as $CaCO3$ equivalents). This parameter influences water's suitability for domestic and industrial purposes, with the observed range aligning well within acceptable limits for various applications.

Chemical Oxygen Demand (COD) levels were measured between 40 to 84 mg/L. COD is an important indicator of organic pollutants in water, reflecting the amount of oxygen required to oxidize organic matter. The observed range suggests varying levels of organic pollution, warranting continued monitoring and potential remediation measures to maintain water quality.

Biochemical Oxygen Demand (BOD), another crucial indicator of organic pollution, ranged from 10 to 20 mg/L in the samples. BOD measures the amount of dissolved oxygen consumed by microorganisms during the decomposition of organic matter. The measured values indicate moderate levels of organic pollutants, which require ongoing assessment to prevent adverse impacts on aquatic ecosystems and water quality.

In conclusion, the analysis results affirm that the water samples from the study area generally meet regulatory standards for pH, TDS, sulfate, total hardness, COD, and BOD. Regular monitoring and proactive management strategies will be essential to sustain water quality, mitigate pollution sources, and safeguard environmental and public health in the study area.

Based on the findings presented, the water quality falls under Class C as per the Water Quality Criteria set by the Central Pollution Control Board. Class C criteria typically define water quality suitable for certain designated uses after appropriate treatment.

3.12.4 Sampling of Surface Water & Ground Water (Hotspots) within 2 km radius from project boundary

Water sampling within a 2km radius serves as a crucial method for assessing water quality and environmental health within a defined geographic area due to which this serves as a hotspot. Since water sampling was conducted at a total of 9 locations within 2km radius of the project boundary. Details of monitoring locations and map of the study area are given in **Table 3.12** and **Figure 3.11.** The monitoring photographs are shown in **Figure 3.12.**

Table 3.12: Sampling Locations within 2 Km of the study area

Sr. No.	Ground Water Locations	Distance	Direction	Latitude	Longitude
GWH1	Nigam prathmik Vidyalaya	1.21km	NW	28° 48' 19.332" N	77° 3' 11.551" E
GWH2	Ganga Toli Temple	0.81km	SSW	28° 47' 18.028" N	77° 3' 31.257" E
GWH3	Primary school N block sec.3	1.35km	S	28° 46' 58.544" N	77° 3' 50.047" E
GWH4	Sandhyashi Hospital	1.24km	E	28° 47' 44.921" N	77° 4' 32.999" E
GWH5	M/s Srasti Paints Sector-3	1.77km	SW	28° 47' 13.903" N	77° 2' 44.199" E
GWH6	R.K.G. Polymers Pvt. Ltd	1.66km	SW	28° 47' 21.270" N	77° 2' 44.675" E
GWH7	Hanuman Mandir	1.83km	ESE	28° 47' 35.538" N	77° 4' 53.758" E
GWH8	Stellar Plastic Bawana Sector-5	1.20km	NE	28° 48' 12.342" N	77° 4' 22.037" E
Surface Water Location					
SWH1	Pond Near JJ colony Bus Stand	1.52km	NNW	28°48'36.77"N	77° 3'20.19"E

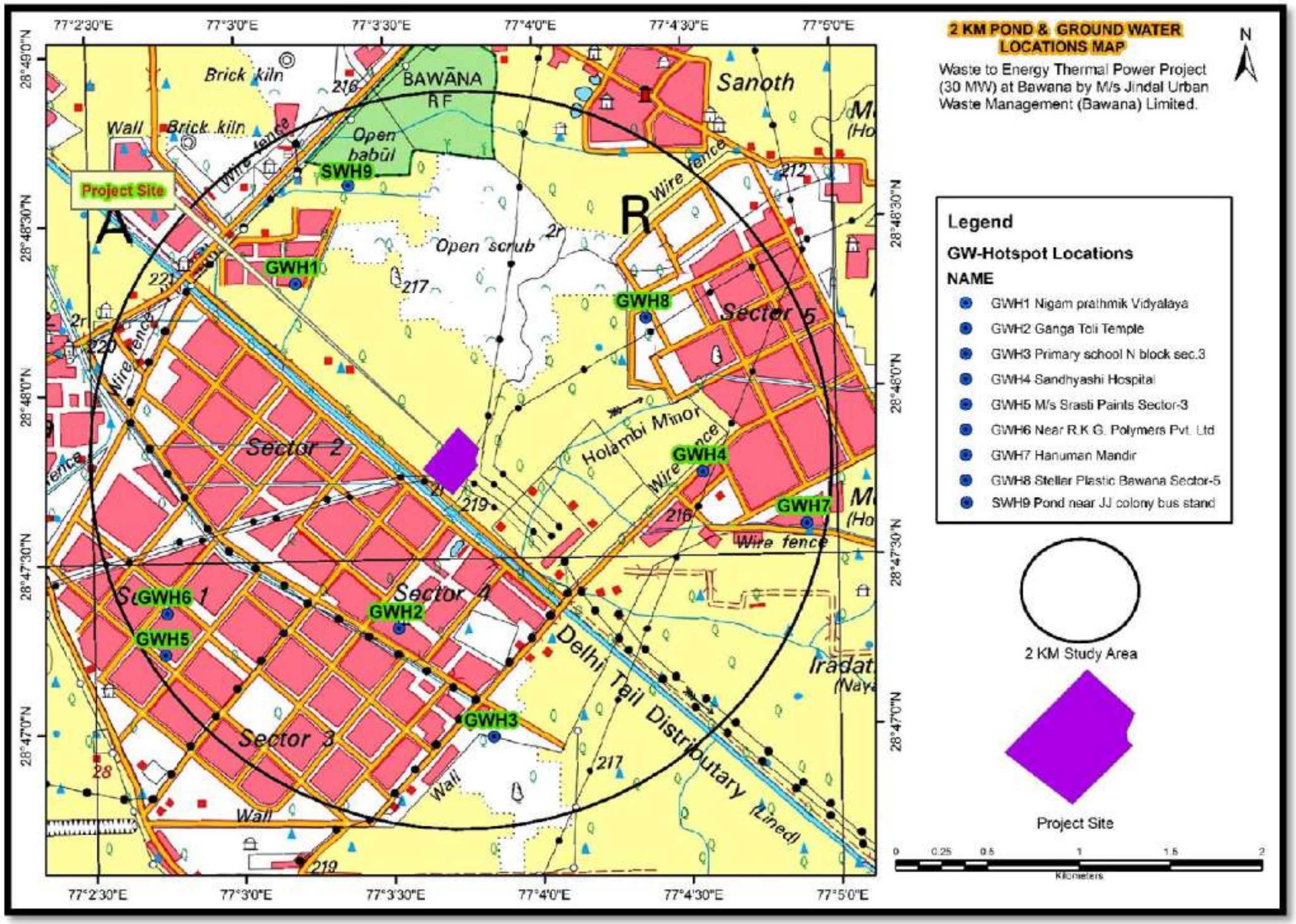

Figure 3.11:- Ground Water & Surface Water Sampling Stations within 2 Km of the study area

3.12.5 Results and Interpretation for 2km study area

The results for the 2km study area are given in **Table 3.13 and Table 3.14.**

Table 3.13: Ground Water Results for 2km study area

Waste to Energy Bawana Project Ground Water Results												
SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement	GWH-1	GWH-2	GWH-3	GWH-4	GWH-5	GWH-6	GWH-7	GWH-8
					M/s Srasti Paints Sector-3	Nigam Prathmik Vidhyalay	Ganga Toli Temple	Sandhyashi Hospital	Primary School Block-N , Sector-3	R.K. G. Polymers Pvt. Ltd	Hanuman Mandir	Stellar Plastic Bawana Sector-5
1	Colour	5	15	Hazen	<5	<5	<5	<5	<5	<5	<5	<5
2	Odour	Agreeable	Agreeable	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Taste	Agreeable	Agreeable	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	pH	-	-	-	7.23	7.36	7.42	7.34	7.52	7.16	7.46	7.38
5	Temperature	-	-	°C	20	21	20	22	20	19	20	21
6	Turbidity	1	5	NTU	1.2	1.4	1.1	1.0	1.3	1.2	1.3	1.1

Waste to Energy Bawana Project Ground Water Results												
SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement	GWH-1 M/s Srasti Paints Sector-3	GWH-2 Nigam Prathmik Vidhyalay	GWH-3 Ganga Toli Temple	GWH-4 Sandhyashi Hospital	GWH-5 Primary School Block-N , Sector-3	GWH-6 R.K. G. Polymers Pvt. Ltd	GWH-7 Hanuman Mandir	GWH-8 Stellar Plastic Bawana Sector-5
7	Conductivity	-	-	µmhos/cm	684	632	580	585	677	610	650	564
8	Alkalinity as $CaCO_3$	200	600	mg/l	210	194	184	192	218	190	212	188
9	Total Dissolved Solids	500	200	mg/l	445	411	377	380	440	397	422	366
10	Total Hardness as $CaCO_3$	200	600	mg/l	222	216	194	210	226	212	226	198
11	Calcium as Ca	200	100	mg/l	67.2	63.2	60.0	65.6	64.8	68.8	71.2	62.4
12	Magnesium as Mg	30	100	mg/l	13.1	14.0	10.6	11.2	15.6	9.7	11.6	10.2
13	Chloride as Cl	250	1000	mg/l	78	74	64	68	78	72	70	64
14	Total Phosphorus	-	-	mg/l	0.34	0.56	0.62	0.64	0.58	0.54	0.52	0.52
15	Nitrate as NO_3	45	No relaxation	mg/l	10.5	9.2	9.5	8.6	10.2	10.5	8.5	8.2
16	Sulphate as SO_4	200	400	mg/l	48	44	38	32	42	36	42	30
17	Fluoride as F	1	1.5	mg/l	0.68	0.56	0.62	0.46	0.62	0.48	0.64	0.42

Waste to Energy Bawana Project Ground Water Results

SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement	GWH-1 M/s Srasti Paints Sector-3	GWH-2 Nigam Prathmik Vidhyalay	GWH-3 Ganga Toli Temple	GWH-4 Sandhyashi Hospital	GWH-5 Primary School Block -N , Sector-3	GWH-6 R.K. G. Polymers Pvt. Ltd	GWH-7 Hanuman Mandir	GWH-8 Stellar Plastic Bawana Sector-5
18	Ammonia as total ammonia-N	0.5	No relaxation	mg/l	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
19	Anionic detergents (as MBAS)	0.2	1.00	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
20	Chloramines as Cl_2	4.0	No relaxation	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
21	Free residual chlorine	0.2	1.0	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
22	Mineral oil	0.5	No relaxation	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
23	Phenolic compounds as C_6H_5OH	0.001	0.002	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
24	Cyanide as CN	0.05	No relaxation	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
25	Aluminium as Al	0.03	0.2	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
26	Barium as Ba	0.7	No relaxation	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
27	Boron as B	0.5	1.0	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Waste to Energy Bawana Project Ground Water Results

SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement	GWH-1 M/s Srasti Paints Sector-3	GWH-2 Nigam Prathmik Vidhyalay	GWH-3 Ganga Toli Temple	GWH-4 Sandhyashi Hospital	GWH-5 Primary School Block-N , Sector-3	GWH-6 R.K. G. Polymers Pvt. Ltd	GWH-7 Hanuman Mandir	GWH-8 Stellar Plastic Bawana Sector-5
28	Cadmium as Cd	0.003	No relaxation	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
29	Copper as Cu	0.05	1.5	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
30	Iron as Fe	0.3	No relaxation	mg/l	0.014	0.016	0.008	0.002	0.016	0.014	0.008	0.006
31	Lead as Pb	0.01	No relaxation	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
32	Manganese as Mn	0.1	0.3	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
33	Mercury as Hg	0.001	No relaxation	mg/l	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
34	Molybdenum as Mo	0.07	No relaxation	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
35	Nickel as Ni	0.02	No relaxation	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
36	Selenium as Se	0.01	No relaxation	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Waste to Energy Bawana Project Ground Water Results

SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement	GWH-1 M/s Srasti Paints Sector-3	GWH-2 Nigam Prathmik Vidhyalay	GWH-3 Ganga Toli Temple	GWH-4 Sandhyashi Hospital	GWH-5 Primary School Block -N , Sector-3	GWH-6 R.K. G. Polymers Pvt. Ltd	GWH-7 Hanuman Mandir	GWH-8 Stellar Plastic Bawana Sector -5
37	Silver as Ag	0.1	No relaxation	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
38	Total Arsenic as As	0.01	0.05	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
39	Total Chromium as Cr	0.05	No relaxation	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
40	Zinc as Zn	5	15	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
41	Sodium as Na	-	-	mg/l	64	54	52	48	62	52	56	48
42	Potassium as K	-	-	mg/l	6	6	5	4	5	5	5	4
43	Pesticides	No relaxation	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
44	Polychlorinated biphenyls	0.0005	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
45	Polynuclear aromatic hydrocarbons as PAH	0.0005	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND

Waste to Energy Bawana Project Ground Water Results												
SL. No.	Parameters	Desirable Limits	Permissible Limits	Unit of Measurement	GWH-1	GWH-2	GWH-3	GWH-4	GWH-5	GWH-6	GWH-7	GWH-8
					M/s Srasti Paints Sector-3	Nigam Prathmik Vidhyalay	Ganga Toli Temple	Sandhyashi Hospital	Primary School Block-N , Sector-3	R.K. G. Polymers Pvt. Ltd	Hanuman Mandir	Stellar Plastic Bawana Sector-5
46	Bromoform	0.1	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
47	Dibromochloromethane	0.1	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
48	Bromodichloromethane	0.06	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
49	Chloroform	0.2	No relaxation	mg/l	ND	ND	ND	ND	ND	ND	ND	ND
50	Total Coliform	Shall not be detectable in any 100 ml sample		MPN/100ml	<2	<2	<2	<2	<2	<2	<2	<2
51	Faecal Coliform	Shall not be detectable in any 100 ml sample		MPN/100ml	<2	<2	<2	<2	<2	<2	<2	<2
52	E. coli	Shall not be detectable in any 100 ml sample		MPN/100ml	<2	<2	<2	<2	<2	<2	<2	<2

The groundwater quality at 8 locations was assessed across several parameters. pH levels were measured between 7.16 to 7.52, well within the specified standard range of 6.5 to 8.5, indicating neutral to slightly alkaline conditions. Total Dissolved Solids (TDS) ranged from 366 to 445 mg/L, Chloride levels from 64 to 78 mg/L, Sulphate concentrations from 30 to 48 mg/L, and Total Hardness from 194 to 226 mg/L. Iron content was found to be less than 0.3 mg/L.

Table 3.14: Surface Water Results of 2km study area

Waste to Energy Bawana Project surface water result			
Sl. No.	**Parameters**	**Locations**	**SWH-1**
		Unit of Measurement	**Pond Near JJ Colony Bus Stand**
1	Colour	Hazen Units	<5
2	Odour	-	Agreeable
3	Taste	-	Not done
4	pH	-	7.37
5	Temperature	°C	21
6	Turbidity	NTU	3.5
7	Conductivity	µmhos/cm	807
8	Alkalinity as $CaCO_3$	mg/l	208
9	Total Dissolved Solids	mg/l	524
10	Total Suspended Solids	mg/l	3
11	Total Hardness as $CaCO_3$	mg/l	294
12	Calcium as CaCO3	mg/l	196
13	Magnesium as $CaCO_3$	mg/l	98

Waste to Energy Bawana Project surface water result			
Sl. No.	Parameters	Locations	SWH-1
		Unit of Measurement	Pond Near JJ Colony Bus Stand
14	Chloride as Cl	mg/l	146
15	Total Phosphorus	mg/l	0.22
16	Nitrate as NO_3	mg/l	6.30
17	Sulphate as SO_4	mg/l	38.00
18	Fluoride as F	mg/l	0.33
19	Ammonia as total ammonia-N	mg/l	<0.25
20	Anionic detergents (as MBAS)	mg/l	<0.05
21	Chloramines as Cl_2	mg/l	<0.1
22	Free residual chlorine	mg/l	<0.1
23	Mineral oil	mg/l	<0.1
24	Phenolic compounds as C_6H_5OH	mg/l	<0.001
25	Cyanide as CN	mg/l	<0.01
26	Aluminium as Al	mg/l	<0.005
27	Barium as Ba	mg/l	<0.005
28	Boron as B	mg/l	<0.1
29	Cadmium as Cd	mg/l	<0.002
30	Copper as Cu	mg/l	<0.005
31	Iron as Fe	mg/l	0.08

Waste to Energy Bawana Project surface water result			
Sl. No.	Parameters	Locations	SWH-1
		Unit of Measurement	Pond Near JJ Colony Bus Stand
32	Lead as Pb	mg/l	<0.005
33	Manganese as Mn	mg/l	<0.005
34	Mercury as Hg	mg/l	<0.0005
35	Molybdenum as Mo	mg/l	<0.005
36	Nickel as Ni	mg/l	<0.005
37	Selenium as Se	mg/l	<0.005
38	Silver as Ag	mg/l	<0.005
39	Total Arsenic as As	mg/l	<0.005
40	Total Chromium as Cr	mg/l	<0.005
41	Zinc as Zn	mg/l	<0.02
42	Sodium as Na	mg/l	64
43	Potassium as K	mg/l	6
44	Pesticides	mg/l	ND
45	Polychlorinated biphenyls	mg/l	ND
46	Polynuclear aromatic hydrocarbons as PAH	mg/l	ND
47	Bromoform	mg/l	ND
48	Dibromochloromethane	mg/l	ND
49	Bromodichloromethane	mg/l	ND

Waste to Energy Bawana Project surface water result			
Sl. No.	**Parameters**	**Locations**	**SWH-1**
		Unit of Measurement	**Pond Near JJ Colony Bus Stand**
50	Chloroform	mg/l	ND
51	Dissolved Oxygen	mg/l	5.6
52	BOD	mg/l	20
53	COD	mg/l	54
54	Total Coliform	MPN/100ml	2210
55	Faecal Coliform	MPN/100ml	940
56	E. coli	MPN/100ml	460

The results of the surface water near JJ Colony Bus Stand indicated favorable water quality condition suitable for various environmental parameters. The water appeared clear with a low turbidity of 3.5 NTU and a pH of 7.37, indicating near-neutral acidity. Temperature was recorded as 21°C. The water showed acceptable levels of conductivity (807 µmhos/cm) and alkalinity (208 mg/l as $CaCO_3$). These results were compared against the Central Pollution Control Board (CPCB) water quality criteria, suggesting that all parameters measured fall within permissible limits as per CPCB standards.


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Delhi, Delhi, India
G7-6, Dr K N Katju Marg, Pocket 7, Sector 11G, Rohini, Delhi, 110085, India
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Google


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GPS Map Camera
Delhi, Delhi, India
KHERA MAAN BRIDGE, 110082, Western Yamuna Canal Link Road, Sector 29, Khera Khurd Village, Delhi, 110082, India
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GPS Map Camera
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Long 77.059772°
16/05/23 11:00 AM GMT +05:30
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Figure 3.12:Water Sampling Photographs

3.13 AMBIENT AIR QUALITY

3.13.1 Sampling and Analytical Technique

In order to assess the Ambient Air Quality (AAQ), Time averaged in – situ sampling was adopted by passing a known volume of air through a trap, and a collecting medium (filter paper and bubbler). Respirable Dust Sampler and Ambient Fine Dust Sampler were used for the purpose. The samples for CO were collected in bladder.

3.13.2 Particulate Matter ($PM_{2.5}$)

Method used was Gravimetric Method. Particulate matter was collected on the 37mm diameter glass micro fiber Filter Paper.

3.13.3 Particulate Matter (PM_{10})

Ambient Fine sampler - IS: 5182 (Part 23):2006. Particulate matter was collected on the GF/A Filter Paper. The mass of these particles is determined by the difference in filter paper weight prior to and after sampling.

3.13.4 Sulphur dioxide (SO_2)

SO_2 was measured following IS: 5182; Part – II – 2001 and reaffirmed 2006 method. SO_2 was absorbed through a solution of Potassium tetra chloro mercurate (TCM). This procedure results in the formation of a di-chloro sulphite mercurate complex. The Sulphite ion produced during sampling is reacted with sulphamic acid, formaldehyde, and para rosaniline to form an azo dye and then determined calorimetrically.

3.13.5 Nitrogen Oxides

NOx was measured following IS: 5182; Part – VI – 2006 method. NO_2 was collected by bubbling air through a sodium hydroxide- sodium arsenite solution to form a stable solution of **$NaNO_2$.** Nitrite Ion so produced during sampling is reacted with hydrogen peroxide, Sulphur anilamide and NEDA to form an azodye and then determined calorimetrically.

3.13.6 Carbon Monoxide

CO was measured following IS: 5182 Part –X-1999, Reaffirmed 2003 method. CO was monitored an hourly basis whereas other parameters were monitored on 24 hourly bases. CO was analyzed by Non-Dispersive Infra-Red Spectroscopy (NDIR).

3.13.7 Mercury (Hg)

Mercury was measured following Inductively Coupled Plasma (ICP) Spectroscopy. This is an analytical technique used to measure and identify elements within a sample matrix based on the ionization of the elements within the sample.

3.13.8 Ambient Air Quality Monitoring locations

As per ToR issued by MoEF&CC, the location of the monitoring stations was so decided taking into consideration the upwind direction, pre-dominant downwind direction and other dominant directions. The ambient air quality monitoring was carried out at 8 stations and locations of Air Monitoring are shown in **Table 3.15, Figure 3.13**. The monitoring photographs has been shown in **Figure 3.14.**

Table 3.15: Location of Ambient Air Quality Monitoring Stations

Air Monitoring Location						
Sr. No	**Location**	**Land Use Type**	**Distance**	**Direction**	**Latitude**	**Longitude**
AAQ 1	Near TamilNadu Waste Management Limited , Sector-5, Bawana, Delhi	Industrial Area	0.58km	NE (Crosswind)	28° 47' 49.422" N	77° 4' 4.251" E
AAQ 2	Near CISF camp Rohini sector 34 Delhi	Residential Area	2.36km	SE (Downwind)	28° 46' 42.258" N	77° 4' 37.435" E
AAQ 3	Near Vaishno Devi Mandir Khera Kalan, Delhi	Residential Area	5.73km	SE (Downwind)	28° 46' 27.276" N	77° 6' 55.983" E
AAQ 4	Near Post Office Ghoga Delhi	Residential Area	4.25km	NW (Upwind)	28° 49' 56.185" N	77° 2' 57.332" E
AAQ 5	Near Mahesh Hosiery Factory Private Limited Secto1 Bawana Delhi	Commercial Area	2.03km	SW (Crosswind)	28° 47' 11.281" N	77° 2' 39.355" E
AAQ 6	Near Bank of Baroda Narela New Delhi	Commercial Area	5.42Km	NE (Crosswind)	28° 49' 40.187" N	77° 6' 6.248" E
AAQ 7	Near Shri Balaji Mandir Sec-11 Rohni Delhi	Residential Area	8.68km	SE (Downwind)	28° 43' 46.783" N	77° 6' 37.012" E
AAQ 8	Near Government Animal Hospital Ferozpur Bangar Village Haryana	Residential Area	8.58km	NW (Upwind)	28° 49' 42.974" N	76° 58' 57.633" E

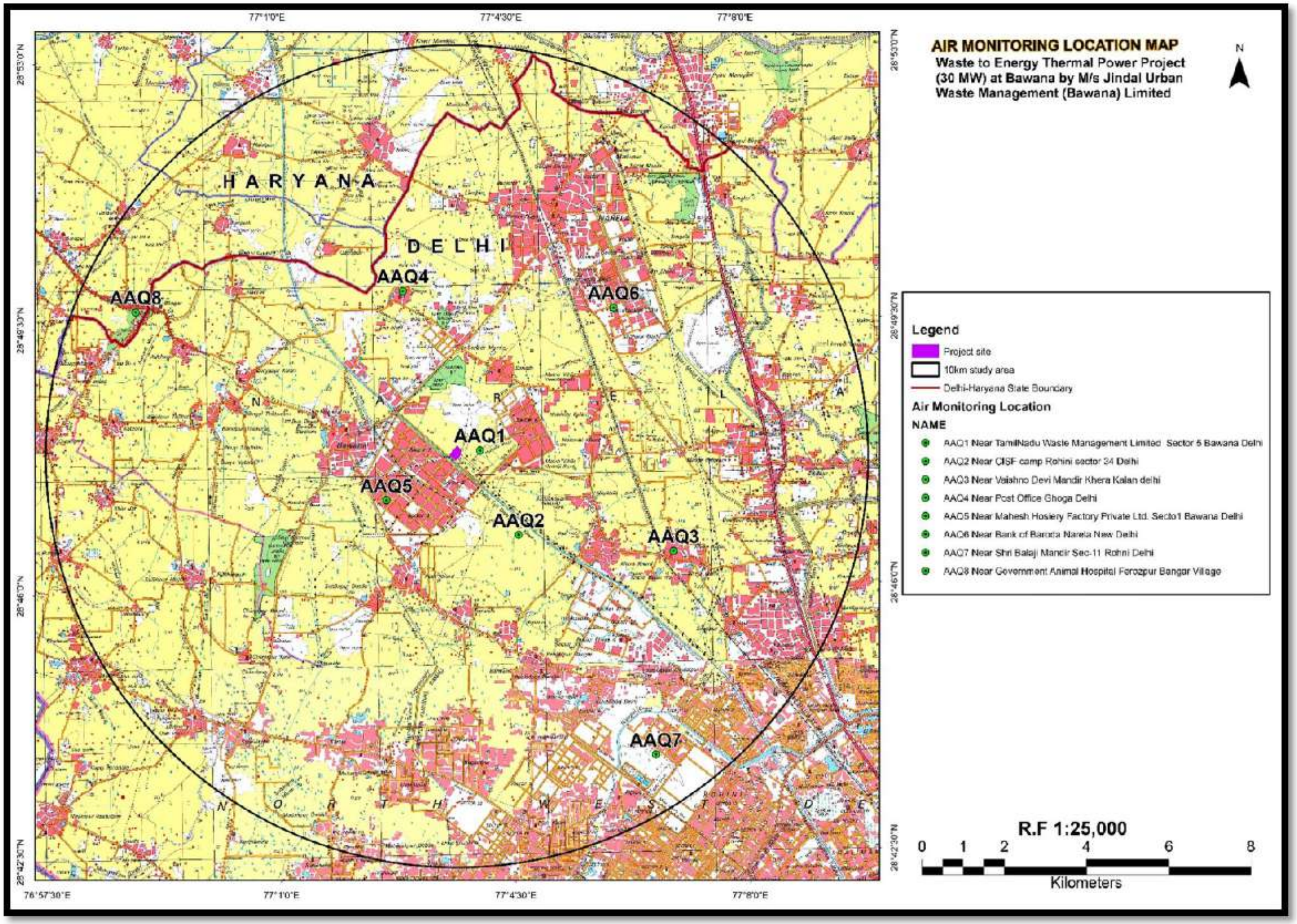
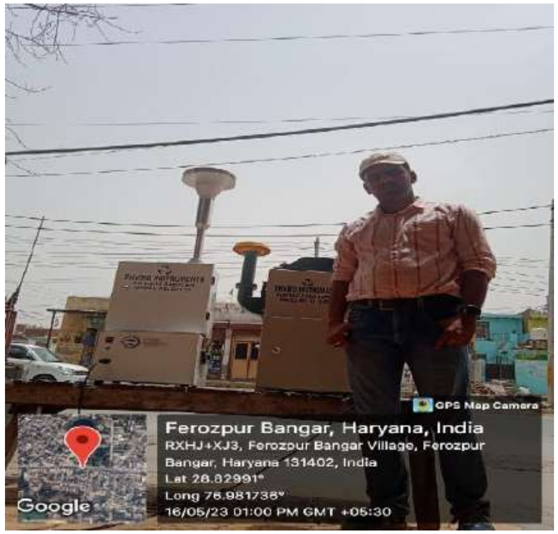


Figure 3.13:- Ambient Air Quality Sampling Stations showing on Toposheet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GPS Map Camera
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Google

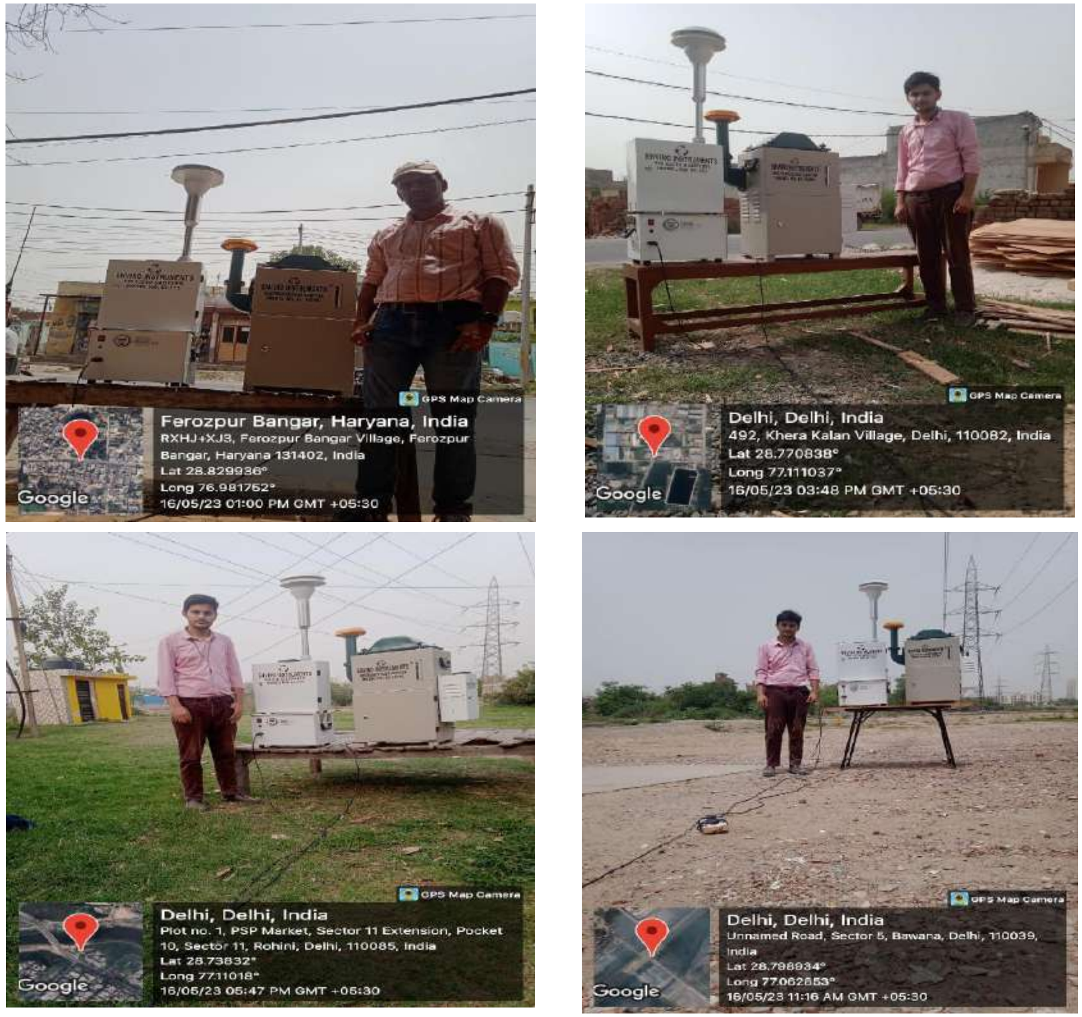


Figure 3.14:- Air Monitoring Photographs

3.13.9 Results and Interpretation of Ambient Air Quality

The monitoring results of AAQ are given from **Table 3.17(a) to Table 3.17(h).** The CPCB standard for AAQ is given in **Table 3.16.**

Table 3.16: National air Quality Standards

Pollutants	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m^3	Annual* 24 Hours**	50 80	20 80	- Improved West and Gaeke method - Ultraviolet Fluorescence
Nitrogen Dioxide (NO_2), µg/m^3	Annual* 24 Hours**	40 80	30 80	- Jacob & Hochheiser modified ($NaoH$-$NaAsO_2$) Method - Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m^3	Annual* 24 Hours**	60 100	60 100	- Gravimetric - TEOM - Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m^3	Annual* 24 Hours**	40 60	40 60	- Gravimetric - TEOM - Beta attenuation
Ozone (O_3), µg/m^3	8 Hours* 1 Hours**	100 180	100 180	- UV Photometric - Chemiluminescence - Chemical Method
Lead (Pb), µg/m^3	Annual* 24 Hours**	0.50 1.0	0.50 1.0	- AAS/IC Method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
Carbon Monoxide (CO), µg / m^3	8 Hours* 1 Hours**	2000 4000	2000 4000	- Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m^3	Annual* 24 Hours**	100 400	100 400	- Chemiluminescence - Indophenol method
Benzene (C_6H_6), µg/m^3	Annual*	05	05	- Gas Chromatography (GC) based continuous analyzer - Adsorption and desorption followed by GC analysis

Pollutants	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Benzo(a) Pyrene (BaP) Particulate phase only, µg/m^3	Annual*	01	01	- Solvent extraction followed by HPLC/GC analysis
Arsenic (As), µg/m^3	Annual*	06	06	- AAS/IC Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), µg/m^3	Annual*	20	20	- AAS/IC Method after sampling on EPM 2000 or equivalent filter paper

Source: *Central Pollution Control Board*

* Annual Arithmetic mean of minimum 104 measurement in a year at a particulate site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limit specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Table 3.17 (a): Ambient Air Monitoring Result at Near Tamil Nadu Waste Management Limited Sector-5 Bawana Delhi (AAQMS1)

AAQ 1	Near Tamil Nadu Waste Management Limited, Sector-5, Bawana, Delhi						
MONTH	DATE	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	CO (µg/m³)	Hg (µg/m³)
Mar-23	01.03.2023	236	142	10	23	0.75	BDL
	04.03.2023	198	119	9	17	0.77	BDL
	08.03.2023	164	98	12	21	0.76	BDL
	11.03.2023	150	90	14	16	0.82	BDL
	15.03.2023	169	101	10	22	0.72	BDL
	18.03.2023	192	115	9	18	0.64	BDL
	22.03.2023	216	130	12	20	0.59	BDL
	25.03.2023	204	122	16	22	0.78	BDL
Apr-23	01.04.2023	144	86	8	18	0.81	BDL
	04.04.2023	234	140	12	21	0.77	BDL
	08.04.2023	266	160	9	16	0.81	BDL
	11.04.2023	316	190	10	22	0.72	BDL
	15.04.2023	324	194	11	21	0.82	BDL
	18.04.2023	284	170	8	17	0.81	BDL
	22.04.2023	370	222	9	19	0.66	BDL
	25.04.2023	272	163	10	16	0.72	BDL
May-23	01.05.2023	280	168	12	20	0.66	BDL
	04.05.2023	124	74	15	22	0.78	BDL
	08.05.2023	146	88	14	19	0.76	BDL
	11.05.2023	150	90	12	21	0.64	BDL
	15.05.2023	77	46	9	16	0.75	BDL
	18.05.2023	143	86	13	22	0.67	BDL

	22.05.2023	232	139	10	16	0.84	BDL
	25.05.2023	208	125	12	20	0.64	BDL
	Max	**370**	**222**	**16**	**23**	**0.84**	**BDL**
	Min	**77**	**46**	**8**	**16**	**0.59**	**BDL**
	Avg	**212.46**	**127.48**	**11.08**	**19.38**	**0.74**	**BDL**
	98th percentile	**348.84**	**209.30**	**15.54**	**22.54**	**0.83**	**BDL**

Table No. 3.17 (b): Ambient Air Monitoring Result at Near CISF Camp Rohini, Sector-34, Delhi (AAQMS2)

AAQ 2	**Near CISF Camp Rohini, Sector-34, Delhi**						
MONTH	**DATE**	**PM_{10} (µg/m³)**	**$PM_{2.5}$ (µg/m³)**	**SO_2 (µg/m³)**	**NO_2 (µg/m³)**	**CO (µg/m³)**	**Hg (µg/m³)**
Mar-23	01.03.2023	228	137	12	24	0.66	BDL
	04.03.2023	190	114	8	20	0.56	BDL
	08.03.2023	158	95	9	22	0.52	BDL
	11.03.2023	146	88	12	24	0.65	BDL
	15.03.2023	164	98	10	21	0.78	BDL
	18.03.2023	184	110	8	24	0.76	BDL
	22.03.2023	208	125	10	26	0.67	BDL
	25.03.2023	197	118	8	22	0.76	BDL
Apr-23	01.04.2023	138	83	11	24	0.71	BDL
	04.04.2023	224	134	8	22	0.77	BDL
	08.04.2023	256	154	10	24	0.68	BDL
	11.04.2023	306	184	7	20	0.71	BDL
	15.04.2023	314	188	14	28	0.65	BDL
	18.04.2023	276	166	9	26	0.62	BDL
	22.04.2023	358	215	8	24	0.58	BDL
	25.04.2023	264	158	10	28	0.68	BDL

May-23	01.05.2023	280	168	9	24	0.74	BDL
	04.05.2023	120	72	14	22	0.61	BDL
	08.05.2023	142	85	12	20	0.65	BDL
	11.05.2023	148	89	8	24	0.63	BDL
	15.05.2023	128	77	14	28	0.54	BDL
	18.05.2023	154	92	8	26	0.61	BDL
	22.05.2023	136	82	10	24	0.71	BDL
	25.05.2023	208	125	9	20	0.66	BDL
	Max	**358**	**215**	**14**	**28**	**0.78**	**BDL**
	Min	**120**	**72**	**7**	**20**	**0.52**	**BDL**
	Avg	**205.29**	**123.18**	**9.92**	**23.63**	**0.66**	**BDL**
	98th percentile	**337.76**	**202.66**	**14.00**	**28.00**	**0.78**	**BDL**

Table No. 3.17 (c): Ambient Air Monitoring Result at Near Vaishno Devi Mandir Khera Kalan Delhi (AAQMS3)

AAQ 3	**Near Vaishno Devi Mandir, Khera Kalan, Delhi**						
MONTH	**DATE**	**PM_{10} (µg/m^3)**	**$PM_{2.5}$ (µg/m^3)**	**SO_2 (µg/m^3)**	**NO_2 (µg/m^3)**	**CO (µg/m^3)**	**Hg (µg/m^3)**
Mar-23	01.03.2023	244	146	13	19	0.75	BDL
	04.03.2023	204	122	7	20	0.77	BDL
	08.03.2023	168	101	13	17	0.76	BDL
	11.03.2023	154	92	11	19	0.62	BDL
	15.03.2023	174	104	8	16	0.72	BDL
	18.03.2023	196	118	13	25	0.64	BDL
	22.03.2023	224	134	9	18	0.59	BDL
	25.03.2023	208	125	10	20	0.54	BDL
Apr-23	01.04.2023	148	89	9	24	0.66	BDL
	04.04.2023	240	144	10	28	0.77	BDL
	08.04.2023	274	164	14	21	0.76	BDL

AAQ 3	Near Vaishno Devi Mandir, Khera Kalan, Delhi						
MONTH	**DATE**	**PM_{10} (µg/m³)**	**$PM_{2.5}$ (µg/m³)**	**SO_2 (µg/m³)**	**NO_2 (µg/m³)**	**CO (µg/m³)**	**Hg (µg/m³)**
	11.04.2023	326	196	6	19	0.72	BDL
	15.04.2023	334	200	7	26	0.64	BDL
	18.04.2023	294	176	10	22	0.56	BDL
	22.04.2023	380	228	8	16	0.66	BDL
	25.04.2023	282	169	11	20	0.72	BDL
May-23	01.05.2023	320	192	7	26	0.66	BDL
	04.05.2023	124	74	10	14	0.78	BDL
	08.05.2023	142	85	8	22	0.76	BDL
	11.05.2023	150	90	11	20	0.64	BDL
	15.05.2023	126	76	8	24	0.75	BDL
	18.05.2023	154	92	12	16	0.67	BDL
	22.05.2023	136	82	12	20	0.62	BDL
	25.05.2023	208	125	15	22	0.64	BDL
	Max	**380**	**228**	**15**	**28**	**0.78**	**BDL**
	Min	**124**	**74**	**6**	**14**	**0.54**	**BDL**
	Avg	**217.08**	**130.25**	**10.08**	**20.58**	**0.68**	**BDL**
	98th percentile	**358.84**	**215.30**	**14.54**	**27.08**	**0.78**	**BDL**

Table No. 3.17 (d): Ambient Air Monitoring Result at Near Post Office Ghoga, Delhi (AAQMS4)

AAQ 4	Near Post Office Ghoga, Delhi						
MONTH	DATE	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 ($\mu g/m^3$)	Hg ($\mu g/m^3$)
Mar-23	02.03.2023	94	56	9	19	0.74	BDL
	05.03.2023	172	103	11	22	0.72	BDL
	09.03.2023	152	91	10	23	0.77	BDL
	12.03.2023	208	125	8	20	0.71	BDL
	16.03.2023	232	139	12	22	0.68	BDL
	19.03.2023	205	123	11	23	0.63	BDL
	23.03.2023	84	50	8	19	0.56	BDL
	26.03.2023	100	60	11	21	0.52	BDL
Apr-23	02.04.2023	143	86	11	20	0.62	BDL
	05.04.2023	176	106	8	17	0.78	BDL
	09.04.2023	126	76	10	21	0.62	BDL
	12.04.2023	180	108	9	18	0.54	BDL
	16.04.2023	158	95	15	22	0.64	BDL
	19.04.2023	194	116	8	14	0.62	BDL
	23.04.2023	218	131	8	21	0.72	BDL
	26.04.2023	234	140	11	23	0.64	BDL
May-23	02.05.2023	188	113	9	21	0.73	BDL
	05.05.2023	246	148	13	24	0.66	BDL
	09.05.2023	272	163	10	22	0.52	BDL
	12.05.2023	184	110	12	25	0.71	BDL
	16.05.2023	240	144	9	24	0.78	BDL
	19.05.2023	216	130	7	18	0.62	BDL
	23.05.2023	288	173	10	20	0.66	BDL
	26.05.2023	294	176	8	18	0.72	BDL

AAQ 4	Near Post Office Ghoga, Delhi						
MONTH	**DATE**	**PM_{10} (µg/m^3)**	**$PM_{2.5}$ (µg/m^3)**	**SO_2 (µg/m^3)**	**NO_2 (µg/m^3)**	**CO (µg/m^3)**	**Hg (µg/m^3)**
	Max	**294**	**176**	**15**	**25**	**0.78**	**BDL**
	Min	**84**	**50**	**7**	**14**	**0.52**	**BDL**
	Avg	**191.83**	**115.10**	**9.92**	**20.71**	**0.66**	**BDL**
	98th percentile	**291.24**	**174.74**	**14.08**	**24.54**	**0.78**	**BDL**

Table No. 3.17 (e): Ambient Air Monitoring Result at Near Mahesh Hosiery Factory Private Limited Sector 1 Bawana (AAQMS5)

AAQ 5	Near Mahesh Hosiery Factory Private Limited, Sector 1, Bawana						
MONTH	**DATE**	**PM_{10} (µg/m^3)**	**$PM_{2.5}$ (µg/m^3)**	**SO_2 (µg/m^3)**	**NO_2 (µg/m^3)**	**CO (µg/m^3)**	**Hg (µg/m^3)**
Mar-23	02.03.2023	164	98	11	24	0.66	BDL
	05.03.2023	118	71	8	20	0.56	BDL
	09.03.2023	146	88	12	23	0.52	BDL
	12.03.2023	186	112	9	18	0.65	BDL
	16.03.2023	224	134	12	24	0.78	BDL
	19.03.2023	194	116	11	20	0.76	BDL
	23.03.2023	162	97	8	18	0.67	BDL
	26.03.2023	152	91	10	20	0.76	BDL
Apr-23	02.04.2023	134	80	11	26	0.71	BDL
	05.04.2023	174	104	13	25	0.77	BDL
	09.04.2023	164	98	10	20	0.68	BDL
	12.04.2023	134	80	9	18	0.71	BDL
	16.04.2023	218	131	14	24	0.65	BDL

AAQ 5	Near Mahesh Hosiery Factory Private Limited, Sector 1, Bawana						
MONTH	**DATE**	**PM_{10} (µg/m^3)**	**$PM_{2.5}$ (µg/m^3)**	**SO_2 (µg/m^3)**	**NO_2 (µg/m^3)**	**CO (µg/m^3)**	**Hg (µg/m^3)**
	19.04.2023	194	116	7	18	0.62	BDL
	23.04.2023	214	128	12	24	0.82	BDL
	26.04.2023	254	152	6	22	0.68	BDL
May-23	02.05.2023	282	169	12	20	0.74	BDL
	05.05.2023	264	158	9	26	0.61	BDL
	09.05.2023	274	164	13	24	0.65	BDL
	12.05.2023	268	161	10	20	0.63	BDL
	16.05.2023	254	152	8	24	0.54	BDL
	19.05.2023	264	158	12	26	0.61	BDL
	23.05.2023	258	155	9	20	0.71	BDL
	26.05.2023	264	158	12	24	0.66	BDL
	Max	**282**	**169**	**14**	**26**	**0.82**	**BDL**
	Min	**118**	**71**	**6**	**18**	**0.52**	**BDL**
	Avrg	**206.67**	**124.00**	**10.52**	**22.00**	**0.67**	**BDL**
	98th percentile	**278.32**	**166.99**	**13.81**	**26.00**	**0.80**	**BDL**

Table No. 3.17 (f): Ambient Air Monitoring Result at Near Bank of Baroda Narela New Delhi (AAQMS6)

AAQ 6	Near Bank of Baroda Narela, New Delhi						
MONTH	**DATE**	**PM_{10} (µg/m^3)**	**$PM_{2.5}$ (µg/m^3)**	**SO_2 (µg/m^3)**	**NO_2 (µg/m^3)**	**CO (µg/m^3)**	**Hg (µg/m^3)**
	02.03.2023	98	59	10	20	0.62	BDL
Mar-23	05.03.2023	116	70	9	19	0.68	BDL
	09.03.2023	146	88	6	22	0.69	BDL

AAQ 6	Near Bank of Baroda Narela, New Delhi						
MONTH	**DATE**	**PM_{10} (µg/m^3)**	**$PM_{2.5}$ (µg/m^3)**	**SO_2 (µg/m^3)**	**NO_2 (µg/m^3)**	**CO (µg/m^3)**	**Hg (µg/m^3)**
	12.03.2023	192	115	11	19	0.64	BDL
	16.03.2023	224	134	8	24	0.58	BDL
	19.03.2023	198	119	10	23	0.72	BDL
	23.03.2023	164	98	8	21	0.62	BDL
	26.03.2023	152	91	10	18	0.59	BDL
Apr-23	02.04.2023	138	83	8	22	0.62	BDL
	05.04.2023	170	102	7	21	0.66	BDL
	09.04.2023	122	73	11	18	0.62	BDL
	12.04.2023	174	104	10	16	0.64	BDL
	16.04.2023	152	91	8	21	0.66	BDL
	19.04.2023	188	113	11	20	0.62	BDL
	23.04.2023	210	126	9	23	0.66	BDL
	26.04.2023	246	148	11	18	0.64	BDL
May-23	02.05.2023	282	169	10	18	0.65	BDL
	05.05.2023	334	200	11	19	0.62	BDL
	09.05.2023	264	158	8	23	0.65	BDL
	12.05.2023	304	182	10	21	0.58	BDL
	16.05.2023	266	160	11	19	0.66	BDL
	19.05.2023	282	169	10	23	0.65	BDL
	23.05.2023	274	164	8	23	0.68	BDL
	26.05.2023	284	170	6	27	0.64	BDL
	Max	**334**	**200**	**11**	**27**	**0.72**	**BDL**
	Min	**98**	**59**	**6**	**16**	**0.58**	**BDL**
	Avrg	**207.50**	**124.50**	**9.32**	**20.48**	**0.64**	**BDL**
	98th percentile	**320.20**	**192.12**	**11.28**	**25.53**	**0.71**	**BDL**

Table No. 3.17 (g): Ambient Air Monitoring Result at Near Shri Balaji Mandir Sec-11 Rohini (AAQMS7)

AAQ 7	Near Shri Balaji Mandir, Sec-11, Rohini						
MONTH	DATE	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	CO (µg/m³)	Hg (µg/m³)
Mar-23	03.03.2023	204	122	8	17	0.62	BDL
	06.03.2023	116	70	12	24	0.77	BDL
	10.03.2023	220	132	9	21	0.62	BDL
	13.03.2023	186	112	12	20	0.72	BDL
	17.03.2023	190	114	11	19	0.76	BDL
	20.03.2023	224	134	9	21	0.66	BDL
	24.03.2023	156	94	13	32	0.74	BDL
	27.03.2023	144	86	10	22	0.67	BDL
Apr-23	03.04.2023	252	151	12	28	0.74	BDL
	06.04.2023	224	134	8	22	0.66	BDL
	10.04.2023	286	172	16	18	0.71	BDL
	13.04.2023	292	175	9	30	0.62	BDL
	17.04.2023	144	86	14	26	0.78	BDL
	20.04.2023	152	91	8	22	0.72	BDL
	24.04.2023	236	142	18	30	0.52	BDL
	27.04.2023	98	59	10	28	0.56	BDL
May-23	03.05.2023	106	64	8	26	0.64	BDL
	06.05.2023	154	92	14	20	0.77	BDL
	10.05.2023	144	86	8	30	0.64	BDL
	13.05.2023	162	97	13	24	0.52	BDL
	17.05.2023	182	109	9	26	0.64	BDL
	20.05.2023	192	115	16	22	0.66	BDL
	24.05.2023	174	104	5	18	0.72	BDL
	27.05.2023	164	98	16	22	0.76	BDL

AAQ 7	Near Shri Balaji Mandir, Sec-11, Rohini						
MONTH	**DATE**	**PM_{10} (µg/m³)**	**$PM_{2.5}$ (µg/m³)**	**SO_2 (µg/m³)**	**NO_2 (µg/m³)**	**CO (µg/m³)**	**Hg (µg/m³)**
	Max	**292**	**175**	**18**	**32**	**0.78**	**BDL**
	Min	**98**	**59**	**5**	**17**	**0.52**	**BDL**
	Avrg	**183.42**	**110.05**	**11.17**	**23.67**	**0.68**	**BDL**
	98th percentile	**289.24**	**173.54**	**17.08**	**31.08**	**0.78**	**BDL**

Table No. 3.17 (h): Ambient Air Monitoring Result at Near Government Animal Hospital, Ferozpur Bangar Village, Haryana (AAQMS8)

AAQ 8	Near Government Animal Hospital Ferozpur Bangar Village, Haryana						
MONTH	**DATE**	**PM_{10} (µg/m³)**	**$PM_{2.5}$ (µg/m³)**	**SO_2 (µg/m³)**	**NO_2 (µg/m³)**	**CO (µg/m³)**	**Hg (µg/m³)**
Mar-23	03.06.2023	118	71	18	20	0.68	BDL
	06.03.2023	224	134	11	21	0.64	BDL
	10.03.2023	186	112	9	24	0.68	BDL
	13.03.2023	192	115	13	21	0.76	BDL
	17.03.2023	224	134	11	23	0.58	BDL
	20.03.2023	158	95	8	26	0.84	BDL
	24.03.2023	146	88	10	22	0.72	BDL
	27.03.2023	208	125	9	24	0.82	BDL
Apr-23	03.04.2023	218	131	10	20	0.62	BDL
	06.04.2023	129	77	8	22	0.68	BDL
	10.04.2023	152	91	16	26	0.72	BDL
	13.04.2023	236	142	9	30	0.58	BDL
	17.04.2023	224	134	14	26	0.70	BDL
	20.04.2023	238	143	11	20	0.82	BDL
	24.04.2023	216	130	7	21	0.64	BDL

AAQ 8	Near Government Animal Hospital Ferozpur Bangar Village, Haryana						
MONTH	**DATE**	**PM_{10} (µg/m³)**	**$PM_{2.5}$ (µg/m³)**	**SO_2 (µg/m³)**	**NO_2 (µg/m³)**	**CO (µg/m³)**	**Hg (µg/m³)**
	27.04.2023	182	109	11	23	0.76	BDL
May-23	03.05.2023	194	116	13	24	0.72	BDL
	06.05.2023	218	131	10	21	0.62	BDL
	10.05.2023	244	146	9	25	0.76	BDL
	13.05.2023	184	110	8	22	0.66	BDL
	17.05.2023	196	118	9	26	0.62	BDL
	20.05.2023	208	125	16	22	0.72	BDL
	24.05.2023	218	131	13	23	0.72	BDL
	27.05.2023	206	124	9	19	0.62	BDL
Max		**244**	**146**	**18**	**30**	**0.84**	**BDL**
Min		**118**	**71**	**7**	**19**	**0.58**	**BDL**
Avrg		**196.63**	**117.98**	**10.92**	**22.96**	**0.70**	**BDL**
98th percentile		**241.24**	**144.74**	**17.08**	**28.16**	**0.83**	**BDL**

The results of Ambient Air Quality Monitoring across 8 stations indicate varying concentrations of pollutants. The particulate matter, PM_{10} concentrations ranged from a minimum of 77.0 µg/m³ to a maximum of 380.0 µg/m³, while $PM_{2.5}$ levels varied between 46.0 µg/m³ and 228.0 µg/m³. The $PM_{2.5}$ was recorded highest (228.0 µg/m³) at AQ3 (Near Vaishno Devi Mandir Khera Kalan Delhi), while PM_{10} was recorded highest (380.0 µg/m³) at AQ3 (Near Vaishno Devi Mandir Khera Kalan Delhi). These findings highlight fluctuations in airborne particulates, which are crucial indicators of air quality and potential respiratory health risks.

In terms of gaseous pollutants, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO), all remained within permissible limits set by the National Ambient Air Quality (NAAQ) Standards for residential and rural areas. The concentrations of NO_2 ranged from 14.0 µg/m³ to 32.0 µg/m³, SO2 from 5.0 µg/m³ to 18.0 µg/m³, and CO from 0.52 mg/m³ to 0.84 mg/m³. These results indicate compliance with regulatory thresholds aimed at safeguarding public health from the adverse effects of these gases, which can originate from vehicle emissions, industrial processes, and other combustion sources.

Furthermore, the concentrations of mercury (Hg) were found to be below the detection limit (BDL). This is reassuring from a health perspective, as mercury contamination in ambient air can pose significant risks to human health and ecosystems.

3.14 SOIL QUALITY

Soil is an important ecological factor supporting biodiversity on the earth for sustainable development. Hence, the productive status of soil needs to be maintained for survival of the biota. The characterization of soil quality helps in assessing the health of the soil.

3.14.1 Methodology of Soil Analysis

The International Pipette Method (Black, 1964) has been adopted for determination of particle size analysis. Physical parameters such as bulk density, porosity and water holding capacity were determined by the following KR Box Method (Keen - Raczkowski, 1921).

The chemical characteristics of soil were determined by preparing soil extract in distilled water in ratio 1:2 (as per Jackson procedure, 1967). Organic matter is determined in terms of organic carbon by Walkley & Black method (1972). Fertility status of soil in terms of nitrogen and phosphorus and potassium is determined by Kjeldhal method, Olsen’s method (1954) and Flame Photometer (Jackson (1967)), respectively. Soil sampling was done at 8 locations. The name of sampling locations are given in **Table 3.18** and **Figure 3.15.** The soil monitoring photographs are given in **Figure 3.16.**

Table 3.18: Soil sampling locations

Sr. No.	Location	Land Use Type	Distance	Direction	Latitude	Longitude
SQ 1	Near Project Site	Agriculture Land	0.16km	E	28° 47' 43.450" N	77° 3' 49.088" E
SQ 2	Near Ramky Enviro Engineers Ltd Sector 5, Bawana Delhi	Waste Land	1.01km	NE	28° 48' 9.283" N	77° 4' 7.630" E
SQ 3	Near Shani Dev Mandir Ghoga Delhi	Agriculture Land	4.40km	N	28° 50' 6.437" N	77° 3' 32.283" E
SQ4	Near Chor piap forest - National forest Kanjhawala Delhi	Agriculture Land	5.31km	SW	28° 46' 33.112" N	77° 0' 44.758" E
SQ 5	Near Camp Deva Farm - Picnic ground Alipur New Delhi (Agricultural Area)	Waste Land	4.86km	SE	28° 47' 15.633" N	77° 6' 37.933" E
SQ 6	Near Gopal Gau Sadan Harewali New Delhi (Pond)	Waste Land	4.61km	NW	28° 50' 2.802" N	77° 1' 31.951" E
SQ 7	Near Vivansh Air& Water Solutions Prahladpur, Rohini Delhi	Vegetation Land	7.90km	SE	28° 44' 0.655" N	77° 6' 9.798" E
SQ 8	Near Khera Sports Club, Khera Khurd Rd Sector 35, Rohini	Agriculture Land	3.62km	SE	28° 46' 47.735" N	77° 5' 41.329" E

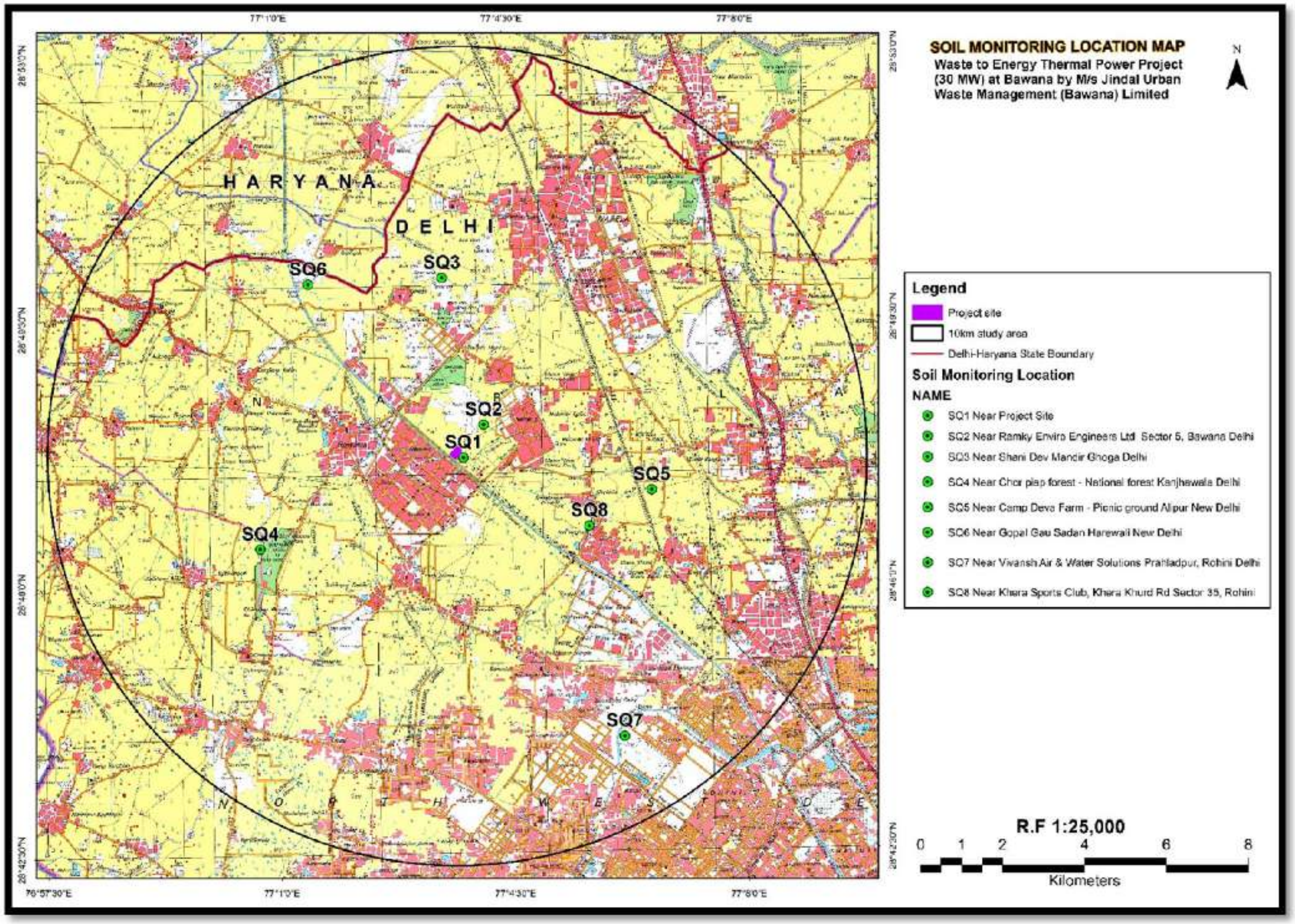


Figure 3.15:- Showing Soil Sampling Stations


GPS Map Camera
Delhi, Delhi, India
Western Yamuna Canal Link Road, DSIIDC Industrial Area, Sector 5, Bawana, Delhi, 110039, India
Lat 28.796579°
Long 77.060567°
30/03/23 01:22 PM GMT +05:30
Google


GPS Map Camera
Delhi, Delhi, India
Unnamed Road, Sector 5, Bawana, Delhi, 110040, India
Lat 28.799482°
Long 77.062231°
28/04/23 11:29 AM GMT +05:30
Google


GPS Map Camera
Delhi, Delhi, India
Bhagwan Parshuram Marg, Asthal Colony, Ghoga, Delhi, 110039, India
Lat 28.825048°
Long 77.058149°
28/04/23 02:22 PM GMT +05:30
Google


GPS Map Camera
Delhi, Delhi, India
246, DSIIDC Industrial Area, Sector 4, Bawana, Delhi, 110039, India
Lat 28.793822°
Long 77.058406°
30/03/23 01:22 PM GMT +05:30
Google

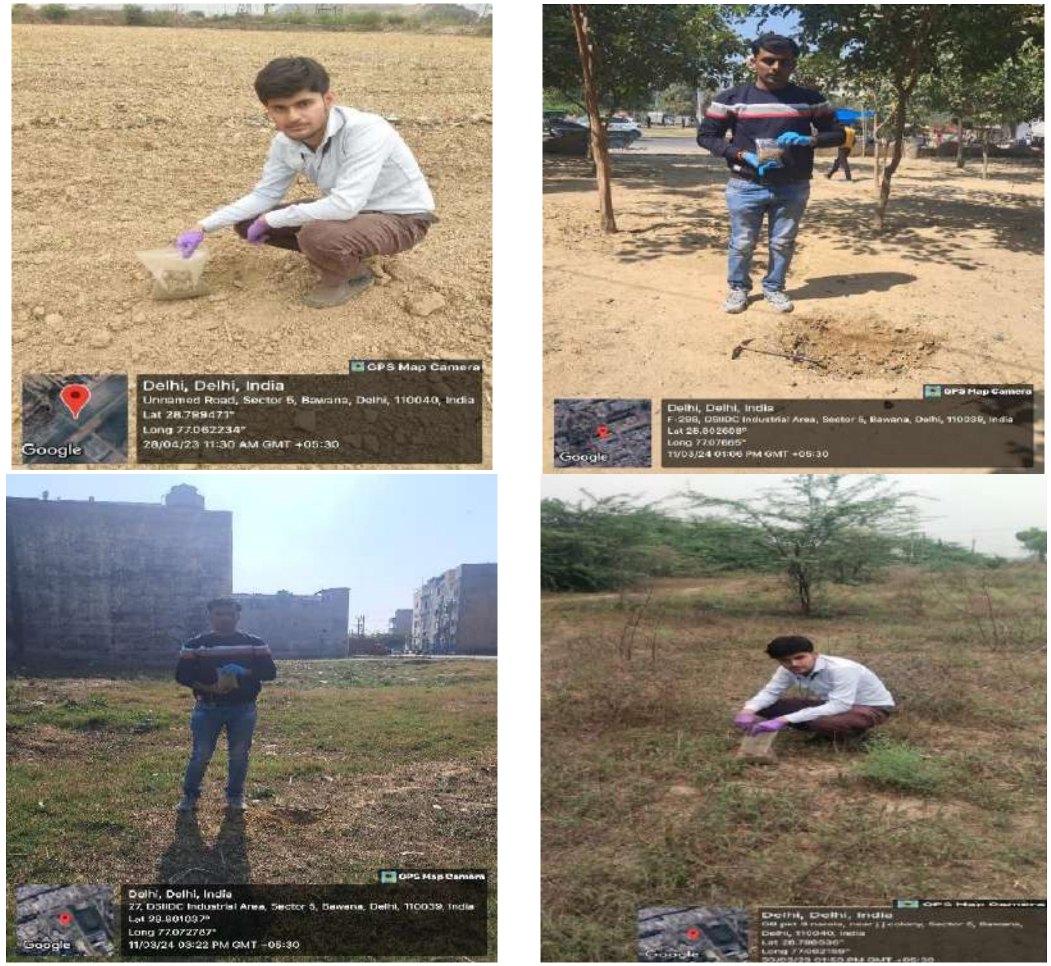


Figure 3.16:- Soil Monitoring Photographs

3.14.2 Results and Interpretation of Soil Quality

The soil quality monitoring results are presented in **Table-3.19.**

Table 3.19: Soil Quality Results

Sr. No.	Parameters	Units	SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	SQ7	SQ8
			Near Project Site	Near Ramky Enviro Engineers Ltd. Sector 5, Bawana Delhi	Near Shani Dev Mandir Ghoga Delhi	Near Chor Chiap Forest - National Forest Kanjhawala	Near Camp Deva Farm - Picnic Ground Alipur New Delhi	Near Gopal Gau Sadan Harewali New Delhi	Near Vivansh Air& Water Solutions Prahladpur, Rohini Delhi	Near Khera Sports Club, Khera Khurd Rd Sector 35, Rohini
1	pH	-	7.12	6.22	6.8	7.2	7.35	6.92	7.33	7.66
2	Bulk Density	gm/cm^3	1.55	1.57	1.68	1.49	1.63	1.72	1.59	1.62
3	Conductivity	Micro mhos/cm	238	312	286	252	278	284	280	324
4	Moisture	%	6	5.9	7.1	6.8	6.6	6.4	7.2	5.8
5	Texture	-	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
6	Sand	%	84	88	82	78	85	84	78	76
7	Clay	%	10	8	11	16	12	8	12	14
8	Silt	%	6	4	7	6	3	8	10	10
9	Sodium	mg/100gm	4.2	4.5	5.7	5.4	4.9	3.7	5.2	6.1
10	Nitrogen	mg/100gm	14.36	13.91	15.87	15.07	16.23	15.69	16.36	16.01

Sr. No.	Parameters	Units	SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	SQ7	SQ8
			Near Project Site	Near Ramky Enviro Engineers Ltd. Sector 5, Bawana Delhi	Near Shani Dev Mandir Ghoga Delhi	Near Chor Chiap Forest - National Forest Kanjhawala	Near Camp Deva Farm - Picnic Ground Alipur New Delhi	Near Gopal Gau Sadan Harewali New Delhi	Near Vivansh Air& Water Solutions Prahladpur, Rohini Delhi	Near Khera Sports Club, Khera Khurd Rd Sector 35, Rohini
		Kg/ha	321.66	311.58	355.49	337.57	363.55	351.46	366.46	358.62
11	Phosphorous	mg/100gm	0.75	0.66	0.84	0.89	0.62	0.84	0.8	0.66
		Kg/ha	16.80	14.78	18.82	19.94	13.89	18.82	17.92	14.78
12	Potassium	mg/100gm	9.45	8.74	9.90	8.56	8.92	9.63	10.34	9.9
		Kg/ha	211.68	195.78	221.76	191.74	199.81	215.71	231.62	221.76
13	CEC	meq/100gm	7.46	6.64	8.34	10.72	8.56	6.70	8.74	10.48
14	Organic Matter	%	1.23	1.32	1.42	1.36	1.28	1.35	1.37	1.74
15	Ca	meq/100gm	2.72	2.68	3.34	3.22	2.59	2.84	3.12	2.78
16	Mg	meq/100gm	1.66	1.24	2.2	1.8	1.32	1.76	1.58	2.2
17	SAR	-	0.49	0.57	0.59	0.59	0.61	0.42	0.59	0.66
18	Silver as Ag	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND
19	Arsenic as As	mg/kg	6.625	5.885	1.029	5.206	5.784	1.425	5.969	ND
20	Boron as B	mg/kg	9.872	9.972	1.606	16.788	17.152	2.913	7.365	1.550
21	Barium as Ba	mg/kg	307.652	79.281	14.917	250.718	256.571	62.741	166.168	38.189
22	Cadmium as Cd	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND
23	Chromium as Cr	mg/kg	25.352	26.534	4.750	26.348	26.954	6.791	17.222	4.120
24	Copper as Cu	mg/kg	28.982	28.558	3.998	23.402	23.884	5.495	17.500	4.853

Sr. No.	Parameters	Units	SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	SQ7	SQ8
			Near Project Site	Near Ramky Enviro Engineers Ltd. Sector 5, Bawana Delhi	Near Shani Dev Mandir Ghoga Delhi	Near Chor Chiap Forest - National Forest Kanjhawala	Near Camp Deva Farm - Picnic Ground Alipur New Delhi	Near Gopal Gau Sadan Harewali New Delhi	Near Vivansh Air& Water Solutions Prahladpur, Rohini Delhi	Near Khera Sports Club, Khera Khurd Rd Sector 35, Rohini
25	Mercury as Hg	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND
26	Manganese as Mn	mg/kg	256.503	271.190	59.237	284.538	292.224	65.426	206.431	47.558
27	Nickel as Ni	mg/kg	20.654	24.936	4.639	24.110	24.669	6.738	17.903	4.535
28	Lead as Pb	mg/kg	16.791	14.889	2.177	12.363	12.916	4.237	7.528	2.034
29	Selenium as Se	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND
30	Zinc as Zn	mg/kg	63.025	61.530	11.014	56.739	57.635	18.256	34.939	11.005

- The study area's soil composition is characterized as Sandy Loam, which is known for its balanced mixture of sand, silt and clay particles, offering good drainage. pH value ranges from 6.22 to 7.66. Additionally, organic matter content was measured between 1.23% to 1.74%, indicating moderate levels that contribute to soil fertility and structure.
- Nitrogen levels ranged from 311.58 kg/ha to 366.46 kg/ha, phosphorus concentrations varied between 13.89 kg/ha to 19.94 kg/ha and potassium content ranged from 191.74 kg/ha to 231.62 kg/ha. Copper ranged from 3.998 mg/kg to 28.98 mg/kg, Manganese levels ranged from 47.55 mg/kg to 292.224 mg/kg, Zinc levels ranged from 11.005 mg/kg to 63.025 mg/kg.

3.15 COMPARATIVE STUDY OF PREVIOUS BASELINE DATA AND EXISTING BASELINE DATA

The purpose of the study is to conduct a comparative analysis between previous baseline data and existing baseline data. This approach is vital for several reasons. Firstly, it allows for an assessment of how conditions have evolved or remained static since the previous data collection. Secondly, it provides insights into whether interventions or natural changes have influenced the parameters being measured. Finally, it aids in identifying trends, patterns or anomalies that may help in decision-making and resource allocation.

Baseline study conducted for the proposed project in the year 2023 has been compared with the baseline study conducted by nearby industries in 2019 and 2022. The 2019 and 2022 data pertains to Delhi Municipal Solid Waste Solutions Limited (DMSWSL), Bawana *(Source: EIA Report*) and the data of 2023 pertains to the EIA study of the proposed Waste to Energy (WtE) Bawana project.

Since, the monitoring locations are not the same and there are temporal differences, hence a precise comparison was not possible. However, as mentioned in the ToR, comparative charts have been prepared with respect to below mentioned parameters:-

1. Soil Environment
2. Water Environment
3. Noise Environment
4. Air Environment

The changes observed from previous baseline study and present baseline study have been described below:

3.15.1 Soil Environment

3.15.1.1 Comparative study of soil quality for 2019, 2022 and 2023.

The table provides results for various parameters of soil samples taken in 2019, 2022 and 2023. The texture of the soil consistently remained sandy loam across all years. The pH values (1:5 extract) showed variations over the years in 2019, it was 8.1, decreasing to 7.8 in 2022 and further to 7.2 in 2023. Electrical conductivity (EC) values (1:5 extract) fluctuated significantly: from 386 µS/cm in 2019 to 303 µS/cm in 2022 and down to 238 µS/cm in 2023, indicating a general decrease. Bulk density (g/cc) varied from 1.05 in 2019 to 1.28 in 2022 and then increased to 1.49 in 2023. Total organic carbon content (%) exhibited an increase from 0.32% in 2019 to 0.50% in 2022 and a further rise to 1.36% in 2023. The concentration of nutrients such as Calcium (as Ca), Magnesium (as Mg), Copper (as Cu), Boron (as B), Manganese (as Mn) and Zinc (as Zn) showed different trends across the years with some elements increasing and decreasing over the years. The comparative results is tabulated in **Table 3.20 (a) & 3.20 (b)**:-

Table 3.20 (a): Comparison of soil quality results for the year 2019, 2022 and 2023

Parameter	Unit	Analysis results											
		Near Project Site			Sector 5, Bawana Delhi			Ghoga, Delhi			Forest Kanjhawala, Delhi		
		2019	2022	2023	2019	2022	2023	2019	2022	2023	2019	2022	2023
Texture	-	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
pH (1:5 extract)	--	8.1	7.8	7.12	8.3	8.1	6.22	7.9	8.3	6.8	7.7	7.8	7.2
EC (1:5 extract)	µS/cm	386	303	238	456	234	312	465	195	286	480	133	252
Bulk Density	g/cc	1.05	1.28	1.55	1.22	1.23	1.57	1.13	1.32	1.68	1.21	1.25	1.49
Total organic Carbon	%	0.32	0.50	1.23	0.25	0.79	1.32	0.15	0.49	1.42	0.55	0.40	1.36
Calcium as Ca	mg/Kg	146	554	544	223	298	536	280	536	668	245	270	644
Magnesium as Mg	mg/Kg	44	60.0	199.2	58	50.1	148.8	68	64.3	264	60	64.4	216
Copper as Cu	mg/Kg	5.4	24.2	28.982	11.2	11.7	28.558	8.5	15.1	3.998	6.6	7.2	23.402
Boron as B	mg/Kg	18	10.7	9.872	22	12.2	9.972	25	16.8	1.606	32	8.8	16.788
Manganese as Mn	mg/Kg	123	326	256.503	234	539	271.190	214	294	59.237	185	199	284.538
Zinc as Zn	mg/Kg	26	117	63.025	43	46.7	61.530	48	78.1	11.014	52	35.9	56.739

Table 3.20 (b): Comparison of soil quality results for the year 2019, 2022 and 2023

Parameter	Unit	Analysis results											
		Alipur, New Delhi			Harewali, New Delhi			Rohini, Delhi			Khera Khurd Sector 35, Rohini		
		2019	2022	2023	2019	2022	2023	2019	2022	2023	2019	2022	2023
Texture	-	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
pH (1:5 extract)	--	8.4	7.7	7.35	7.8	8.2	6.92	7.5	8.1	7.33	7.7	8.3	7.66
EC (1:5 extract)	µS/cm	412	200	278	405	537	284	425	146	280	393	165	324
Bulk Density	g/cc	1.55	1.22	1.63	1.22	1.34	1.72	1.08	1.46	1.59	1.01	1.24	1.62
Total organic Carbon	%	0.18	1.50	1.28	0.21	0.63	1.35	0.22	0.30	1.37	0.24	0.57	1.74
Calcium as Ca	mg/Kg	205	466	2.59	134	378	2.84	175	221	3.12	158	299	2.78
Magnesium as Mg	mg/Kg	75	64.4	158.4	38	50.5	211.2	65	37.8	189.6	48	44.5	264
Copper as Cu	mg/Kg	10.5	13.2	23.884	7.8	11.6	5.495	7.2	15.7	17.500	6.8	11.3	4.853
Boron as B	mg/Kg	35	28.4	17.152	28	32.3	2.913	22	12.2	7.365	32	20.4	1.550
Manganese as Mn	mg/Kg	160	296	292.224	192	286	65.426	202	236	206.431	175	186	47.558
Zinc as Zn	mg/Kg	42	51.3	57.635	28	55.3	18.256	36	50.8	34.939	40	35.8	11.005

3.15.2 Water Environment

3.15.2.1 Comparative study of ground water quality from the year 2019, 2022 and 2023

The table represents results for various water quality parameters across the years 2019, 2022, and 2023. The pH values showed slight variations: starting from 7.4 in 2019 and 7.5 in 2022, increasing to 7.58 in 2023. Total Dissolved Solids (TDS) (mg/L) varied significantly: from 560 in 2019 to 680 in 2022 and then decreasing to 404 in 2023. Turbidity (NTU) showed fluctuating values across the years, with notable changes such as 0.5 in 2019, decreasing to less than 0.1 in 2022 and then increasing to 1.0 in 2023. Alkalinity (mg/L as $CaCO_3$) ranged from 196 in 2019, 245 in 2022 and decreased to 210 in 2023. Chloride (mg/L) varied from 68 in 2019 to 98.3 in 2022 and then decreased to 78 in 2023. Sulphate (mg/L) showed variations with values such as 92 in 2019, 71.2 in 2022 and 52 in 2023. Nitrate (mg/L) values fluctuated from 14.0 in 2019 to 34.1 in 2022 and then decreased to 10.2 in 2023. Hardness (mg/L as $CaCO_3$) ranged from 193 in 2019, 198 in 2022 and 222 in 2023. Sodium (mg/L) showed variations from 98.0 in 2019, 162 in 2022 and 52 in 2023. Potassium (mg/L) varied from 12.0 in 2019, 10.1 in 2022 and 5 in 2023. Fluoride (mg/L) showed variations from 1.22 in 2019, 1.24 in 2022 and 0.59 in 2023. Iron (mg/L) showed variations from 0.26 in 2019, less than 0.2 in 2022 and 0.002 in 2023. Comparison of ground water results for the year 2019, 2022 and 2023 is given in the **Table 3.21 (a) & 3.21 (b):-**

Table 3.21 (a): Comparison of ground water results for the year 2019, 2022 and 2023

Parameter	Unit	Analysis results											
		Narela			Holambi Khurd, Delhi			Puth Khurd, Delhi			Sector-24, Rohini Delhi		
		2019	2022	2023	2019	2022	2023	2019	2022	2023	2019	2022	2023
pH	--	7.4	7.5	6.94	7.7	7.8	7.11	7.6	8.0	7.44	7.7	7.9	7.58
TDS	mg/L	560	680	404	1505	1031	414	1220	1150	449	1425	1020	433
Turbidity	NTU	0.5	<0.1	1.3	0.8	<0.1	1.6	1.1	0.3	1.4	0.5	0.1	1.0
Alkalinity as $CaCO_3$	mg/L	196	245	194	312	340	188	285	393	220	324	372	210
Chloride as Cl	mg/L	68	98.3	70	480	201	76	324	244	84	423	152	78
Sulphate as SO_4	mg/L	92	71.2	45	122	141	49	134	210	44	143	160	52
Nitrate as NO_3	mg/L	14.0	34.1	11.4	32	22.2	11.8	40	11.1	11.9	25	43.3	10.2
Hardness as $CaCO_3$	mg/L	193	198	176	468	436	181	353	458	198	455	399	222
Sodium as Na	mg/L	98.0	162	62	275	182	62	265	192	66	280	204	52
Potassium as K	mg/L	12.0	10.1	6	112	14.4	6	75	22.2	7	85	28.4	5
Fluoride as F	mg/L	1.22	1.24	0.66	1.43	1.16	0.62	1.12	1.23	0.74	1.25	1.33	0.59
Iron as Fe	mg/L	0.26	<0.2	0.013	0.32	7.8	0.01	0.65	<0.2	0.003	0.93	<0.2	0.002

Table 3.21 (b): Comparison of ground water results for the year 2019, 2022 and 2023

Parameter	Unit	Analysis results											
		Kanjhawala			Bawana Village, Delhi			Alipur, New Delhi			Khera Khurd, Delhi		
		2019	2022	2023	2019	2022	2023	2019	2022	2023	2019	2022	2023
pH	--	7.9	7.4	7.36	8.4	7.7	7.28	8.2	8.2	7.45	8.1	8.4	7.35
TDS	mg/L	1210	795	452	1345	2162	698	1444	2373	444	1405	2040	232
Turbidity	NTU	0.5	0.1	1.1	1.2	0.1	1.4	0.5	0.2	1.3	0.8	0.3	1.2
Alkalinity as $CaCO_3$	mg/L	345	240	228	412	350	218	382	439	232	360	428	204
Chloride as Cl	mg/L	365	250	66	380	685	82	412	560	62	395	605	65
Sulphate as SO_4	mg/L	85	32.1	55	122	364	58	143	591	53	152	346	46
Nitrate as NO_3	mg/L	22	8.4	13.8	28	43.0	12.7	32	40.2	13.4	40	43.8	11.7
Total Hardness as $CaCO_3$	mg/L	472	345	244	545	735	250	581	849	236	535	886	134
Sodium as Na	mg/L	230	140	54	240	490	45	260	510	54	245	402	45
Potassium as K	mg/L	60	5.2	6	65	38.1	5	80	28.2	5	65	21.6	5
Fluoride as F	mg/L	1.24	1.21	0.67	1.08	1.62	0.81	1.02	1.79	0.69	1.04	1.58	0.57
Iron as Fe	mg/L	0.56	<0.2	0.005	0.65	<0.2	0.014	0.82	<0.2	<0.3	0.26	<0.2	0.006

3.15.2.2 Surface water

The water quality parameters measured over the years 2019, 2022 and 2023 show significant variations reflecting changes in environmental conditions and water treatment processes. pH levels exhibited slight fluctuations, starting at 8.2 in 2019 and decreasing to 7.8 in 2022 before stabilizing at 7.34 in 2023. Total Suspended Solids (TSS) decreased from 34 mg/L in 2019 to 4 mg/L in 2023, indicating improvements in water clarity. Total Dissolved Solids (TDS) declined from 858 mg/L in 2019 to 301 mg/L in 2023, suggesting reduced mineral content. Turbidity (NTU) decreased notably from 6.2 in 2019 to 0.6 in 2022, then slightly increased to 2.5 in 2023. Alkalinity (mg/L as $CaCO_3$) saw a sharp decrease from 275 mg/L in 2019 to 88 mg/L in 2022, followed by a slight increase to 148 mg/L in 2023. Chloride levels decreased from 163 mg/L in 2019 to 46 mg/L in 2023, indicating reduced salinity. Sulphate concentrations fluctuated, with a peak of 118 mg/L in 2019 and a low of 27 mg/L in 2023. Nitrates varied from 12 mg/L in 2019 to 10.5 mg/L in 2023. Total Hardness (mg/L as $CaCO_3$) showed slight variations, ranging from 297 mg/L in 2019 to 180 mg/L in 2023. Sodium and potassium levels exhibited reductions over the years, reflecting changes in water composition. Fluoride and Iron concentrations remained relatively stable, with minor fluctuations. Dissolved Oxygen (DO) levels increased from 2.8 mg/L in 2019 to 6.3 mg/L in 2023, indicating improved water oxygenation. Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) levels varied, indicating fluctuations in organic pollutant content. Total Coliform counts showed varying levels of bacterial contamination across the years. These findings highlight dynamic shifts in water quality parameters influenced by natural processes and human activities with implications for water resource management and environmental health. Comparison of surface water results for the year 2019, 2022 and 2023 is given in the **Table 3.22:-**

Table 3.22: Comparison of surface water results for the year 2019, 2022 and 2023

Parameter	Units	Results					
		Rohini, Delhi			Begam Vihar, Delhi		
		2019	2022	2023	2019	2022	2023
pH	---	8.2	7.8	7.28	7.5	7.4	7.34
TSS	mg/L	34	30	4	22	15	4
TDS	mg/L	858	314	301	565	436	311
Turbidity	NTU	6.2	0.6	2.5	4.4	0.4	2.5
Alkalinity as $CaCO_3$	mg/L	275	91.0	158	142	88.0	148
Chloride as Cl	mg/L	163	69.0	43	120	68.0	46
Sulphate as SO4	mg/L	118	38.7	27	62	92.0	40
Nitrates as NO3	mg/L	12	1.4	8.4	22	7.5	10.5
Total Hardness as $CaCO_3$	mg/L	297	161	196	177	228	180
Sodium as Na	mg/L	154	18.0	32	112	38.0	32
Potassium as K	mg/L	43	5.1	4	22	5.8	6
Fluoride as F	mg/L	1.15	1.18	0.52	1.34	1.42	0.54
Iron as Fe	mg/L	0.23	0.34	0.011	0.28	0.41	0.011
DO	mg/L	2.8	4.6	6.2	5.2	2.4	6.3
COD	mg/l	74	15.0	42	52	69.0	42
BOD	mg/l	26	<4	10	18	27	10
Total Coliform	MPN/100ml	>1600	>1600	1480	>1600	>1600	1410

3.15.3 Noise Environment

3.15.3.1 Comparative study of noise levels from the year 2019, 2022 and 2023

The noise monitoring data from 2019, 2022 and 2023 reveals varying levels of noise pollution during both daytime and nighttime. Daytime noise levels ranged from 51.4 dB to 66.5 dB in 2019, 52 dB to 66.25 dB in 2022 and 42.6 dB to 54.8 dB in 2023. Nighttime noise levels showed a similar trend, varying from 36.2 dB to 50.5 dB in 2019, 36.2 dB to 51.15 dB in 2022 and 36.8 dB to 42.6 dB in 2023. Across the years, there were fluctuations in noise levels with some decreases observed from 2019 to 2023, particularly noticeable in nighttime. The comparison of noise level monitoring is given in **Table 3.23:**

Table 3.23: Comparison of noise monitoring results for the year 2019, 2022 and 2023 - dB (A)

Sr. No.	Location	Day time results			Night time results		
		2019	2022	2023	2019	2022	2023
1	Sector 5 Bawana, Delhi	56.75	57.2	54.8	45.8	46.7	42.6
2	Rohini, Delhi	52.55	52.4	42.6	44.95	45.35	39.2
3	Khera Kalan, Delhi	66.5	66.25	45.2	53.55	53.95	36.8
4	Mahatma Gandhi Chowk, Sonipat	51.4	52	50.4	44.45	44.8	40.5
5	DSIIDC Industrial Area, Bawana	60.35	59.85	52.6	48.25	48.85	41.5
6	DSIDC Industrial Area, Narela	60.55	60.9	46.5	48.65	48.95	40.6
7	Rohni, Delhi	60.85	61.6	43.8	50.5	51.15	37.8
8	Ferozpur Bangar Village, Haryana	61.65	60.45	46.5	50.55	50.35	36.2

3.15.4 Air Environment

3.15.4.1 Comparative study of Air quality from the year 2019, 2022 and 2023

The air quality data for PM_{10} and $PM_{2.5}$, SO_2, NO_2 and CO across the years 2019, 2022 and 2023 reveals significant variations in pollutant concentrations. PM_{10} levels ranged widely from 70.0 to 171 µg/m3 in 2019, 74.3 to 212 µg/m3 in 2022 and 41.4 to 84.3 µg/m3 in 2023. $PM_{2.5}$ concentrations also varied, ranging from 48.3 to 132 µg/m3 in 2019, 56.5 to 132 µg/m3 in 2022 and 46 to 222 µg/m3 in 2023. SO2 levels showed fluctuations with values ranging between 15.8 to 28.1 µg/m3 in 2019, 17.3 to 36.3 µg/m3 in 2022 and 24.8 to 38.1 µg/m3 in 2023. Similarly, NO_2 concentrations varied from 14 to 29 µg/m3 in 2019, 16 to 38.1 µg/m3 in 2022 and 19 to 32 µg/m3 in 2023. CO levels exhibited ranges of 850 to 1354 µg/m3 in 2019, 810 to 1482 µg/m3 in 2022 and 520 to 840 µg/m3 in 2023. These data illustrate the dynamic nature of air quality parameters over the mentioned period, indicating fluctuations influenced by factors such as industrial activities, traffic emissions and meteorological conditions. Comparison of Particulate matter results are given in **Table 3.24 (a), Table 3.24 (b)** and **Table 3.24 (c):-**

Table 3.24 (a): Comparison of Particulate matter results

Locations	PM_{10}						$PM_{2.5}$					
	2019		2022		2023		2019		2022		2023	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Sector 5, Bawana, Delhi	70.0	81.1	74.3	84.5	77	370	41.4	53.5	48.3	56.5	46	222
Rohini, Delhi	152	171	168	212	120	358	78.3	84.3	104	132	72	215
Khera Kalan, Delhi	132	150	140	162	124	380	66.2	79.8	75.7	110	74	228
Ghoga, Delhi	133	155	158	178	84	294	69.8	82.9	101	120	50	176
Sector-1 Bawana, Delhi	148	160	150	168	118	282	64.2	81.1	78.3	104	71	169
Narela, New Delhi	93.7	125	105	132	98	334	50.4	67.3	62.3	78.4	59	200
Sector-11, Rohni Delhi	126	164	115	170	98	292	48.7	60.3	76.5	98.6	59	175
Ferozpur Bangar Village, Haryana	80.3	105	78.5	115	118	244	66.2	80.9	49.8	72.1	71	146

Table 3.24 (b): Comparison of SO_2 and NO_2 results

Locations	SO_2 ($\mu g/m^3$)						NO_2 ($\mu g/m^3$)					
	2019		2022		2023		2019		2022		2023	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Sector 5, Bawana, Delhi	17.8	22.8	16.9	23.5	8	16	24.3	29.3	26.5	30.1	16	23
Rohini, Delhi	20.2	25.5	21.4	28.1	7	14	29.1	36.3	31.2	38.1	20	28
Khera Kalan, Delhi	19.2	22.3	20.8	23.4	6	15	28.4	31.5	28.8	32.4	14	28
Ghoga, Delhi	18.5	21.5	21.2	24.2	7	15	27.9	30.9	29.7	33.2	14	25
Sector-1 Bawana, Delhi	21.1	24.1	20.6	25.3	6	14	30.5	33.8	31.2	35.3	18	26
Narela, New Delhi	17.6	22.5	19.8	23.2	6	11	25.6	30.4	28.4	32.1	16	27
Sector-11, Rohni Delhi	20.1	23.7	21.2	25.4	5	18	28.8	32.1	30.4	34.8	17	32
Ferozpur Bangar Village, Haryana	15.8	19.8	17.3	20.4	7	18	22.5	28.9	24.8	29.3	19	30

Table 3.24 (c): Comparison of CO results

Locations	CO (µg/m³)					
	2019		2022		2023	
	Min	Max	Min	Max	Min	Max
Sector 5, Bawana, Delhi	850	980	810	860	590	840
Rohini, Delhi	1140	1354	1250	1482	520	780
Khera Kalan, Delhi	1015	1180	1080	1220	540	780
Ghoga, Delhi	960	1178	1025	1290	520	780
Sector-1 Bawana, Delhi	1045	1250	1140	1345	520	820
Narela, New Delhi	1024	1154	1080	1175	580	720
Sector-11, Rohni Delhi	1150	1280	980	1220	520	780
Ferozpur Bangar Village, Haryana	880	1010	820	955	580	840

3.15.5 Conclusion

The data collected across various environmental parameters from 2019, 2022 and 2023 shows dynamic fluctuations and trends. Soil analyses reveal a consistent sandy loam texture throughout the years, with notable changes in pH, electrical conductivity, bulk density and total organic carbon. pH levels decreased steadily from 8.1 in 2019 to 7.2 in 2023, while electrical conductivity decreased from 386 µS/cm to 238 µS/cm over the same period. Bulk density increased from 1.05 g/cc in 2019 to 1.49 g/cc in 2023, indicating potential compaction. Conversely, total organic carbon content rose from 0.32% to 1.36%, indicating increased organic matter. Water quality parameters also showed variability, with pH ranging from 7.4 to 7.58 and significant changes in Total Dissolved Solids, Turbidity, Alkalinity, Chloride, Sulphate, Nitrate, Hardness, Sodium, Potassium, Fluoride and Iron concentrations across the years. Noise levels exhibited fluctuations, notably showing decreasing levels during nighttime from 2019 to 2023. Air quality measurements for PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO indicated varying pollutant concentrations, reflecting changes influenced by industrial activities and meteorological conditions.

3.16 BIOLOGICAL ENVIRONMENT

Biodiversity is defined as the variability among living organisms which includes floral, faunal and microbial diversity, the ecosystems and the ecological processes of which they are parts. NCT of Delhi represents a mature topography with vast, gently undulatory plains dominated by Yamuna River, low linear ridges and isolated hillocks. The study area is located in Bawana which is part of the Northern region of Delhi. The area has industrial area, villages, agriculture land, forest patches, water bodies and residential colony. Continuous industrial growth and urbanization has put the biodiversity of the area under pressure. The harmful chemicals and gases from these industries has potential to disturb the natural abode of various plants and animals.

The biodiversity of the area is crucial for maintaining the health of the ecosystem. Therefore, study of local biological environment is necessary to understand existing environment condition and on the basis of the study, possible impacts and their mitigation measures can be suggested. This section discusses the status of flora and fauna in the study area. It also tries to shed light on terrestrial ecology and aquatic ecology of the project site and its surroundings.

Objectives of Biological Study

The main objectives of biological study were:

- To collect the baseline data of the existing flora and fauna within the study area.
- To assess the RET (rare, endangered, threatened) species and schedule I species found within the study area.
- To assess ecological sensitive area found within the study area.
- To predict the probable effects of the project-related activities during construction and operation phases on the biological environment.
- To suggest mitigation measures for conserving biodiversity and managing ecosystems health and human well-being.

3.16.1 Methodology

- The primary baseline survey was conducted to assess the nature of the existing habitat and species composition. The study was carried out in 10 km radius of the project site. The floral species were identified with the help of plant taxonomy manual, published literatures, reports and websites (BSI and State/District Forest Departments etc.). In addition, information was also collected with vernacular names of plant species from local inhabitants.
- The Phyto-sociological study was carried out using square quadrat technique through random sampling procedure. Quadrats of 10m x 10m for tree species, 5m x 5m for shrub species and 1m x 1m for herb species were used for sampling purposes.
- Different sampling techniques were employed for documenting different faunal groups. For herpetofauna (Amphibians and Reptiles), visual encounter survey; for avifauna, point count and transect methods and for mammals, direct and indirect sightings (signs like tracks, pellets and pugmarks) were adopted. Interactions with local people were also done to know the wildlife found in the study area.
- The water bodies in the area were also assessed for the status of the aquatic ecology. Zooplankton and Phytoplankton samples were collected from surface water bodies of sampling sites. Identification of phytoplankton was done with the help of standard books and monographs (Turner, 1892; smith, 1924, Ward and Whipple 1959) and the identification of zooplankton was done with the help of reference books including that of Ward and Wipples (1959). Fish were also collected

using standard methods like using fishing nets. Information from local fishermen were also collected.

- Moreover, authentic secondary sources of information i.e. Govt. publications, published research papers and web search have also been referred which are given below in the **Table-3.25.**

Table 3.25: Authentic Secondary Sources Referred for Biodiversity Assessment

- *Biswas, Jayita & Dookia, Sumit & Faisal, Mohammad. (2017). Butterflies of Delhi with new additions and an annotated checklist from Delhi, India. International Journal of Zoology Studies. 4. 2455-7269.*
- *https://delhiplanning.delhi.gov.in/sites/default/files/Planning/ch._7_agriculture_and_rural_development_0.pdf*
- *https://www.inaturalist.org/places/delhi-in#page=1&taxon=47158*
- *https://forest.delhi.gov.in/sites/default/files/generic_multiple_files/common-indigenous-species-in-delhi-2_0.pdf*
- *Khera, Neeraj & Mehta, V. & Sabata, B.C. (2009). Interrelationship of birds and habitat features in urban greenspaces in Delhi, India. Urban Forestry & Urban Greening. 8. 187-196. 10.1016/j.ufug.2009.05.001.*
- *https://www.envirobiotechjournals.com/EEC/v27i32021/EEC-51.pdf*
- *Dwivedi, Mayank & Meena, Devender & Rather, Shabir & Danda, Shagun & Kasana, Shruti. (2018). Floristic Diversity at Asola Bhatti Wildlife Sanctuary, Delhi, India. Phytomorphology: An International Journal of Plant Morphology. 68. 15-29.*
- *Madan, Sohail & Prakash, Surya & Yadav, Geeta & Kohli, Lakhan & Singh, Rajendra & Jnu-Eiacp, Geodiversity And Impact On Environment. (2023). Avifaunal Diversity of Asola Bhatti Wildlife Sanctuary, Delhi. 28. 2-33.*
- *Meena, Archana. (2020). 02-Archana Meena 95-102.*
- *https://faunaofindia.nic.in/PDFVolumes/sfs/037/index.pdf*
- *Parvez & Kumar, M & Pandey, R. (2021). Avifaunal diversity of National Zoological Park, Delhi. 19. 79-87. 10.5281/zenodo.5059710.*
- *Paul, Monalisa & Sultana, Aisha. (2020). Studies on butterfly (Insecta: Lepidoptera) diversity across different urban landscapes of Delhi, India. Current science. 118. 819-827.*
- *Prakash, Surya & Maurya, C & Prakash, Ved & Singh, Saurabh & Jaiswal, Akash & Jnu-Eiacp, Geodiversity And Impact On Environment. (2022). Butterfly Diversity of Jawaharlal Nehru University Campus, Delhi -India ' A long-term pioneer study'. 26. 2-18.*
- *https://ebird.org/india/region/IN-DL-NW?yr=all&m=&rank=mrec*
- *BSI (2016). State wise Distribution of Endemic and Threatened plant taxa of India. http://www.bsienvis.nic.in/Database/E_3942.aspx.*
- *http://cpcbenvis.nic.in/scanned%20reports/PROBES-75%20Guidelines%20For%20Developing%20Greenbelts.pdf*

- *Champion, H.G. and Seth (1968). A revised survey of the forest types of India. Govt. of India Press, Nasik, India.*
- *Rodgers, W. A., Panwar, H.S., & Mathur, V.B. (2000). Wildlife protected area network in India: a review (Executive summary). Published by Wildlife Institute of India, Dehradun. 44*
- *IUCN RED LIST; https://www.iucnredlist.org/species/23049/81069636.*
- *Joshi, K.D. & Alam, Absar & Jha, Dharm & Srivastava, S.K. & Kumar, V. (2016). Fish diversity, composition and invasion of exotic fishes in river Yamuna under altered water quality conditions. Indian Journal of Animal Sciences. 86. 957-963. 10.56093/ijans.v86i8.60837.*
- *Malhotra Priyanka. 2014. Species Diversity and Distribution of Zooplankton of Western Yamuna Canal in Yamunanagar (Haryana) India with Special Reference to Industrial Pollution. International Research Journal of Environment Sciences. Vol. 3(8), 61-63*
- *Priyanka, M., Anita, B., & Girish, C. (2014). Phytoplankton Diversity of Western Yamuna Canal and River Yamuna in Yamunanagar, Haryana, India.*
- *A. P. Sharma et al. 2014. The Ecology and Fishery Status of River Yamuna. Central Inland Fisheries Research Institute, Barrackpore. ISSN: 0970-616*
- *Tanveera Tabasum. 2018. Zooplankton assemblages along the longitudinal gradient of the River Yamuna floodplains in Delhi. International Journal of Creative Research Thoughts. Volume 6, Issue 1. ISSN: 2320-2882*
- *Usha Moza & D. N. Mishra. 2003. Ecodynamics and Fishery Status of Upper Stretch of River Yamuna and Associated Canals. Central Inland Fisheries Research Institute, Barrackpore. ISSN 0970-616 X*
- *https://sandrp.in/2019/04/28/yamuna-fish-fisher-folks-at-palla/*

3.16.2 Ecology and Biodiversity sampling location of the Study Area

The sampling locations of Terrestrial Ecology (TE) & Aquatic Ecology (AE) are presented in **Table-3.26** and depicted in **Figure 3.17.**

Table 3.26: Ecology and Biodiversity sampling locations

S. No.	Location Name	Sampling Code	Direction	Distance (Km)	Environment Sensitive Type	Coordinates	
						Latitude	Longitude
1.	Western Yamuna canal Near Iron Bridge Bawana	AE1	SW	0.15km	Canal	28° 47' 45.159" N	77° 3' 45.692" E
2.	Village Pond Near Grand Amar Public School Budhanpur, Majra	AE2	SW	6.51km	Pond	28° 47' 43.195" N	77° 3' 38.366" E
3.	Near Indraprastha CNG Station Marmurpur	AE3	NE	9.04km	Nalah	28° 46' 4.664" N	77° 0' 7.087" E

S. No.	Location Name	Sampling Code	Direction	Distance (Km)	Environment Sensitive Type	Coordinates	
						Latitude	Longitude
4.	Near Iron Bridge Bawana	TE1	SW	0.14km	Vegetation near canal	28° 51' 25.635" N	77° 7' 24.913" E
5.	Bawana RF Sanoth village	TE2	N	2.29km	Forest	28° 47' 40.182" N	77° 3' 43.554" E
6.	Ghoga RF Near Ghoga Akhada	TE3	N	3.16km	Forest	28° 49' 1.106" N	77° 3' 43.427" E
7.	Sultanpur RF Near Bharat Petroleum Sultanpur Dabas	TE4	SW	4.89km	Forest	28° 49' 29.184" N	77° 3' 29.816" E
8.	Narela RF Marmurpur	TE5	NE	9.01km	Forest	28° 46' 28.420" N	77° 1' 7.490" E
9.	Near Shri Balaji Mandir Sec-11 Rohini	TE6	SE	8.55km	Forest near Temple	28° 51' 24.462" N	77° 7' 22.582" E

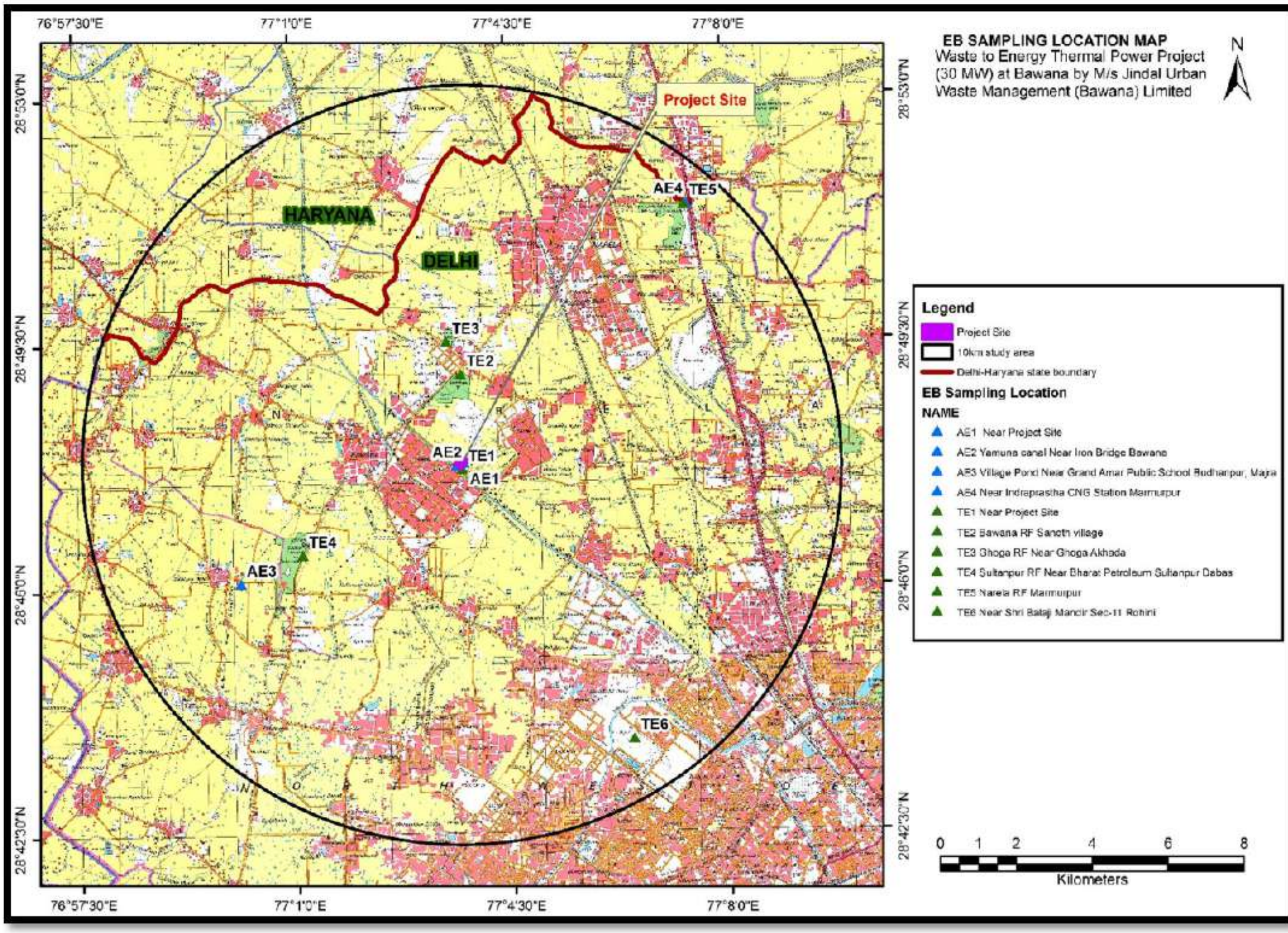


Figure 3.17: - Aquatic & Terrestrial Biodiversity sampling locations

3.16.3 Presence of Ecologically Sensitive Area

There is no protected area (National Park/Wild Life Sanctuary) within the study area. However, four reserve forests are coming under 10km stretch of the study area, which is Ghoga RF, Bawana RF, Sultanpur RF, Narela RF. Western Yamuna Canal is flowing near to the project site at a distance of 32m.

3.16.4 Forest types and natural vegetation at regional level

Vegetation in the state belongs to Tropical Dry Deciduous and Tropical Thorn Forest type. The project area mostly bears shrubby growth of bushy plant species and annual weeds. The top layer is dominated by *Prospopis juliflora*. Most of the woody species represent Tropical Thorny Forest and Open Scrub Forest Type (Champion and Seth, 1968).

3.16.5 Biogeography Zone

As far as Biogeographical zones and provinces (*Rodger, Panwar, and Mathur. 2000*) are concerned, Delhi state comes under Zone 4: Semi-arid. The study area comes under Biogeographic provinces: Zone 4A: Semi-arid-Punjab Plains.

3.16.6 Terrestrial Ecology

3.16.6.1 Floral composition of the study area

A list of floral species has been prepared based on site observations, discussion with local people and through available authentic literature. The floral composition along with common name, family, life form is listed below **Table-3.27.** The % distribution of total floral species is shown in **Table 3.28** & **Figure-3.18.**

Table 3.27: List of floral species of the study area

S. No.	Scientific Name	Common Name	Family	IUCN Status
	Trees			
1.	*Acacia leucophloea*	Ronjh	Mimosaceae	LC
2.	*Acacia nilotica*	Babul	Fabaceae	LC
3.	*Aegle marmelos*	Bel	Rutaceae	NT
4.	*Albizia lebbeck*	Siris	Fabaceae	LC
5.	*Alstonia scholaris*	Saptparna	Apocynaceae	LC
6.	*Azadirachta indica*	Neem	Meliaceae	LC
7.	*Bauhinia variegata*	Kachnar	Fabaceae	LC
8.	*Bauhinia purpurea*	Butterfly Tree	Caesalpiniaceae	LC
9.	*Bombax ceiba*	Semal	Malvaceae	LC
10.	*Butea monosperma*	Palash	Fabaceae	LC
11.	*Cassia fistula*	Amaltash	Fabaceae	LC
12.	*Dalbergia sissoo*	Shisham	Fabaceae	LC
13.	*Eucalyptus sp.*	Safeda	Myrtaceae	LC
14.	*Ficus benghalensis*	Bargad	Moraceae	-
15.	*Ficus racemosa*	Gulahar	Moraceae	LC
16.	*Ficus religiosa*	Peepal	Moraceae	LC
17.	*Ficus virens*	White Fig	Moraceae	LC
18.	*Hardwickia binata*	Anjan	Fabaceae	LC
19.	*Holoptelea integrifolia*	Indian Elm	Ulmaceae	-
20.	*Madhuca longifolia*	Mahua	Sapotaceae	-
21.	*Mangifera indica*	Mango	Anacardiaceae	-
22.	*Melia azedarach*	Bakain	Miliaceae	LC

S. No.	Scientific Name	Common Name	Family	IUCN Status
23.	*Moringa oleifera*	Sahajan	Moringaceae	LC
24.	*Morus alba*	Shahtoot	Magnoliopsida	LC
25.	*Phyllanthus emblica*	Amla	Phyllanthus	LC
26.	*Pithecellobium dulce*	Jungle Jalebi	Magnoliopsida	LC
27.	*Pongamia pinnata*	Pongam Oil Tree	Fabaceae	LC
28.	*Polyalthia longifolia*	False Ashok	Annonaceae	-
29.	*Prosopis cineraria*	Jhand	Mimosaceae	-
30.	*Prosopis juliflora*	Vilayati Kikar	Fabaceae	-
31.	*Senna siamea*	Kassod Tree	Fabaceae	LC
32.	*Syzigium cumini*	Jamun	Myrtaceae	LC
33.	*Tamarindus indica*	Imli	Fabaceae	LC
34.	*Terminalia arjuna*	Arjun	Combretaceae	-
Shrubs				
1.	*Abutilon indicum*	Indian mallow	Malvaceae	-
2.	*Calotropis procera*	Aak	Apocynaceae	LC
3.	*Cannabis sativa*	Bhangh	Cannabaceae	-
4.	*Datura innoxia*	Angle's Trumpet	Solanaceae	-
5.	*Lantana camara*	Lantana	Verbenaceae	-
6.	*Opuntia sp.*	Naghphani	Cactaceae	-
7.	*Ricinus communis*	Castor Bean	Euphoribiaceae	-
Herbs				
1.	*Achyranthes aspera*	Prickly Chaff Flower	Amaranthaceae	-
2.	*Aerva lanata*	Mountain Knotgrass	Amaranthaceae	-
3.	*Ageratum houstonianum*	Floss Flower	Asteraceae	-
4.	*Alysicarpus monilifer*	Necklace-Pod Alyce Clover	Fabaceae	-
5.	*Argemone mexicana*	Mexican Poppy	Papaveraceae	-
6.	*Boerhavia diffusa*	Red Spiderling	Nyctaginaceae	-
7.	*Commelina benghalensis*	Dayflower	Commelinaceae	LC
8.	*Euphorbia hirta*	Dove Milk	Euphorbiaceae	-
9.	*Chenopodium album*	Bathua	Amaranthaceae	
Climbers				
1.	*Convolvulus arvensis*	Morning Glory	Convolvulaceae	-
2.	*Cuscuta reflexa*	Amarbel	Convolvulaceae	LC
3.	*Ipomea aquatica*	Water Morning Glory	Convolvulaceae	-
4.	*Tinospora cordifolia*	Heart-leave Moonseed	Menispermaceae	-
Grasses				

S. No.	Scientific Name	Common Name	Family	IUCN Status
1.	*Cenchrus ciliaris*	Buffel Grass	Poaceae	LC
2.	*Cenchrus setigerus*	Birdwood Grass	Poaceae	-
3.	*Chrysopogon fulvus*	Reddish-Yellow Beardgrass	Poaceae	-
4.	*Cynodon dactylon*	Bermuda Grass	Poaceae	-
5.	*Desmostachya bipinnata*	Daaabh	Poaceae	LC
6.	*Digitaria sp.*			
7.	*Saccharum sp.*	-	Poaceae	-
Abbreviations: LC= Least Concerned, VU= Vulnerable, NT= Near Threatened, EN= Endangered				
Source: Based on Primary Site visit and Secondary Data				

Table 3.28: Number of Floral species in Different Categories of the Study Area

S. No	Plant Life Form	Number of Species in the study area
1.	Trees	34
2.	Shrubs	7
3.	Herbs	9
4.	Grasses	7
5.	Climbers	4

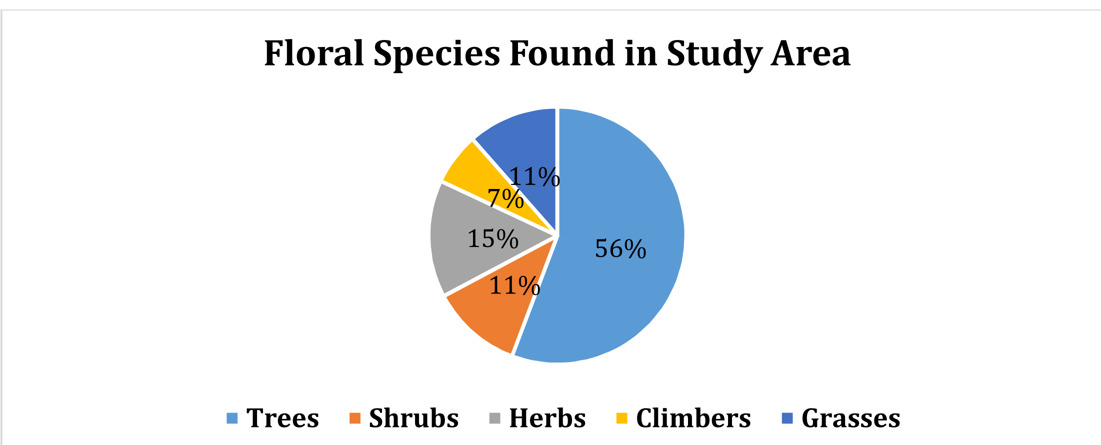


Figure 3.18:- Pie diagram showing percentage distribution of floral species

3.16.6.2 Phytosociology study within 10km area

The results of phyto-sociological attributes study for trees, shrubs and herbs are given in **Table 3.29**, **Table 3.30** and **Table 3.31,** respectively.

Table 3.29: Phyto-sociological attributes of Trees in the study area

S. No.	Species	Frequency	Density	Abundance	RF	RD	RDo	IVI
1.	*Prosopis juliflora*	100	17.75	17.75	13.33	53.38	2.67	69.38
2.	*Cassia saemea*	100	3.75	3.75	13.33	11.27	11.10	35.71
3.	*Albizzia lebbeck*	100	3.75	3.75	13.33	11.27	1.09	25.70
4.	*Eucalyptis sp.*	75	3	3	10	9.02	38.99	58.01
5.	*Azadirachta indica*	50	0.5	1	6.66	1.50	28.32	36.49
6.	*Melia azedarach*	75	0.5	1	10	1.50	3.55	15.06
7.	*Acacia nilotica*	100	1	1.33	13.333	3.007	9.10	25.44
8.	*Pongamia pinnata*	50	2.75	2.75	6.66	8.27	4.21	19.154
9.	*Ziziphus mauritian*	100	0.25	1	13.33	0.75	0.92	15.014
Total					**100**	**100**	**100**	
Shannon-Wiener Index (H)=1.65								
RF: Relative Frequency, RD: Relative Density, RDo: Relative Dominance, IVI: Importance Value Index								

Table 3.30: Phyto-sociological attributes of Shrubs in the study area

S. No.	Species	Frequency	Density	Abundance	RF	RD	RDo	IVI
1.	*Calotropis procera*	25	0.5	1	8.33	4.65	0.011	12.99
2.	*Lantana camara*	25	0.5	2	8.33	4.65	0.234	13.21
3.	*Ricinus communis*	75	4.75	6.33	25	44.18	2.58	71.76
4.	*Opuntia sp.*	75	3	4	25	27.90	97.16	150.07
5.	*Abitulum indicum*	100	2	2	33.33	18.60	0.004	51.94
	Total	**300**	**10.75**		**100**	**100**	**100**	
Shannon-Wiener Index (H)=1.42								
RF: Relative Frequency, RD: Relative Density, RDo: Relative Dominance, IVI: Importance Value Index								

Table 3.31: Phyto-sociological attributes of Herbs in the study area

S. No.	Species	Frequency	Density	Abundance	RF	RD	RDo	IVI
1.	*Achyranthes aspera*	100	7.75	7.75	12.12	8.44	1.37	21.94

2.	*Ageratum houstonianum*	100	5.5	5.5	12.12	5.99	0.30	18.42
3.	*Chenopodium album*	100	25	25	12.12	27.24	3.10	42.47
4.	*Digitaria sp.*	100	4.25	4.25	12.12	4.63	2.80	19.55
5.	*Parthenium hysterophorus*	75	5	6.6	9.09	5.44	8.69	23.23
6.	*Lysimachia arvensis*	75	7.25	8.33	9.09	7.90	5.31	22.31
7.	*Cynodon dactylon*	100	12.75	12.75	12.12	13.89	3.67	29.69
8.	*Saccharum sp.*	100	10	10	12.12	10.89	68.20	91.22
9.	*Oxalis corniculata*	25	2.25	4.5	3.03	2.45	3.41	8.89
10.	*Lepidium didymus*	50			6.06	13.07	3.10	22.24
Total		**825**	89	103.25	**100**	100	**100**	
Shannon-Wiener Index (H)=1.74								
RF: Relative Frequency, RD: Relative Density, RDo: Relative Dominance, IVI: Importance Value Index								

3.16.7 Vegetation structure around sampling location

a) Project site

The project area is located near Bawana industrial area, on the periphery of project site Yamuna canal is flowing. There is no natural plantation in the project site although the area has some plantation near project site and Yamuna canal. The land has mustard cultivation. The trees include *Cassia seamea, Melia azedarach, Azadirachta indica, Eucalyptus sp., Acacia nilotica, Acacia leucophloea, and Pongamia pinnata.* Shrubs include Calotropis procera and in herbs *Ageratum houstonianum, Chenopodium album, Parthenium hysterophorus, Argemone mexicana, Achyranthes aspera, Digitaria sp., Cynodon dactylon, Saccrum sp.*

Roadside plantation include *Acacia leucophloea, Dalbergia sissoo, Calotropis procera , Azadirachta indica, Terminalia arjuna, Ficus benghalensis,* In shrub *Nerium oleander, Tecoma stans, and Calliandra haematocephala,* and grass include *Cynodon dactylon*.

Figure 3.19:- Project site **Figure 3.20: Western Yamuna canal**

(b) Near Ghoga

Ghogha is located within 10km of the study area. The top layer dominated by *Prosopis juliflora*. Middle storey includes shrubs *Abutilon indicum*, and *Calotropis procera*, and the ground layer include *Cynodon dactylon*, *Oxalis corniculata*, *Chenopodium album*, and *Saccharum sp.* Roadside plantation include *Azadirachta indica*, *Dalbergia sissoo*, *Melia azedarach*, *Acacia leucophloea*, shrubs include *Calotropis procera*, and herb & grass include *Parthenium hysterophorus, Cynodon dactylon*, and *Saccharum sp.*

Figure 3.21:- Vegetation in Ghoga

(c) Near Sanoth Village

Sanoth Village is located within 10km of the study area. The main trees are *Acacia nilotica*, *Prosopis juliflora*, and *Albizia lebbeck*. Middle layer include Shrubs such as *opuntia sp.* Herbs & grasses include *Chenopodium album*, *Parthenium hysterophorus*, *Saccharum sp.*, *Cynodon dactylon*.

Roadside plantation include, *Acacia nilotica*, *Moringa oleifera*, *Azadirachta indica*, *Alstonia scholaris*, *Dalbergia sisso*, *Ficus benghalensis*, *Ficus religiosa* and *Phoenix dactylifera*. In climber Bougainvillea was present. Shrubs include *Calotropis procera*, and *Nerium oleander* and herb/grass include *Cynodon dactylon*.

Figure 3.22:- Vegetation in Sanoth

(d) Near Sultanpur

Sultanpur is located within 10km of the study area. It has more of thorny tree and less of shrubs. The area is dominated by *Prosopis Juliflora* in trees. Shrubs include *Calotropis procera* and herb include *Chenopodium alblum*, *Saccharum sp.* and *Cynadon dactylon*.

The roadside plantation includes *Acacia leucopholia*, *Ficus benghalensis*, *Ziziphus mauritiana*, and *Dalbergia sisso*. Shrubs include *Calotropis procera*, and Herbs & grasses include *Chenopodium album Saccharum sp.*, and *Cynadon dactylon.*

Figure 3.23:- Vegetation in Sultanpur

(e) Near Rohini 11

Rohini sector 11 is located within 10km of the study area. The area has natural roadside plantations. The main tree species found in area are of *Prosopis juliflora*, and *Acacia nilotica*. Shrubs include *Calotropis procera*. Herbs & grasses include *Chenopodium album*, *Pathenium hysterophorus* and grasses include *Cynadon dactylon*, and *Saccharum sp.*

Roadside plantations include *Pongam pinnata*, *Ficus benghalensis*, *Polyalthia longifolia*, *Alstonia scholaris*, *Bombax cebia*, *Azadirachta indica*, and *Dalbergia sisso* Shrubs include *Lantana camara* and *Calotropis procera*, and grasses include *Saccharum sp.*, and *Cynadon dactylon*.

(f) Near Marmurpur

Marmurpur is located within 10km of the study area. The area has thorny vegetation. The main vegetation in trees are *Prosopis juliflora*, *Eucalyptus sp.*, and *Ziziphus mauritiana*. Shrubby growth includes *Calotropis procera* and herbs & grasses include *Chenopodium album*, *Saccrum sp.* and *Cynadon dactylon*.

Roadside plantations include *Prosopis juliflora*, *Azadirachta indica*, *Dalbergia sisso* and *Ficus benghalensis*. Shrubs include *Lantana camara* and *Calotropis procera*, and grasses include *Saccharum sp.*, and *Cynadon dactylon*.


Figure 3.24:- Vegetation near Marmurpur

3.16.7.1 Agricultural species

The study area has a good deal of land which they utilize for agricultural purposes. The main crops grown in the area are wheat, sugarcane and mustard. The area also has guava orchards.

3.16.7.2 Medicinal Plants

According to Ayurveda, every plant on the earth does possess medicinal property. This means that each and every plant is equally important for its biological activities, ecology and environment. Being little rich in vegetation the area harbors sparse occurrence of medicinal plants and aromatic plants. These plants are used for treating a variety of ailments as a single herb and also in combination with other plants. The common herbal medicinal flora observed in the study area are listed below in **Table 3.32.**

Table 3.32: Medicinally important floral species

S. No.	Scientific Name	Common Name	Family	Part use
1.	*Acacia leucopholea*	Ronjh	Fabaceae	Bark, leaves and roots
2.	*Achyranthes aspera*	Prickly Chaff Flower	Amaranthaceae	Root, seed and leaves
3.	*Aegle marmelos*	Bel	Rutaceae	Bark, fruits, and roots
4.	*Argemone mexicana*	Pili kateli	Papaveraceae	Whole plant
5.	*Azadirachta indica*	Neem	Meliaceae	Roots, bark, gum, leaves, fruit, seed

6.	*Canabis sativa*	Bhang	Cannabaceae	Leaves and seeds
7.	*Cuscuta reflexa*	Amarbel	Convolvulaceae	Whole plant
8.	*Dalbergia sissoo*	Shisham	Fabaceae	Seeds, Leaves and Bark
9.	*Emblica officinalis*	Ambla	Euphorbiaceae	
10.	*Euphorbia hirta*	Dove Milk	Euphorbiaceae	Flower and fruit
11.	*Phyllanthus amarus*	Bhuiavla	Euphorbiaceae	
12.	*Terminalia arjuna*	Baheda	Combretaceae	Bark, leaves, and fruits
13.	*Ficus benghalensis*	Banyan tree	Moraceae	Stem, roots, aerial roots, vegetative buds, leaves,
14.	*Ficus religiosa*	Peepal	Moraceae	Bark, leaves, fruits, and roots
15.	*Mangifera indica*	Aam	Anacardiaceae	Bark, leaves, Fruit and Kernel
16.	*Ziziphus mauritiana*	Ber	Rhamnaceae	Root and stem bark, leaves, and fruits
Source: Based on Primary and Secondary Survey				

3.16.7.1 Rare/endangered or threatened flora

There are no rare or endangered or threatened plant species in the study area. All the plants found in the study area are of common occurrence.

3.16.7.2 Faunal Species of the Study Area

A list of faunal species (Mammals, Avifauna, Amphibians, Reptilians and Butterflies) of the study area has been prepared on the basis of primary survey, discussion with local people and through available secondary resources. The faunal composition is listed below in **Table -3.33** and % of distribution of total fauna is shown in **Figure-3.25**.

Table 3.33: Faunal species reported from the study area

S. No.	Scientific Name	Common Name	Family	IUCN/WPA Status
Mammals				
1.	*Funambulus pennanti*	Northen Palm Squirrel	Sciuridae	LC/-
2.	*Herpestes auropunctatus*	Small Indian Moongoose	Herpestidae	**LC/I**
3.	*Lepus nigricollis*	Indian Black-naped Hare	Leporidae	LC/II
4.	*Macaca mulatta*	Rhesus Macaque	Cercopithecidae	LC/-

S. No.	Scientific Name	Common Name	Family	IUCN/WPA Status
5.	*Mus booduga*	Field Mouse	Muridae	LC/-
Avifauna				
1.	*Accipiter badius*	Shikra	Accipitridae	**LC/I**
2.	*Acridotheres ginginianus*	Bank Myna	Sturidae	LC/II
3.	*Acridotheres tristis*	Common Myna	Sturidae	LC/II
4.	*Actitis hypoleucos*	Common Sandpiper	Scolopacidae	LC/II
5.	*Alcedo atthis*	Common Kingfisher	Alcedinidae	LC/II
6.	*Amandava amandava*	Red Avadavat	Estrildidae	LC/II
7.	*Apus affinis*	Little Swift	Apodidae	LC/II
8.	*Ardeola grayii*	Indian Pond Heron	Ardeidae	LC/II
9.	*Athene brama*	Spotted Owlet	Strigidae	LC/II
10.	*Centropus sinensis*	Greater Coucal	Cuculidae	LC/II
11.	*Columba livia*	Rock Pigeon	Columbiae	LC/-
12.	*Coracias benghalensis*	Indian Roller	Coraciidae	LC/II
13.	*Dendrocitta vagabunda*	Rufous Treepie	Corvidae	LC/II
14.	*Dinopium benghalense*	Black rumped flameback	Picidae	LC/II
15.	*Egretta garzetta*	Little Egret	Ardeidae	LC/II
16.	*Eudynamys scolopacea*	Asian Koel	Cuculidae	LC/II
17.	*Halcyon smyrnensis*	White-throated Kingfisher	Ardeidae	LC/II
18.	*Himantopus himantopus*	Black Winged Stilt	Recurvirostridae	LC/-
19.	*Megalaima haemacephala*	Coppersmith Barbet	Megalaimidae	LC/II
20.	*Milvus migrans*	Black Kite	Accipitridae	LC/II
21.	*Mycteria leucocephala*	Painted stroke	Ciconiidae	NT/II
22.	*Nectarinia asiatica*	Purple Sunbird	Nectariniidae	LC/II
23.	*Ocyceros birostris*	Indian Grey Hornbill	Bucerotidae	LC/II
24.	*Passer domesticus*	House Sparrow	Passeridae	LC/II
25.	*Pavo cristatus*	Indian Peafowl	Phasianidae	**LC/I**
26.	*Pseudibis papillosa*	Red-headed Ibis	Threskiornithidae	LC/II
27.	*Psittacula eupatria*	Alexandrine Parakeet	Psittacidae	NT/II
28.	*Pycnonotus cafer*	Red-vented Bulbul	Pycnonotidae	LC/II
29.	*Threskiornis melanocephalus*	Black-headed Ibis	Threskiornithidae	NT/II
30.	*Treron phoenicoptera*	Yellow Footed Green Pigeon	Columbidae	LC/II
31.	*Turdoides striatus*	Jungle Babbler	Leiotrichidae	LC/II
32.	*Vanellus indicus*	Red-wattled Lapwing	Charadriidae	LC/
33.	*Upupa epops*	Common Hoopoe	Upupidae	LC/II

S. No.	Scientific Name	Common Name	Family	IUCN/WPA Status
Butterflies				
1.	*Ariadne merione*	Common Castor	Nymphalidae	-
2.	*Belenois aurota*	Pioneer White	Pieridae	LC/-
3.	*Catopsilia pyranthe*	Mottled Emigrant	Pieridae	-
4.	*Chilades pandava*	Plain Cupid	Lycaenidae	-
5.	*Danaus chrysippus*	Plain Tiger	Nymphalidae	LC/-
6.	*Eurema hecabe*	Common Grass Yellow	Pieridae	LC/-
7.	*Hypolimnas misippus*	Danaid Eggfly	Nymphalidae	
8.	*Melanitis leda*	Common Evening Brown	Nymphalidae	
9.	*Papilio demoleus*	Common Swallowtail	Papilionidae	LC/-
10.	*Phalanta phalantha*	Common Leopard	Nymphalidae	LC/-
11.	*Spindasis vulcanus*	Common Silverline	Lycaenidae	-
12.	*Zizula hylax*	Tiny Grass Blue	Lycaenidae	LC/-
Amphibians				
1.	*Bufo stomaticus*	Indus Valley Toad	Bufonidae	LC/-
2.	*Duttaphrynus melanostictus*	Asian Common Toad	Bufonidae	LC/-
3.	*Euphlyctis cyanophlyctis*	Skittering Frog	Dicroglossidae	LC/II
Reptiles				
1.	*Calotes versicolor*	Oriental Garden Lizard	Agamidae	LC/-
2.	*Eutropis carinata*	Keeled Indian Mabuya	Scincidae	LC/-
3.	*Hemidactylus leschenaultii*	Bark Gecko	Gekkonidae	LC/-
Abbreviations: LC= Least Concerned, VU= Vulnerable, NT= Near Threatened, EN= Endangered WPA= Wildlife Protection Act 2022				
Source: Based on Primary Site visit and Secondary Survey				

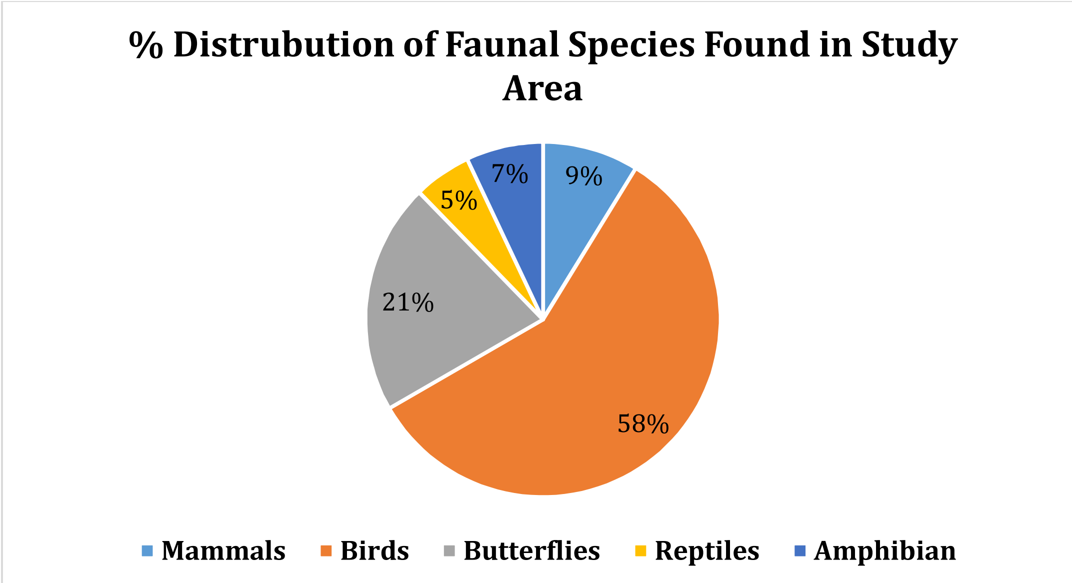


Figure 3.25: - Pie diagram showing percentage distribution of fauna species

3.16.8 Aquatic Ecology

Western Yamuna Canal is the major water body which is flowing at a distance of approx. 200 m, in South-West direction from the project site. The river does not harbor flora and fauna of significance. Beside Yamuna canal the other two aquatic locations are also given in sampling location **Table 3.34.** Lists of the phytoplankton, zooplankton and fish present in the study area are given in **Table-3.35** to **Table-3.36,** respectively.

Table 3.34: Sampling Location of Aquatic Ecology

S. No.	Location Name	Sampling Code	Environment Sensitive Type
1	AE1 Western Yamuna canal Near Iron Bridge Bawana	AE1	Water
2	AE2 Village Pond Near Grand Amar Public School Budhanpur, Majra	AE2	Water
3	AE3 Near Indraprastha CNG Station Marmurpur (Nalla)	A3	Water

Table 3.35: Phytoplankton found in the study area

S. No.	Family	Species
1.	**Bacillariophyceae**	*Diatoma sp.*
2.		*Achnanthes sp.*

3.		*Navicula sp.*
4.		*Cyclotella sp.*
5.		*Nitzschia sp.*
6.		*Tabellaria sp.*
7.		*Frustulia sp.*
8.	**Chlorophyceae**	*Spirogyra sp.*
9.		*Ulothrix sp.*
10.		*Cladophora sp.*
11.		*Pediastrum sp.*
12.	**Mixophyceae**	*Oscilaltoria sp.*
13.		*Nostoc sp.*

Table 3.36: Zooplankton found in the study area

S. No.	Class	Species
1.	**Copepoda**	*Cyclops sp.*
2.		*Arctodiaptomus sp.*
3.		*Heliodiaptomus sp.*
4.	**Cladocera**	*Daphnia sp.*
5.		*Diaphanosoma sp.*
6.		*Moina sp.*
7.		*Macrothrix sp.*
8.	**Rotifera**	*Keratella sp.*
9.		*Brachionus sp.*
10.		*Filinia sp.*
11.		*Lecane sp.*
12.		*Monostyla sp.*

3.16.9 Fish species in Study Area

Fishes are commonly found in all type of natural water bodies. To obtain data on the most prominent fish species present in the water bodies and streams, the study area has been inventoried. To compile a list of fishes found in the study, primary survey, interaction with local and secondary materials were reviewed, and the results are shown in **Table 3.37.**

Table 3.37: Fishes found in the study area

S. No.	Common Name	Scientific Name	Family
1.	Cotio	*Osteobrama cotio*	Cyprinidae
2.	Gangetic Mystus	*Mystus cavasius*	Bagridae

3.	Mrigal	*Cirrhinus mrigala*	Cyprinidae
4.	Pool Barb	*Puntius sophore*	Cyprinidae
5.	Ticto Barb	*Pethia ticto*	Cyprinidae
6.	Rohu	*Labeo rohita*	Cyprinidae

Figure 3.26: - Fisheries Pond

3.16.10 Conclusion:

Bawana has bushy and thorny type of vegetation. The project site is located near industrial hub of Bawana. Along with project site, 10km buffer area has been considered for biodiversity assessment. On the basis of primary data of flora, it was found that the area is less rich in vegetation, mostly dominated with thorny vegetation. From the primary survey and secondary literature survey, around 56 fauna and 61 flora were recorded from the study area. As per Wildlife Protection Act 2022, **Three Schedule-I**, species *Pavo cristatus, Herpestes javanicus* and *Accipiter badius* are found in the study area and Wildlife Conservation Plan budget has been mentioned in the Chapter -10. A Wildlife Conservation Plan for these three species has been prepared in detailed and attached as **Annexure-VII**.

3.17 SOCIO-ECONOMIC

Socio-Economic Impact Assessment (SEIA) refers to systematic analysis of various social and economic characteristics of human beings living in a given geographical area (study area/impact area). The prime objective of SEIA is to identify and evaluate potential socio-economic and cultural impacts of a proposed development project on the lives & conditions of people, their families and communities. If the potential impacts are significant and adverse, SEIA assist the developers and other stakeholders to reduce, remove or prevent these impacts from happening. Also, it examined how a development project changes the lives of local residents. The outcome of the study relies on both quantitative and qualitative measure of impacts. The impacts are evaluated in terms of changes in community demographics, housing, employment, market effects, public services, retail business, quality of life and artistic qualities of the community. Further, assessing proposed developments in socio-economic context help the community leaders and local people identify potential social equity issues, evaluate the adequacy of social services and determine whether the project has adverse effects on overall social well-being or not.

SEIA also provides a forum for planning how to maximize the beneficial impacts of a proposed development. Beneficial impacts can include:

a) A better standard of living due to increased access to employment, business opportunities, training, education & health,

b) Greater access to and from a community, and

c) Increase in funding to improve social infrastructure.

3.17.1 Baseline Socio-Economic Status

The analysis of the present socio-economic and cultural condition of the life of the people of an area requires the present/current basic social & economic data/information to gauge the extent of impact of any developmental action/projects on the current scenario in a given surrounding. This present status of the social & economic condition of a given area is called Baseline Socio-economic Status of the area. Baseline data refers to basic information collected before a project/scheme is implemented. It is used later to provide a comparison for assessing impact of the project.

3.17.2 Objectives of the Study

The objectives of Socio-Economic Impact Assessment of the project are as follows:

a) To comprehend the socio-economic status of the people living there in.

b) To assess the probable impact of the project on social and economic aspects.

c) To measure the impact of the project on society.

d) To ensure sustainability of positive impacts.

e) To suggest mitigation measures and agency responsible for taking action in case of adverse impact.

Steps taken to prepare the SEIA Report

- Literature Review.
- Identification of the study area and important landmarks therein.
- Preparation of list of habitations located in the study area.
- Firming up of approach and methodology.
- Collection of Secondary Data from Census Report, district profile, published and un-published literatures, administrative records etc.
- Data Entry and Data Validation.
- Field Visit for Primary Survey.
- Compilation of Primary Data Collected.
- Generation of Tables.
- Data Analysis and preparation of report.
- Mitigation measures suggested based on field survey findings.

3.17.3 Methodology

For the Socio-economic Impact Assessment of the proposed project, a systematic analysis of habitations level studies of various socio-economic characteristics, both in terms of quality and quantity was carried out. Accordingly, both qualitative and quantitative data of the study area was collected through various sources.

For collection of information, Census of India was approached for published data/information, state & district portals were visited and administrative records were referred of the state & district administration.

3.17.4 Tools and Methods used for field survey

- Village/Town Fact Sheet
- Focused Group Discussion Sheet

Interaction with various cross-section of the society and stakeholder's consultation was carried out that included school teachers, local residents etc. Transect walk was carried out to observe the characteristics of the study area. Focused group discussions were conducted to find out the major concerns, needs, aspirations of the people with respect to the upcoming project.

Approximately in 14 % of the study area villages/towns the field survey was carried out. Proximity to the project site and simple random sampling method was used for the selection of the study area villages/towns for survey. During the field visit employment status, schooling & health facility, drainage, health & hygiene, electricity supply, agricultural etc. aspects were considered for assessment. The site visit was done on 12th and 13th of March, 2024.

Field Survey was carried out in the following villages/urban areas mentioned below:

- JJ Colony, Bawana
- Ghoga Village
- Sanoth Village
- Khera Kalan (CT)
- Khera Khurd (CT)
- Budhan Pur Village
- Holambi Khurd Village
- Salah Pur Majra Village
- Chand Pur Village
- Rohini Sector 11
- Mamoor Pur Village

The villages/urban areas for survey were selected based on close proximity from the plant site and few areas from the buffer zone were selected.

3.17.5 Study Area

The study area covers 10 km radius circle around the proposed Waste to Energy Project (30 MW) at Delhi State Industrial and Infrastructure Development Corporation (DSIIDC) Industrial Area, Sector-5, Bawana, Delhi, Thermal Power Plants (Waste to Energy), by M/s Jindal Urban Waste Management (Bawana) Limited.

3.17.5.1 Administrative Description of the Study Area

The study area habitations are spread over the sub districts Narela and Saraswati Vihar of North West district, National Capital Territory (NCT) of Delhi and sub districts Sonipat and Kharkhoda of Sonipat district in Haryana State. The population and amenities of Delhi has been taken according to the percentage of the area falling in the study area. There are 82 identified habitations in the study area out of which there are 53 villages and 29 urban areas/Census Towns. There are two uninhabited villages in the study area. The number of habitations falling in National Capital Territory (NCT) of Delhi is 62 whereas, 20 habitations are from Haryana State of the study area. There is no Rehabilitation and Resettlement (R & R) involved in this project as the area for the proposed project is within Industrial Area Bawana. The habitations are shown in **Figure 3.27** and **Table 3.38.**

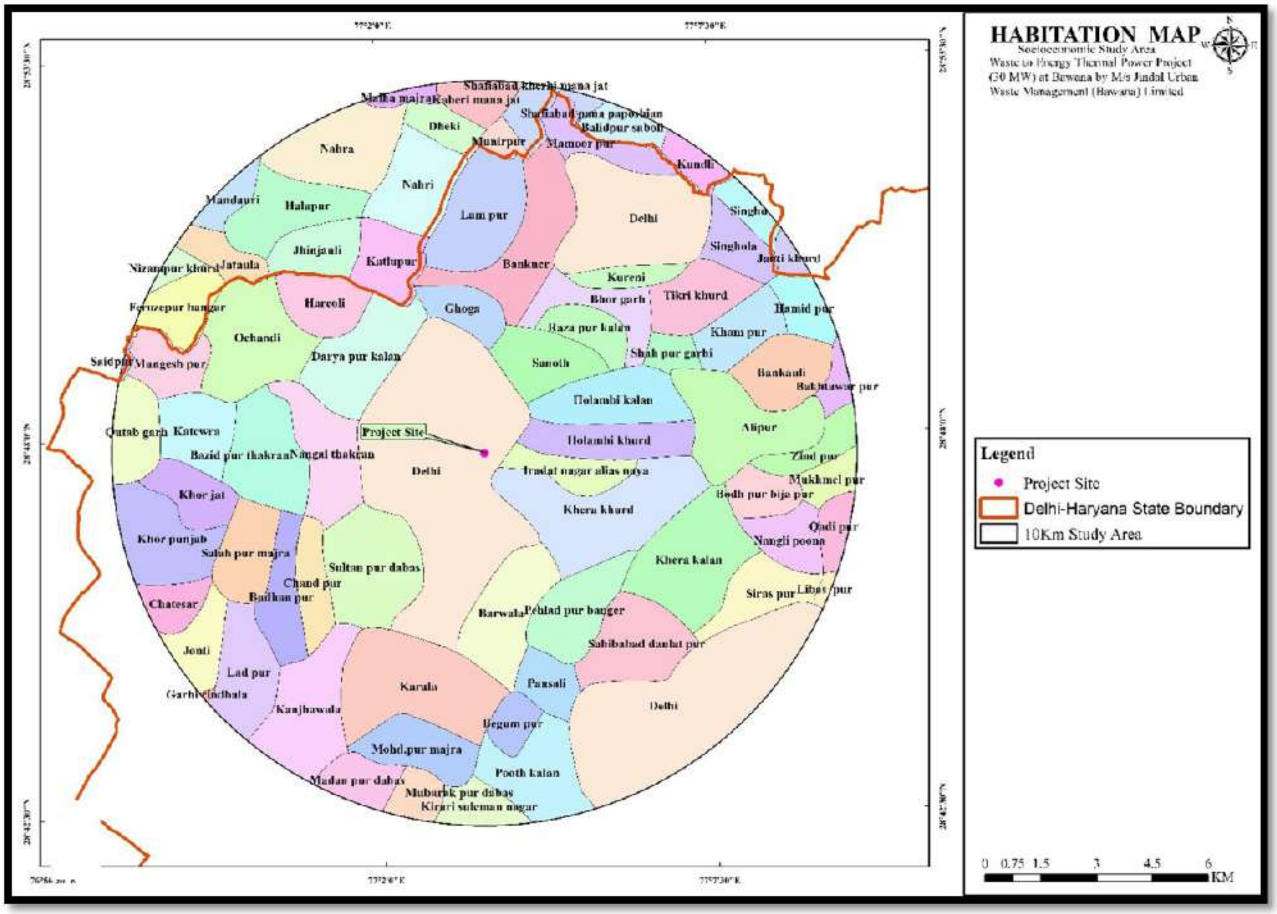


Figure 3.27:- Habitation Map the study area

Table 3.38: List of Towns and villages falling in the study area

Sl. No.	Union Territory/ State	District	Sub-District	Village
1.	Haryana	Sonipat	Sonipat	Bazidpur Saboli
2.	NCT of Delhi	North West	Narela	Bazid Pur Thakran
3.	NCT of Delhi	North West	Narela	Bodh Pur Bija Pur
4.	NCT of Delhi	North West	Saraswati Vihar	Budhan Pur
5.	NCT of Delhi	North West	Saraswati Vihar	Chand Pur
6.	NCT of Delhi	North West	Saraswati Vihar	Chatesar
7.	Haryana	Sonipat	Sonipat	Dheki
8.	Haryana	Sonipat	Kharkhoda	Ferozepur Bangar

Sl. No.	Union Territory/ State	District	Sub-District	Village
9.	NCT of Delhi	North West	Saraswati Vihar	Garhi Rindhala
10.	NCT of Delhi	North West	Narela	Ghoga
11.	Haryana	Sonipat	Sonipat	Halalpur
12.	NCT of Delhi	North West	Narela	Hamid Pur
13.	NCT of Delhi	North West	Narela	Hareoli
14.	NCT of Delhi	North West	Narela	Holambi Kalan
15.	NCT of Delhi	North West	Narela	Holambi Khurd
16.	NCT of Delhi	North West	Narela	Iradat Nagar alias Naya Bans
17.	Haryana	Sonipat	Sonipat	Janti Khurd
18.	Haryana	Sonipat	Kharkhoda	Jataula
19.	Haryana	Sonipat	Kharkhoda	Jhinjauli
20.	NCT of Delhi	North West	Saraswati Vihar	Jonti
21.	Haryana	Sonipat	Sonipat	Kheri Manajat
22.	NCT of Delhi	North West	Narela	Katewara
23.	Haryana	Sonipat	Kharkhoda	Katlupur
24.	NCT of Delhi	North West	Narela	Kham Pur
25.	NCT of Delhi	North West	Saraswati Vihar	Jat Khor
26.	NCT of Delhi	North West	Saraswati Vihar	Punjab Khor
27.	NCT of Delhi	North West	Narela	Kureni
28.	NCT of Delhi	North West	Narela	Lam Pur
29.	NCT of Delhi	North West	Saraswati Vihar	Madan Pur Dabas
30.	Haryana	Sonipat	Sonipat	Malha Majra
31.	NCT of Delhi	North West	Narela	Mamoor Pur
32.	Haryana	Sonipat	Kharkhoda	Mandauri
33.	NCT of Delhi	North West	Narela	Mungesh Pur
34.	Haryana	Sonipat	Sonipat	Munirpur
35.	Haryana	Sonipat	Sonipat	Nahra

Sl. No.	Union Territory/ State	District	Sub-District	Village
36.	Haryana	Sonipat	Sonipat	Nahri
37.	NCT of Delhi	North West	Narela	Nangal Thakran
38.	NCT of Delhi	North West	Narela	Nangli Poona
39.	Haryana	Sonipat	Sonipat	Nathupur
40.	Haryana	Sonipat	Kharkhoda	Nizampur Khurd
41.	NCT of Delhi	North West	Narela	Ochandi
42.	NCT of Delhi	North West	Narela	Pansali
43.	NCT of Delhi	North West	Narela	Raja Pur Kalan (Un-inhabited)
44.	Haryana	Sonipat	Kharkhoda	Saidpur
45.	NCT of Delhi	North West	Saraswati Vihar	Salah Pur Majra
46.	NCT of Delhi	North West	Narela	Sanoth
47.	Haryana	Sonipat	Sonipat	Shafiabad Kheri Manajat
48.	Haryana	Sonipat	Sonipat	Shafiabad Pana Paposhian
49.	NCT of Delhi	North West	Narela	Shah Pur Garhi
50.	NCT of Delhi	North West	Narela	Singhola
51.	NCT of Delhi	North West	Narela	Singhu
52.	NCT of Delhi	North West	Narela	Sultan Pur Dabas
53.	NCT of Delhi	North West	Narela	Zind Pur
Sl. No.	**Union Territory/ State**	**District**	**Sub-District**	**Urban Area**
54.	NCT of Delhi	North West	Narela	Ali Pur
55.	NCT of Delhi	North West	Narela	Bakhtawar Pur
56.	NCT of Delhi	North West	Narela	Bankauli
57.	NCT of Delhi	North West	Narela	Bankner
58.	NCT of Delhi	North West	Narela	Barwala
59.	NCT of Delhi	North West	Saraswati Vihar	Begum Pur
60.	NCT of Delhi	North West	Narela	Bhor Garh

Sl. No.	Union Territory/ State	District	Sub-District	Village
61.	NCT of Delhi	North West	Narela	Darya Pur Kalan
62.	NCT of Delhi	North West	Narela	Bawana
63.	NCT of Delhi	North West	Narela	Narela
64.	NCT of Delhi	North West	Saraswati Vihar	Kanjhawala
65.	NCT of Delhi	North West	Saraswati Vihar	Karala
66.	NCT of Delhi	North West	Narela	Khera Kalan
67.	NCT of Delhi	North West	Narela	Khera Khurd
68.	NCT of Delhi	North West	Saraswati Vihar	Kirari Suleman Nagar
69.	Haryana	Sonipat	Sonipat	Kundli
70.	NCT of Delhi	North West	Saraswati Vihar	Lad Pur
71.	NCT of Delhi	North West	Narela	Libas Pur
72.	NCT of Delhi	North West	Saraswati Vihar	Mohammad Pur Majri
73.	NCT of Delhi	North West	Saraswati Vihar	Mubarak Pur Dabas
74.	NCT of Delhi	North West	Narela	Mukhmel Pur
75.	NCT of Delhi	North West	Narela	Pehlad Pur Bangar
76.	NCT of Delhi	North West	Saraswati Vihar	Pooth Kalan
77.	NCT of Delhi	North West	Narela	Qadi Pur
78.	NCT of Delhi	North West	Saraswati Vihar	Qutab Garh
79.	NCT of Delhi	North West	Narela	Sahibabad Daulat Pur
80.	NCT of Delhi	North West	Narela	Siras Pur
81.	NCT of Delhi	North West	Narela	Tikri Khurd
82.	NCT of Delhi	North West	Saraswati Vihar	Rohini

Source: Primary Census Abstract, 2011

3.17.5.2 Population Distribution of the Study Area

According to Census 2011, total population of the study area has been worked out to 1026489 in which 555573 (54.1 per cent) are males and remaining 470916 (45.9 per cent) are females. The overall sex ratio in the study area has been worked out to 848 females per 1000 males.

The sex ratio of the study area is lower than both North West District (865 females per 1000 males) and that of Sonipat District (856 females per 1000 males).

The population density of the study area is 2546 persons per square kilometer. The density of population of the study area is much lower than the density of population of North West Delhi district (8254 persons per square kilometer) whereas, much higher than the population density of Sonipat (683 persons per square kilometer).

Table 3.39: Total population of the Study Area

Total Population	**1026489**	**100 %**
Male	555573	54.1 %
Female	470916	45.9 %
Sex Ratio	848	

Source: Primary Census Abstract, 2011

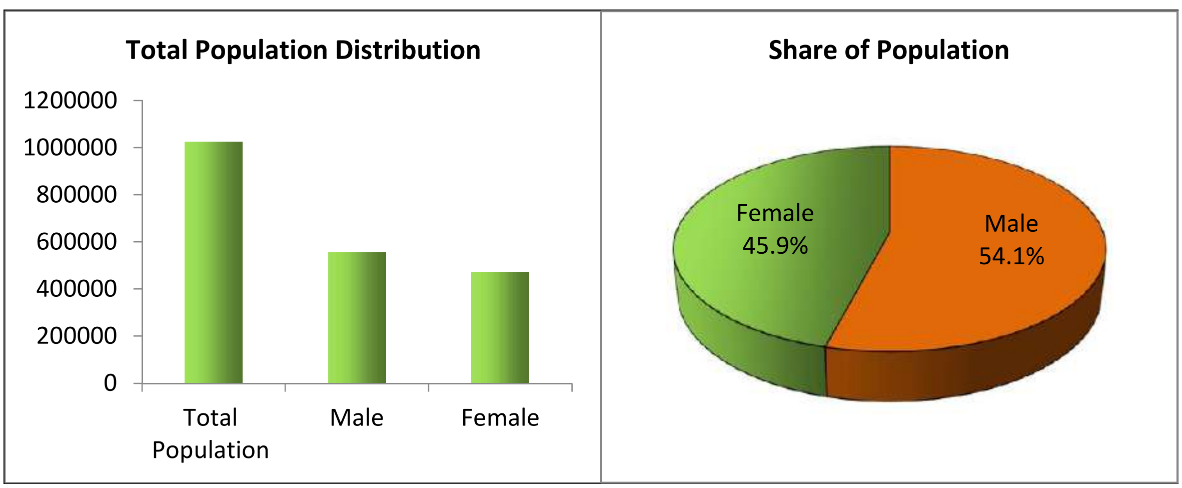


Figure 3.28:- Total Population Distribution of the Study Area

The combined decadal growth rate of North-West District of Delhi and Sonipat District of Haryana during the decade 2001-2011 is 20.575 per cent. Accordingly, the population of the study area in 2022-23 is calculated to be 1237689. The number of the males and females is 669882 and 567807 respectively.

3.17.5.3 Child Population Distribution of the Study Area

In the study area, the total child population of the age group of 0-6 year has been worked out to be 142006 which constitute about 13.8 per cent of the total population. According to the 2011 Census, the proportion of the 0-6 years population of the study area is higher than that both of North West Delhi being 12.3 per cent and Sonipat district being 12.98 per cent.

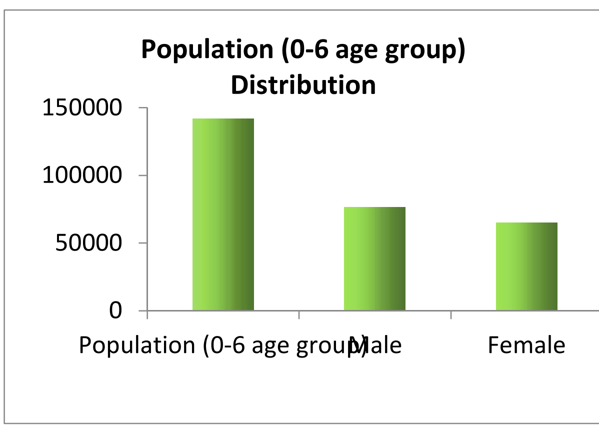
Of the total child population, 76697 (54.0 per cent) are boys and remaining 65309 (46.0 per cent) are girls. The sex ratio of population in this age group is 851 girls per 1000 boys.

The child sex ratio of the (0-6 year's age group) population of the study area is lower than that of North West Delhi district (865 girls per 1000 boys) whereas, higher than that of Sonipat District (798 girls per 1000 boys).

Table 3.40: Child Population of the Study Area

Population (0-6 age group)	**142006**	**100 %**
Male	76697	54.0 %
Female	65309	46.0 %
Sex Ratio	851	

Source: Primary Census Abstract, 2011



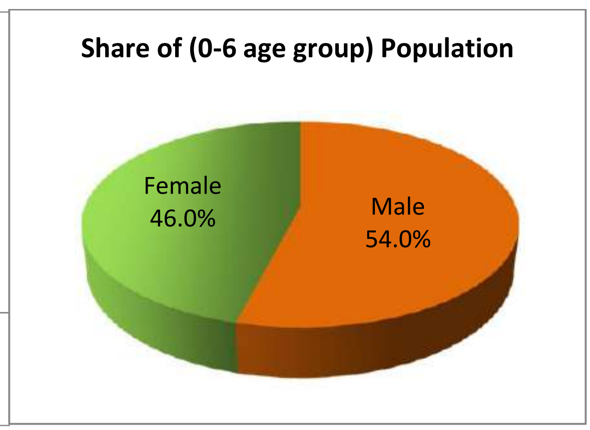


Figure 3.29:- Child Population Distribution of the Study Area

3.17.5.4 Vulnerable Groups Population Distribution of the Study Area

The vulnerable groups includes population of Scheduled Caste and Scheduled Tribe in the study area.

3.17.5.5 Scheduled Caste Population Distribution of the Study Area

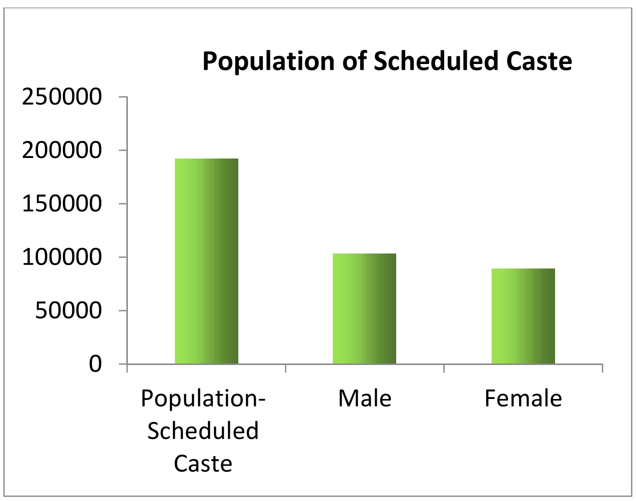
In the study area, Scheduled Caste population is 192357 which constitute 18.7 per cent of the total population of the study area. Of the total Scheduled Caste population, 102974 (53.5 per cent) are males and remaining 89383 (46.5 per cent) are females. The sex ratio among the Scheduled Caste population in the study area has been worked out to 868 females per 1000 males.

The sex ratio of the Scheduled Caste population of the study area (868 females per 1000 males) is lower than North West Delhi district (877 females per 1000 males) whereas, same as that of Sonipat district (868 females per 1000 males).

Table 3.41: Scheduled Caste population of the Study Area

Population- Scheduled Caste	**192357**	**100 %**
Male	102974	53.5 %
Female	89383	46.5 %
Sex Ratio	868	

Source: Primary Census Abstract, 2011



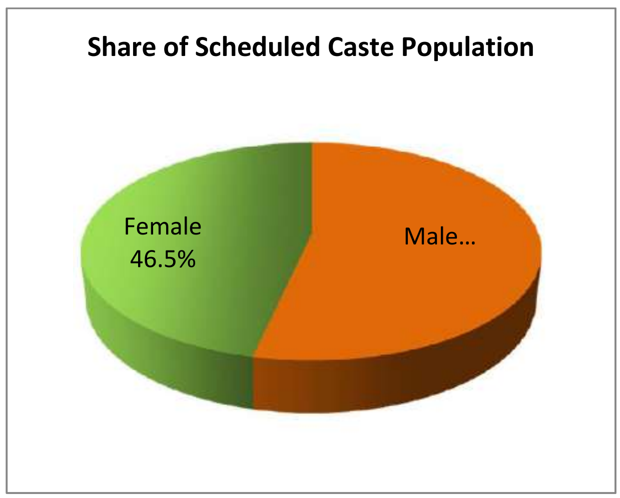


Figure 3.30:- Scheduled Caste Population Distribution of the Study Area

The proportion of the Scheduled caste population in the study area (18.7 per cent) is lower than that of the Scheduled Caste population in North West Delhi district (19.1 per cent) whereas, slightly higher than that of Sonipat district (18.62 per cent).

3.17.5.6 Scheduled Tribe Population Distribution of the Study Area

Scheduled Tribe population is not present in the study area habitations. As there is no Scheduled Tribe population present in the study area so no impact is envisaged on them.

3.17.5.7 Household and Household Size of the Study Area

The entire population of the study area is distributed into 200142 households and the average household size is calculated to be 5 according to the Census of India, 2011. During the site visit it was confirmed that there is a mix of nuclear and joint families residing in the study area habitations.

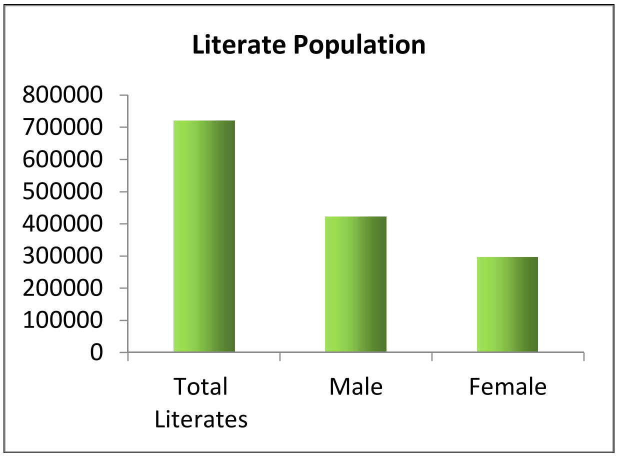
3.17.5.8 Literates, Literacy Rate and Gender Gap in Literacy Rate of the Study Area

In the study area, 719851 (70.1 per cent) of the population is literate in which 422161 (58.6 per cent) are male literates and remaining 297690 (41.4 per cent) are female literates. The per cent age of the literates to the total population of the study area (70.1 per cent) is lower than that of North-West Delhi district (74.1 per cent) and higher than that of Sonipat district (68.8 per cent).
There is a gender gap of 17.2 per cent in the literate population. The per cent of female literates are lower than the male literates. The overall literacy rate has been worked out to 81.4 per cent. The male literacy rate is 88.2 per cent and female literacy rate is 73.4 per cent, creating a gender gap in literacy rate of 14.8 per cent.
The overall, male and female literacy rates of North-West Delhi district are 84.4 per cent, 89.7 percent and 78.4 per cent respectively having a gender gap of 11.3 per cent. The overall, male and female literacy rates of Sonipat district are 79.1 per cent, 87.2 per cent and 69.8 per cent respectively having a gender gap of 17.4 per cent.

Table 3.42: Literates, Literacy Rate of the Study Area

Total Literates	**719851**	**100 %**
Male	422161	58.6 %
Female	297690	41.4 %
Gender Gap in Literates	17.2 %	
Overall Literacy Rate	**81.4**	
Male	88.2	
Female	73.4	
Gender Gap in Literacy Rate	14.8	

Source: Primary Census Abstract, 2011



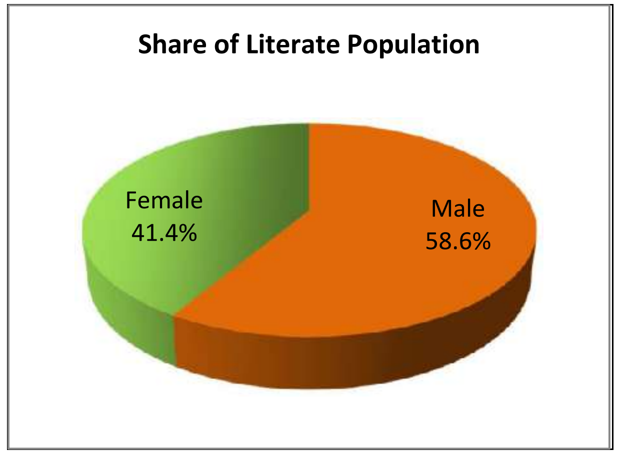


Figure 3.31:- Literate Population Distribution of the Study Area

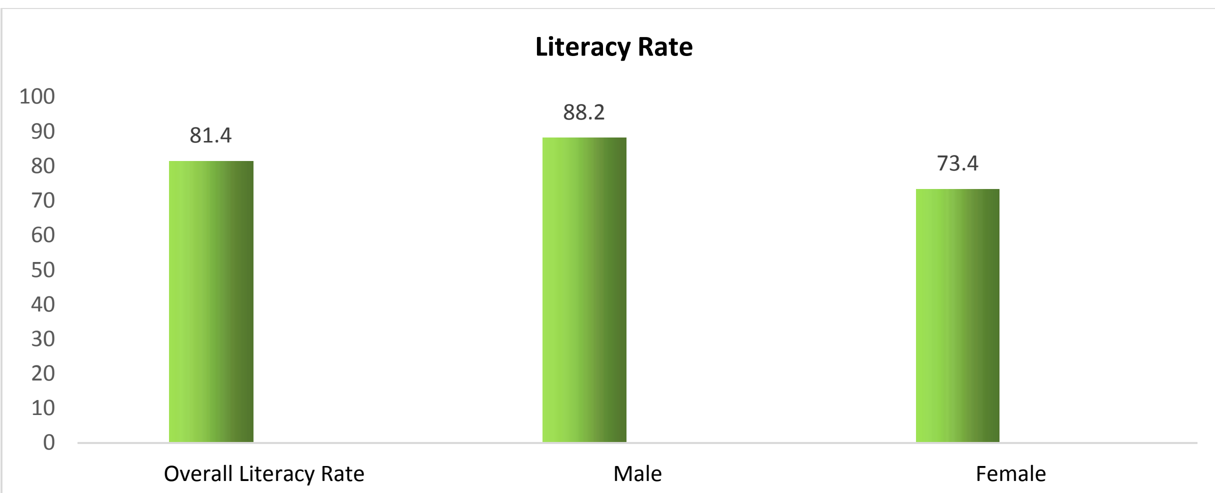


Figure 3.32:- Literacy Rate of the Study Area

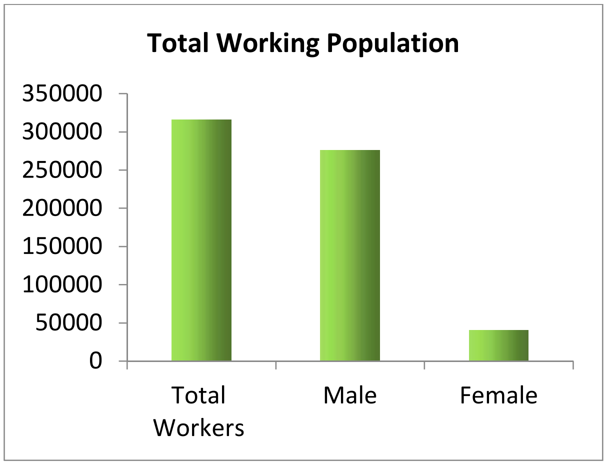
3.17.5.9 Total Working Population of the Study Area

Based on Census 2011, total number of workers in the study area has been worked out to be 316263 which constitute 30.8 per cent of the total population. Of the total workers, 276066 (87.3 per cent) are males and the remaining 40197 (12.7 per cent) are females. There is a significant gender gap of 74.6 per cent in total work participation of males and females.

Table 3.43: Total Workers Population of the Study Area

Total Workers	**316263**	**100 %**
Male	276066	87.3 %
Female	40197	12.7 %
Gender Gap in Work Participation	74.6 %	

Source: Primary Census Abstract, 2011



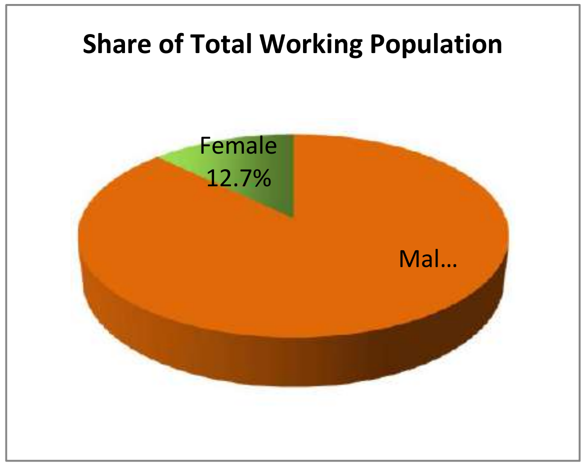


Figure 3.33:- Total Workers Population Distribution of the Study Area

The Work Participation Rate (WPR) of the study area (30.8 per cent) is lower than that of North-West Delhi district (32.5 per cent) and Sonipat district (36.1 per cent).

3.17.5.10 Main Workers of the Study Area

Based on Census 2011, the number of main workers in the study area has been worked out to be 294682 which constitutes 93.2 per cent of the total working population. Of the main workers, 260942 (88.6 per cent) are males and the remaining 33740 (11.4 per cent) are females. There is a significant gender gap of 77.2 per cent in work participation.

Table 3.44: Main Workers of the Study Area

Main Workers	**294682**	**100 %**
Male	260942	88.6 %
Female	33740	11.4 %
Gender Gap in Work Participation	77.2 %	

Source: Primary Census Abstract, 2011

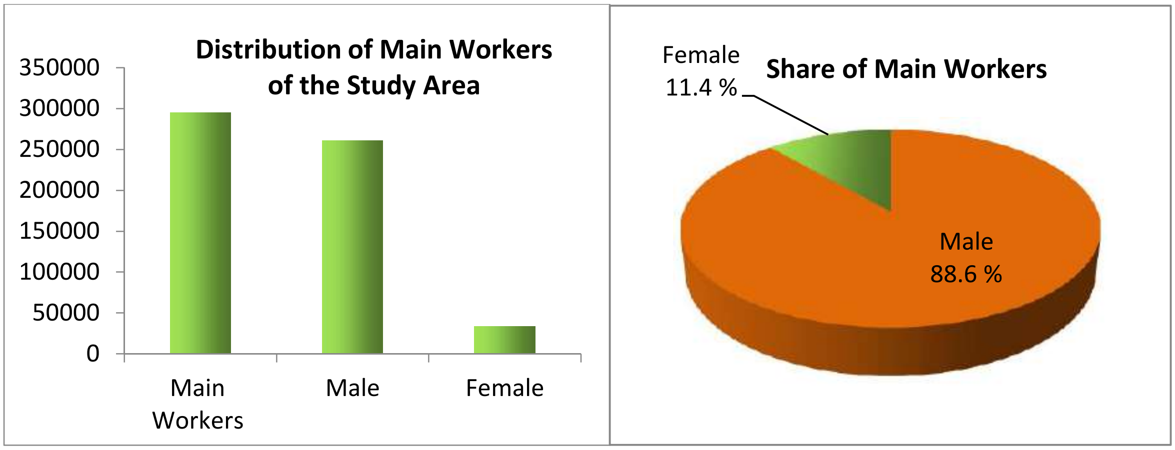


Figure 3.34:- Main Workers Distribution of the Study Area

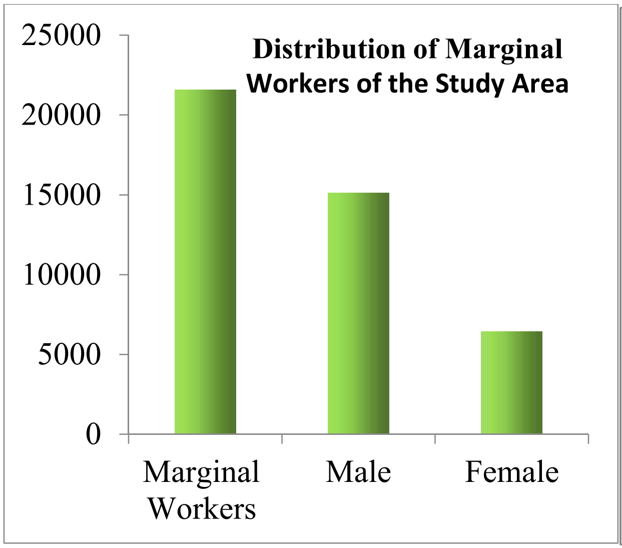
3.17.5.11 Marginal Workers of the Study Area

Based on Census 2011, total number of marginal workers in the study area has been worked out to be 21581 which constitute 6.8 per cent of the total population. Of the marginal workers, 15124 (70.1 per cent) are males and the remaining 6457 (29.9 per cent) are females. There is a gender gap of 40.2 per cent in work participation.

Table 3.45: Marginal Workers of the Study Area

Marginal Workers	**21581**	**100 %**
Male	15124	70.1 %
Female	6457	29.9 %
Gender Gap in Work Participation	40.2 %	

Source: Primary Census Abstract, 2011



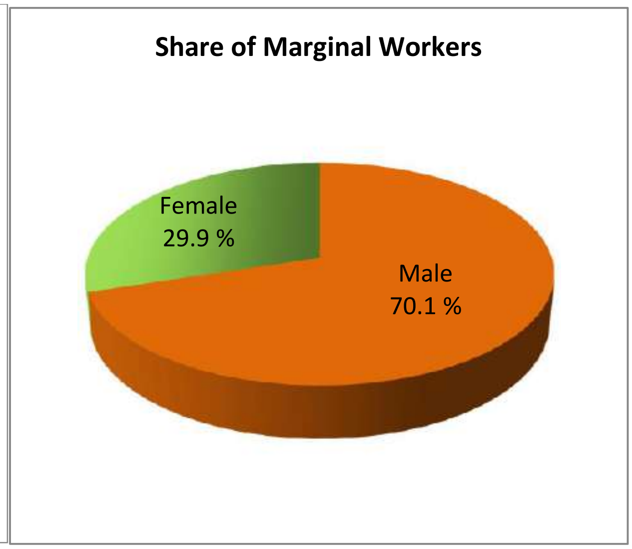


Figure 3.35:- Marginal Workers Distribution of the Study Area

3.17.5.12 Main Workers Population Details of the Study Area

The main workers are further divided into agricultural labourers, cultivators, household industrial workers and other workers'. The sum of the cultivators and agricultural labourers is termed as total agricultural workers.

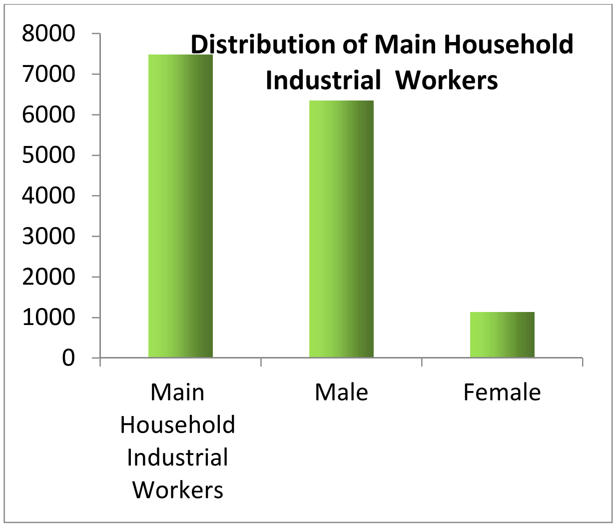
Main Household Industrial Workers of the Study Area

Based on Census 2011, total number of main household workers in the study area is 7483 which constitute 2.5 per cent of the total main working population. Of the main household workers, 6349 (84.8 per cent) are males and the remaining 1134 (15.2 per cent) are females. There is a significant gender gap of 69.6 per cent in work participation.

Table 3.46: Main Household Industrial Workers of the Study Area

Household Industrial Workers	7483	100 %
Male	6349	84.8 %
Female	1134	15.2 %
Gender Gap in Work Participation	69.6 %	

Source: Primary Census Abstract, 2011



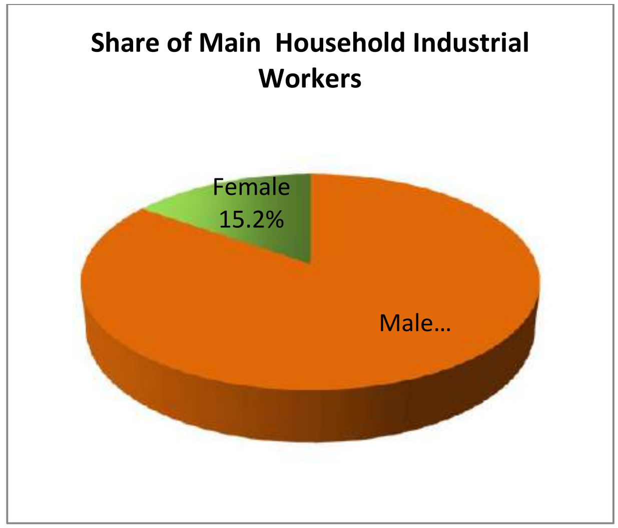


Figure 3.36:- Main Household Workers Distribution of the Study Area

3.17.5.13 Main Agricultural Workers of the Study Area

The sum of the cultivator and agricultural laborers is termed as agricultural workers. Based on Census 2011, total number of main agricultural workers in the study area has been worked out to be 18673 which constitute 6.3 per cent of the total main working population. Of the main agricultural workers, 15498 (83.0 per cent) are males and the remaining 3175 (17.0 per cent) are females. There is a significant gender gap of 66.0 per cent in work participation.

Table 3.47: Main Agricultural Workers of the Study Area

Total Agricultural Workers	**18673**	**100 %**
Male	15498	83.0 %
Female	3175	17.0 %
Gender Gap in Work Participation	66 %	

Source: Primary Census Abstract, 2011

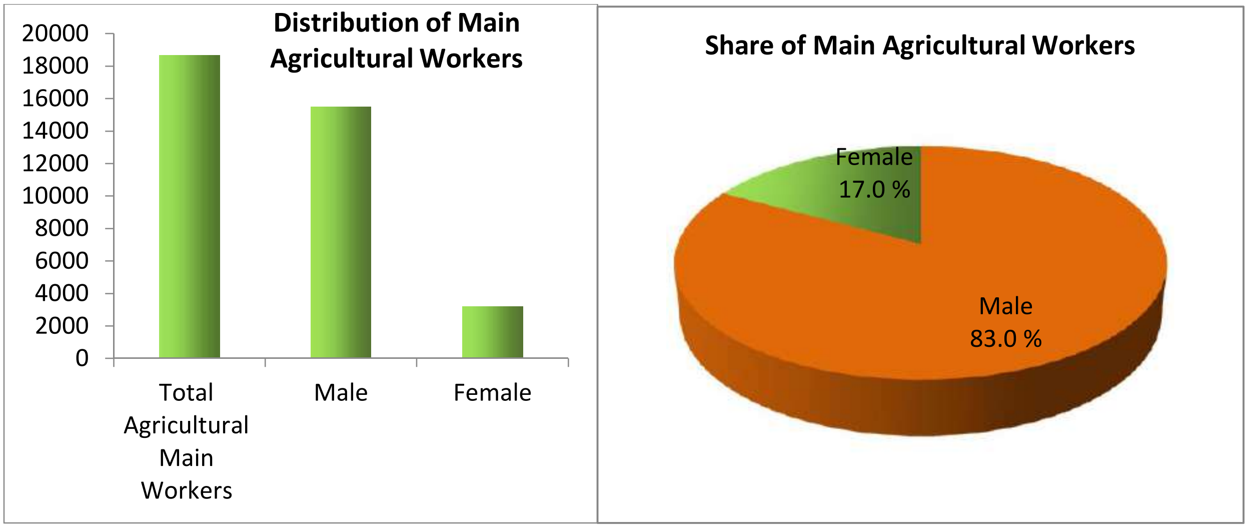


Figure 3.37:- Main Agricultural Workers Distribution of the Study Area

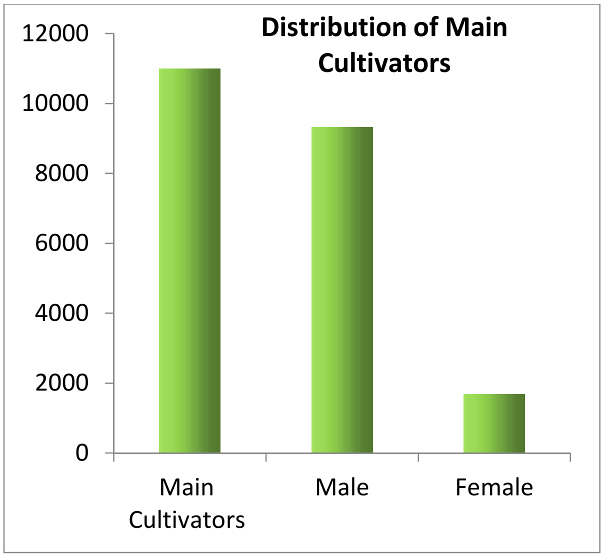
3.17.5.14 Main Cultivator of the Study Area

Based on Census 2011, the total number of main cultivators in the study area has been worked out to be 10994 which constitutes 3.7 per cent of the total main working population. Of the main cultivator workers, 9318 (84.8 per cent) are males and the remaining 1676 (15.2 per cent) are females. There is a significant gender gap of 69.6 per cent in work participation.

Table 3.48: Main Cultivator of the Study Area

Cultivators	**10994**	**100 %**
Male	9318	84.8 %
Female	1676	15.2 %
Gender Gap in Work Participation	69.6 %	

Source: Primary Census Abstract, 2011



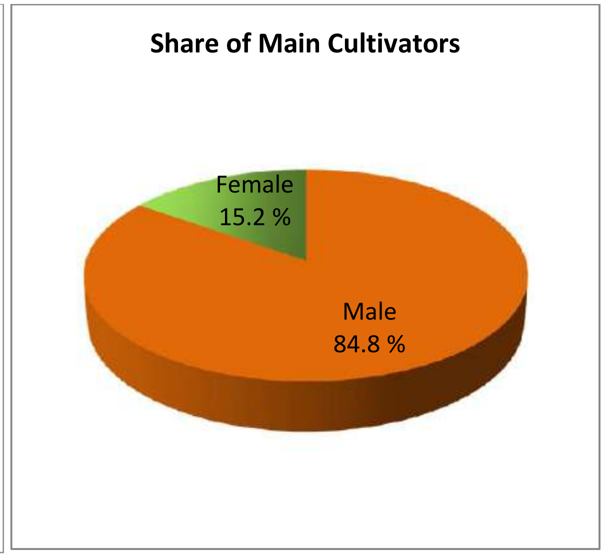


Figure 3.38:- Main Cultivator Distribution of the Study Area

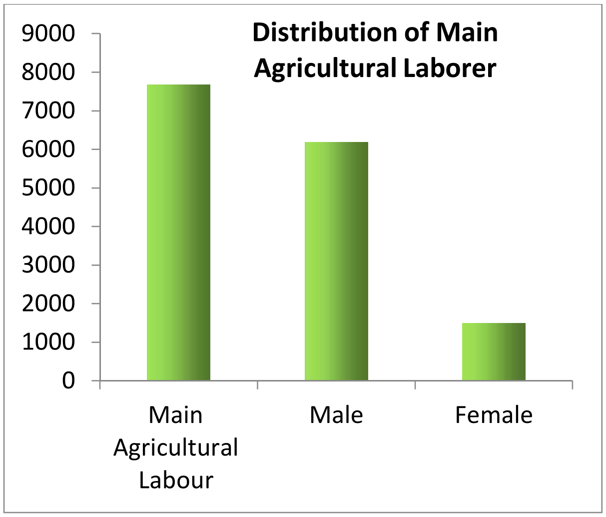
3.17.5.15 Main Agricultural Laborer of the Study Area

Based on Census 2011, the total number of main agricultural laborer in the study area has been worked out to be 7679 which constitute 2.6 per cent of the total main working population. Of the main agricultural laborer, 6180 (80.5 per cent) are males and the remaining 1499 (19.5 per cent) are females. There is a significant gender gap of 61.0 per cent in work participation.

Table 3.49: Main Agricultural Laborer of the Study Area

Total Workers	**7679**	**100 %**
Male	6180	80.5 %
Female	1499	19.5 %
Gender Gap in Work Participation	61.0 %	

Source: Primary Census Abstract, 2011



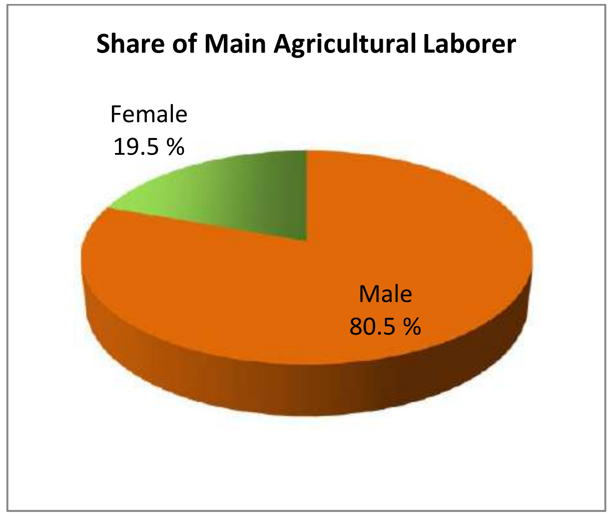


Figure 3.39:- Main Agricultural Labour Distribution of the Study Area

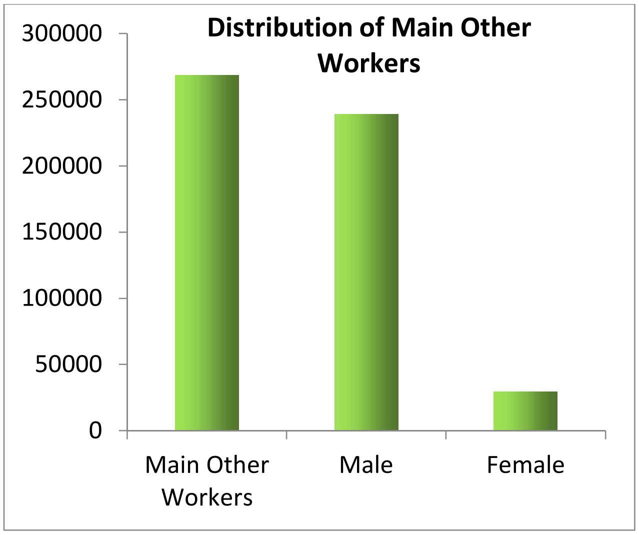
3.17.5.16 Main Other Workers of the Study Area

Based on Census 2011, the total number of other workers in the study area has been worked out to be 268526 which constitute 91.1 per cent of the total main working population. Of the other workers, 239095 (89.0 per cent) are males and the remaining 29431 (11.0 per cent) are females. There is a significant gender gap of 78.0 per cent in work participation.

Table 3.50: Main Other Workers of the Study Area

Total Workers	**268526**	**100 %**
Male	239095	89.0 %
Female	29431	11.0 %
Gender Gap in Work Participation	78 %	

Source: Primary Census Abstract, 2011



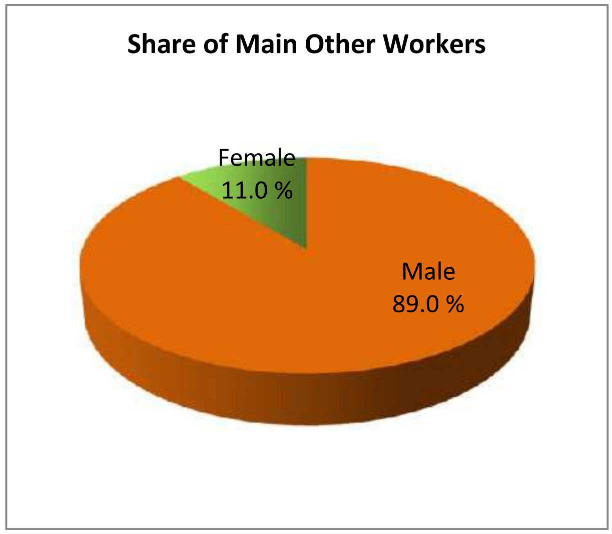


Figure 3.40:- Main Other Workers Distribution of the Study Area

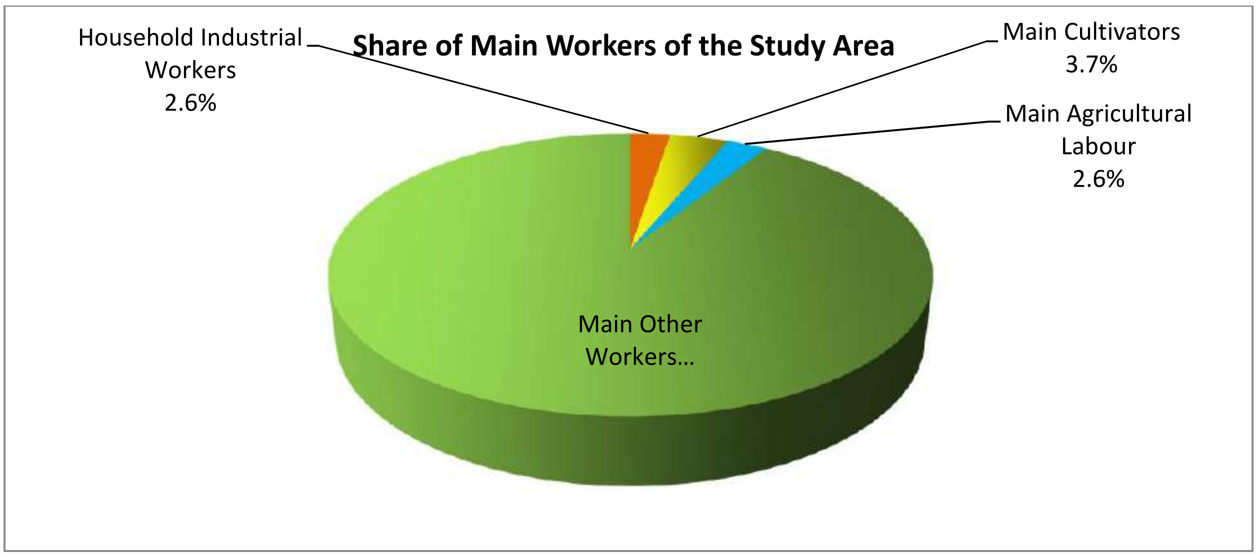


Figure 3.41:- Main Workers Distribution of the Study Area

Out of the total working main population of the study area, 3.7 per cent are cultivators and 2.6 per cent are agricultural labourers. Workers belonging to other workers category are 91.1 per cent whereas, 2.60 per cent belongs to the household industrial workers' category. From the above distribution of workers it is clear that the economy of the study area is mainly dependent on other workers.

The amenities available in the study area habitations is a parameter to assess the quality of life that the inhabitants have. According to the Census of India, 2011 the amenities details of the study area habitations that include both the villages and towns have been shown below in the tables one by one respectively.

3.17.6 BASIC AMENITIES OF THE STUDY AREA:

3.17.6.1 Basic Amenities Available in the Study Area Villages and Urban areas Educational Facility

According to the field survey and Census of India, 2011 there are sufficient number of government/private run schools ranging from Pre- Primary to Senior Secondary educational institutions in the study area villages and urban areas.

Sarvodaya Vidayalaya & MCD Primary Schools is available in almost all the villages or residential colonies of the study area. The Bawana (CT) and Narela is the nearby destination of the Villagers for education or professional degrees like engineering, medical, law and other courses.

For further specialized courses the students are moving to Delhi University, Jamia Milia University, Guru Govind Singh University, Dr. BR Ambedkar University, AIIMS, IIT, DTU etc.

The prominent educational institutions in the study area are Dhakaur Devi Convent School, Mann School & Aditi Maha Vidyalaya etc.

The educational facilities in the study area is given in the **Table 3.51** & **Figure 3.42** as per Census of India, 2011.

Table 3.51: Education Facilities in Village of the Study Area

EDUCATION FACILITIES IN VILLAGE		
	Type of Institutions	**Number**
Educational Facilities	Pre-Primary School (Govt. & Pvt.)	61
	Primary School (Govt. & Pvt.)	109
	Middle School (Govt. & Pvt.)	55
	Secondary School (Govt. & Pvt.)	47
	Senior Secondary School (Govt. & Pvt.)	25

	Arts and Science Degree College (Pvt.)	01
	Engineering College (Pvt.)	03
	Management Institute (Pvt.)	01
	Total	**302**
EDUCATION FACILITIES IN URBAN AREAS		
Educational Facilities	**Type of Institutions**	**Number**
	Primary School (Govt. & Pvt.)	176
	Middle School (Govt. & Pvt.)	103
	Secondary School (Govt. & Pvt.)	82
	Senior Secondary School (Govt. & Pvt.)	60
	Degree College-Art, Science and Commerce (Govt. & Pvt.)	06
	Medical College (Govt.)	01
	Engineering College (Govt. & Pvt.)	05
	Management Institute (Govt. & Pvt.)	05
	Total	**438**

Source: Census of India, 2011

Interaction with the Vice Principal of Govt. Co-Ed, SSS Ghoga Village

Focus Group Discussion with school teachers at Sanoth Village

Figure 3.42: Education Facilities

Source: Primary Social Survey (March-2024)

3.17.6.2 Health Facilities & Epidemiological Study

According to the field survey it was revealed that medical facilities are limited in the villages of the study area. Bawana/Narela are the nearest destinations where hospital/dispensary facilities are available. The ASHA workers make visits on regular basis in PHC/UHC of the study area. The prominent diseases occurring frequently in the study area are fever, Typhoid, malaria, dengue, asthma, TB etc.

The villagers/residential colonies are availing the facility of Ambulance in case of any emergency, which is provided by state and union government/private trust. For treatment of the diseases the people of the study area prefer to visit Government/private hospitals like District Government Hospital, AIIMS, Safdarjung Hospitals, Ganga Ram Hospitals, Apollo Hospitals, Fortis Hospitals etc. which are having sufficient multiple Specialty facilities available there.

The health facilities in the study area is given in the **Table 3.52** as per Census of India, 2011.

Table 3.52: Health facilities in Village of the Study Area

HEALTH FACILITIES IN THE VILLAGES		
	Type of Facilities	**Number**
	Community Health Centre	02
	Primary Health Centre	04
	Primary Health Sub Centre	10
	Maternity And Child Welfare Centre	02
	TB Clinic	02
	Dispensary	14
	Mobile Health Clinic	01
Health Facilities	Non-Government Medical facilities Out Patient	08
	Non-Government Medical facilities In And Out Patient	05
	Total	**48**
HEALTH FACILITIES IN THE URBAN AREAS		
	Type of Facilities	**Number**
	Hospital Allopathic	05
	Dispensary/Health Centre	41
	Family Welfare Centre	04
	Maternity And Child Welfare Centre	07
	Maternity Home	04
Health Facilities	Nursing Home	16
	Mobile Health Clinic	02

	Non-Government Medical Facilities Out Patient	35
	Non-Government Medical Facilities In and Out Patient	211
	Total	**325**

Source: Census of India, 2011

3.17.6.3 Drinking Water Facilities

During the field survey it was revealed that the drinking water requirement of the maximum population in the study area is met by municipal tap water supply. In a few of the study area villages the overhead tank facility is provided by the village Panchayat.

The drinking water/water facilities in the study area is given in the **Table 3.53** & **Figure 3.43** as per Census of India, 2011.

Table 3.53: Drinking Water Facilities in Village of the Study Area

WATER FACILITIES IN VILLAGES		
Drinking Water	**Means of Drinking Water**	**No. of Habitations**
	Tap Water Treated	50
	Tap Water Untreated	08
	Covered Well	07
	Uncovered Well	05
	Hand Pump	49
	Tube Wells/Borehole	43
	River/Canal	11
	Tank/Pond/Lake	18
WATER FACILITIES IN URBAN AREAS		
Drinking Water	**Means of Drinking Water**	**No. of Habitations**
	Tap Water from Treated Source	28
	Tube well /Borehole	01

Source: Primary Social Survey (March-2024)

Figure 3.43: Drinking water Facilities

3.17.6.4 Availability of Power Supply

BSES Rajdhani Power Limited (BRPL), BSES Yamuna Power Limited (BYPL) and Tata Power Delhi Distribution Limited (TPDDL) (earlier NDPL) provides electricity in North-West district of the study area whereas, Uttar Haryana Bijli Vitran Nigam Limited (UHBVNL), a Govt. of Haryana undertaking supplies power to all the households & commercial Complexes in Sonipat district of the study area. The disruption in electricity supply is negligible in the study area. The subsidy/free electricity is also provided by the state government to the residential of Delhi up to a certain limit depending upon its consumption and purpose.

The power supply facilities in the study area is given in the **Table 3.54** & **Figure 3.44** as per Census of India, 2011.

Table 3.54: Power Supply Facilities in Village of the Study Area

POWER SUPPLY IN NUMBER OF VILLAGES		
Electricity Supply	Power Supply for Domestic Uses	51
	Power Supply for Agriculture Uses	51
	Power Supply For Commercial Use	44
POWER SUUPLY IN NUMBER OF URBAN AREAS		
Electricity Supply	Electricity-Domestic Connection	29
	Electricity-Industrial Connection	27
	Electricity-Commercial Connection	24
	Electricity-Road Lighting Connection	29

Source: Census of India, 2011

Figure 3.44: Power Supply Facilities

3.17.6.5 Communication & Transportation Facilities

There is sufficient number of communication facilities in the villages/habitation of the study area in form of Post offices and mobile towers. In Narela/Bawana the main post office of the study area is located. The people now also have their own android mobile phones, which has become a necessity, for fast and easy communication. There are ample means of transportation facilities with in the study area like private/government buses, electric/CNG auto rickshaw, metro rail etc. The large number of the population have their own vehicle like car, motorcycle, Jeep or pick up van etc. for transportation purpose.

The transportation facilities in the study area is given in the **Table 3.55 & Figure 3.45** as per Census of India, 2011.

Table 3.55: Transportation Facilities in Village of the Study Area

TRANSPORTATION FACILITIES IN NUMBER OF VILLAGES		
Road Transportation Facility	Public Bus Service	50
	Private Bus Service	51
	Auto/Modified Autos	12
	Taxi	12
	Vans	24
TRANSPORTATION FACILITIES IN NUMBERS OF URBEN AREAS		
Road Transportation Facility	Bus Service (Public & Private)	29
	Auto/Modified Autos	29
	Taxi	29
	Vans	29

Source: Census of India, 2011

Govt. Transportation Facility in the study area

Govt. Transportation Facility in the study area

Figure 3.45: Transportation Facilities

3.17.6.6 Drainage Facilities

In maximum of the study area villages open drainage facility is available whereas, in some of the villages closed drainage facility is available while 04 of the villages are having no drainage facility according to the Census of India, 2011. During the site visit it was observed that apart from minor congestion there is a good drainage facility available in the villages. The urban areas are having both open and closed drainage facilities in the study area.

The details of the drainage facilities in the study area is given in the **Table 3.56** & **Figure 3.46** as per Census of India, 2011.

Table 3.56: Drainage facilities in Village of the Study Area

<table>
<tr><th colspan="3">DRAINAGE FACILITIES IN NUMBER OF VILLAGES</th></tr>
<tr><td rowspan="3">Sanitation Facility</td><td>Closed Drainage</td><td>06</td></tr>
<tr><td>Open Drainage</td><td>44</td></tr>
<tr><td>No Drainage</td><td>04</td></tr>
<tr><th colspan="3">DRAINAGE FACILITIES IN NUMBER OF URBAN AREAS</th></tr>
</table>

Sanitation Facility	Closed Drainage	01
	Open Drainage	14
	Both Closed & Open Drainage	13

Source: Census of India, 2011

Closed Drainage facility in the study area　　Closed Drainage facility in the study area

Figure 3.46: Drainage facilities

3.17.6.7 Road Facilities

The villages and urban areas are well connected by roads with various National and State Highway along with major district road, other district road etc. During the field survey road condition was found to be in satisfactory condition.

The road facilities in the study area is given in the **Table 3.57** & **Figure 3.47** as per Census of India, 2011.

Table 3.57: Road facilities in Village of the Study Area

ROAD FACILITIES IN NUMBER OF NUMBER OF VILLAGES		
Approach Road	National Highway	09
	State Highway	24
	Major District Road	30
	Other District Road	36
	Black Topped (pucca) Road	51
	Gravel (Kuchha) Road	23
	Water Bounded Macadam	22
	All Weather Road	51
	Footpath	18
ROAD FACILITIES IN NUMBER OF URBAN AREAS		
Approach Road	Pucca Road	29

Source: Census of India, 2011

Village Road in the Study Area

Road in the Study Area, Bawana J.J. Colony

Figure 3.47: Road facilities

3.17.6.8 Banking Facilities

There has been increase in the banking facilities in the study area habitations with rapid growth in number of commercial bank, ATM facilities etc. since last Census of India, 2011.

The banking facilities in the study area is given in the **Table 3.58 & Figure 3.48** as per Census of India, 2011.

Table 3.58: Banking facilities in Village of the Study Area

BANKING FACILITIES IN NUMBER OF VILLAGES		
Banking Facilities	Commercial Bank	11
	Cooperative Bank	04
	Agricultural Credit Societies	05
BANKING FACILITIES IN NUMBER OF URBAN AREAS		
Banking Facilities	Nationalized Bank	49
	Private Commercial Bank	32
	Co-operative Bank	10
	Agricultural Credit Society	08
	Non-Agricultural Credit Society	19

Source: Census of India, 2011

Figure 3.48: Banking facility in Ghoga Village

3.17.7 Other Amenities in the study area

The other amenities facilities in the study area villages are given in the **Table 3.59** as per Census of India, 2011.

Table 3.59: Other amenities in the Study Area

OTHER AMENITIES IN VILLAGES		
Other Amenities	Public Distribution System (PDS) Shop	31
	Nutritional Centres-ICDS	20
	Post Office	15
	Sub Post Office	08
	Birth and Death Registration Office	02

Source: Census of India, 2011

The proposed project can be accessed through the Notified Bawana Industrial Area. The various housing societies in close vicinity to the proposed project are JJ Colony, Metro Vihar, and DDA Flats etc. People who are employed in the various Industries of Bawana Industrial Area are living in nearby places like Bawana, Sanoth etc. as tenants. As a result, these areas have become full of migratory laborer's which is creating extra burden on the resources available that is meant for the local residents. At the same time, it provides extra source of income to flat owners through the rent amount they get from the migratory laborers for the accommodation provided by them.

3.17.8 FINDINGS OF THE FIELD SURVEY

On the basis of the socio-economic survey and consultation with the stakeholders/focused group discussion the social concerns were identified which have been shown in the **Table 3.60** along with the mitigation measures to be taken up by the project proponent:-

Table 3.60: Socio-economic survey and consultation with the stakeholders

Social Component	Issues Raised	Mitigation Measure by the Project Proponent
Livelihood/Employment	Programs for increasing the employment opportunities for the youth of the study area is required.	• There would be opportunity for the employable youth in the proposed project. • Skill Development program/training for making the youth employable in the industries of the Bawana Industrial Area. • Seminars for 12th school students of the study area for getting oriented to technical employment opportunities.
Drinking Water	Some schools and residential area lack safe drinking water facilities especially in close proximity to the project site as reported during the consultation that the supply water is not filtered.	RO facility may be provided to the schools and community centers as per the requirement.
Medical Facility	Regular Health Check-up Camps are required for the villagers that are in close proximity from the project site.	Organizing regular health camps for the employees and the residents of the study area.

Source: Primary Survey and Stakeholders' Consultation, March 2024

3.17.9 Quality of Life*

"According to census 2011, about 70% of the population of the country belong to rural areas. Majority of India's rural population lives with an insufficient social infrastructure and poor access to basic amenities like education, medical drinking water and electricity etc. Amenities are key to understanding quality of life because access to these basic amenities are crucial to rural development as they contribute to physical and material comfort. The availability of services supplied in a rural area is able to influence local resident's quality of life (Layard 2005, Nussbaum and Sen 1993; Alkire, 2002, Prescott-Allen 2001, Ura et al 2004, Stiglitz, et al 2009). The individual quality of life does not depend on utilities of services available, but on functioning and capabilities (Sen, 1980; 1982; 1988). In general, the concept of quality of life has socio- economic dimensions and monetarist measurements embracing social and environmental features. Therefore, a large set of indicators must be premeditated and evaluated to take all of these features into account. However, as Boncinelli and Casini (2014) pointed out that the quality of life includes not only the identification of a set of indicators, but also their aggregation. The development of a region can be identified with an increase in the employment opportunities, availability of infrastructural facilities, amenities and services, proper distribution of resources, increase in production, and investment in consumption and so on (Sixl and Sixl, 1999). Thus, the development refers to an improvement of all the sectors of economic, social and cultural pursuits (Verma, 1993). Availability of modern household amenities and assets also has dominant significance in human life. It is also being realized that key dependencies exist between water supply and sanitation and improvement in the overall human development (Dreze and Murthi 2001; Gupta and Mitra 2002). It is unadventurously believed that housing conditions, availability of drinking water, sanitation facilities, etc. might contribute to the health improvement of the people and determine the quality of life of the society (Nayar, 1997). Other theoretical work by Roback (1985, 1988) and Blanchflower and Oswald (1996) show the relationship between amenities, quality of life, and rural economic growth."

*(*Acknowledgement: Quality of Life in Rural Areas of Moradabad district: A Block-wise Study; Dr. Fatma Mehar Sultana, Assistant Professor (Women's College, Aligarh Muslim University, Aligarh, India); Zaid Alam; Research Scholar (Department of Geography, Aligarh Muslim University, Aligarh, India.)*

3.17.10 Quality of Life of the Study Area

About 79.0 per cent of the total population of the study area is urban whereas 21.0 per cent is rural. The study area habitations are spread over the sub districts Narela and Saraswati Vihar of North-West district, NCT of Delhi and sub districts Sonipat and Kharkhoda of Sonipat district, Haryana. The population and amenities of Delhi is taken as percentage of the area falling in the study area. There are 82 identified habitations in the study area out of which there are 53 villages and 29 urban areas/Census Towns. There are two uninhabited villages in the study area.

In view of the above mentioned concepts, an analysis of the quality of life of the study area was done and was found that owning to the fact that the towns/villages have above average health, education, sanitation facilities and employment opportunities available in the study, the inhabitants have a good quality of life as per the primary field survey and Census of India, 2011. It is expected that the quality of life of the study area will further enhance after the upcoming project.

There is further scope of development and improvement in the basic amenities which are being taken up under the provision of Corporate Social Responsibility by private and government companies registered under the Companies Act, 2013. M/s Jindal Urban Waste Management (Bawana) Limited (JUWMBL) will be contributing to the infrastructural and social development of the area under the provision of the Corporate Environment Responsibility (CER).

CHAPTER 4. ANTICIPATED ENVIRONMENTAL IMPACTS & MITIGATION MEASURES

4.1 INTRODUCTION

This chapter discusses identification and assessment of various environmental impacts due to proposed Waste to Energy plant, Bawana. The same has been mentioned in the Impact matrix given at Section 4.3.7.

The environmental impacts can be categorized as either primary or secondary. The construction and operational phases of the project comprise various activities, each of which may have some impact on environmental components. Various impacts during the construction and operation phase on the environmental have been assessed qualitatively and quantitatively.

The objectives of impact identification and prediction are given below:

- Exceeding of threshold limit: Significance may increase if the threshold is exceeded. For e.g., Emissions of particulate matter & gaseous pollutants exceed the permissible threshold.
- Effectiveness of mitigation: Significance may increase as the effectiveness of mitigation measures decreases e.g., control technologies, which may not assure consistent compliance to the requirements.
- Relative contribution of effects of other actions: Significance may decrease as the significance of nearby larger actions increase.
- Relative rarity of species: Significance may increase as species becomes increasingly rare or threatened.
- Significance of Local Effects: Significance may increase as the significance of local effects is high.
- Magnitude of change relative to natural background variability: Significance may decrease if effects are within natural as simulative capacity or variability.
- Degree of existing disturbance: Significance may increase if the surrounding environment is pristine.

4.2 IMPACTS ASSESSMENT DURING CONSTRUCTION PHASE

4.2.1 Topography

Impact: The topography of the project site is broadly plain. During construction phase, the site will be leveled and excavation will be carried out for construction of the project. However, there will not be any change in the topography.

Mitigation Measure:

a) During construction, only essential required area will be excavated. The rest of the area will be kept undisturbed.

b) The land will be properly landscaped after compaction with grasses and greenery.

4.2.2 Landuse Pattern

Impact: The proposed site has been earmarked for solid waste management facility by DDA in **Zonal Development Plan of Zone "P1" Narela.** The land demarcated for the proposed project is for industrial purposes. Hence, there will be no impact on land use pattern.

4.2.3 Water Environment

Impact: The impact related to water quality during construction activities are as follows:

- Runoff from unpaved and excavated area as during the rain shower leading to change in surface water quality with respect to turbidity and suspended solids.
- Runoff from storage areas of lubricant may affect the surface as well as ground water, if seeps down the water table.
- Sewage and sanitary waste from labor camp.

Mitigation Measures

The impact during rainy season will be temporary in the nature. Therefore, the surface water quality during rains will be impacted marginally for very short duration. Surface water quality and ground water quality will be minimized by following measures:

- Excavation during dry season and proper management of excavated soils,
- Clearing all debris from site as soon as construction is over.
- By providing proper hutment and toilet facilities for construction labor, which will be

develop at site during construction/execution of plant.

- The runoff water from the construction site will be channelized in a pit and the supernatant water will be reused for dust suppression.
- Storage of lubricant etc. will be done in the demarcated area and the runoff from such areas will be collected separately to separate out oil and grease.

4.2.4 Air Environment

Emissions Source: The construction activities that contribute to the impact on the air environment are broadly given below and to minimize these impact, mitigation measures are mentioned in **Table 4.2.**

- Dust generation from earth work (during site clearance and preparation);
- Emissions from the operation of construction equipment and machines.
- Emissions of pollutant from vehicular exhaust.
- Emissions during the unloading of material at the site.
- Emissions which will takes place during mixing of cement with other building materials during construction phase.

Table 4.1 Details of Construction materials

Construction material	Quantity in MT	Source	Mode of transport	Distance from source in Km
Stone Dust	22700	Kotputli, Rajasthan	Road	190
Cement	11700	Kotputli, Rajasthan	Road	195
Aggregates	40500	Kotputli, Rajasthan	Road	184
Steel	4600	Ghaziabad	Road	80

Table 4.2: Release of pollutants to Air and Mitigation measures

Air Pollution Source	Probable Pollutants	Mitigation Measures
Boilers	PM, HCL, SO_2, CO, TOC, HF, NOx, Dioxin & Furan etc.	The state-of-the art Technology i.e. Boilers, FGCS (FGD & Bag Filters) & SNCR for NOx will be installed.

DG sets	Noise, PM, CO & NOx, HC.	Noise monitoring, Acoustic Enclosures will be ensured.
Excavation	PM_{10} & $PM_{2.5}$	Water sprinkling/water spray will be done.
Screening	PM_{10} & $PM_{2.5}$	<10 µm dust and silt will be collected separately & will be send to secured landfills site

- Regular water sprinkling will be done to mitigate fugitive emissions.
- It is proposed to provide adequate dust control system sand loose material handling in covered sheds.
- Plantation of trees around the periphery will be done.
- All the vehicles carrying raw materials will be covered with tarpaulin sheet and will have PUC certificates .The construction and earth moving machineries will be kept in good working condition and maintained regularly.
- The construction power will be drawn from the Delhi DISCOM.

4.2.4.1 Recommendation of the Commission for Air Quality Management in National Capital Region (CAQM)

The Commission for air quality management in National capital Region and adjoining areas was enacted on 12th August, 2021 for better coordination, research, identification and resolution of air quality in NCR. Copy of the Notification constituting CAQM for NCR is attached as **Annexure XII**.

All the recommendation given by the Commission from time to time will be followed religiously by the proposed project.

4.2.5 Noise Environment

The major activities which are likely to increase ambient noise levels during construction phase are:

- Activities related to Foundation work.

- Noise due to movement of vehicles carrying materials and loading & unloading activities.
- Noise from excavation machines, concrete mixer and other construction machines.
- Noise during concreting, hammering, etc.

Mitigation Measures:

- Noise generating equipment will be operated using noise control devices.
- All the vehicles entering in the project site will maintain speed limits and will not blow horns unless it is required.
- The workers involved in operating major noise generating construction equipment will be provided with personal protective equipment like earplugs/earmuffs etc.

4.2.6 Ecology

Impact:

Terrestrial ecology:

The common herbaceous plants of the project site would get disturbed due to site leveling and digging during construction. However, there would not be impact on trees present in the periphery of the project site. No tree cutting will be done during construction of the project.

The fauna of the nearby area may get affected due to noise generated from earth moving machineries and vehicular movements. Wastewater generation at construction site includes surface runoff which may contain pollutants and traces of solvents, paints, metal compounds etc. which may impact the groundwater, nearby surface water resources, soil and biodiversity, if not managed properly. There is no national park, wildlife sanctuaries or biosphere reserve within 10km radius of the project site.

Aquatic ecology:

Construction activities can significantly affect aquatic ecosystems by altering habitats, degrading water quality, and disrupting ecological processes. There is no fresh water source present within the project site but a nallah is passing through the project site. Western Yamuna Canal is located 32m in the South-West direction which flows adjacent to the project site. Yamuna River is located 13.6 km in the East direction.

Mitigation measures

- The excavated soil from the project site should be kept separately and should be used to plantation activity.

- Planting flowering and fruit bearing tree for avifauna and other faunal species.
- In order to avoid faunal disturbance, no construction activity would be allowed after sunset.
- No construction activity would be allowed during rainy days, so that no surface run off would take place.
- Greenbelt will be carried out in the periphery of plant premises. This will help in mitigating potential ecological disturbances and also enhance the aesthetic view of the plant. Greenbelt will be developed in an area of 24281.14 sq.m. with native species. Plantation/greenery programme will be carried out simultaneously with construction of the project.
- All the vehicles entering the project site will maintain speed limits and will not blow horns unless it is required.
- To minimize the impact of dust generated during the construction phase on the nearby vegetation, water sprinkling will be done to suppress the dust pollution.

4.2.7 Socio-Economic

Following are likely impacts of the project:

4.2.7.1 Impact on Aesthetic Beauty of the Area

The dumping of solid wastes in the open areas has created aesthetic problems as the beauty of the place has got destroyed. Besides, the above the waste at the Bhalswa landfill is a source of food for various rodents like rats, flies, mosquitoes and the like. Hence, it is a potential source of many disease. The toxic hazardous substances in the wastes are harmful to human and animal health. The plastics if eaten by cows could be fatal. The Solid wastes can pollute water and their burning can lead to air pollution. The proposed project would help in reducing these associated problems of landfill site.

4.2.7.2 Employment Opportunities for Job Seekers

The proposed project would generate direct and indirect employment. The employment opportunities will be for skilled, semi-skilled and unskilled workers both during construction and operation phase of the project. This will lead to generation of employment at local level. Creation of employment opportunities for job seekers in the region is a positive impact of the proposed project.

During the Construction Phase

Number of Employment Opportunities (Contract): 570

Number of On Roll Employment Opportunities: 60

Total Number of Employment Opportunities during the Construction Phase (On Roll + Contract): 630

4.2.7.3 Impact on Health

Waste-to-Energy (WtE) plants will significantly improve the health conditions compared to landfill sites because solid waste at landfills can contaminate water, while burning waste leads to air pollution. Additionally, the toxic hazardous substances present in waste pose risks to both human and animal health. Implementing WtE projects would mitigate these associated problems commonly found at landfill sites.

4.2.7.4 Impact on Demographic Scenario of the Project Area.

There will be no change in the demographic pattern of the study area including sex ratio as there will be no in-migration or out migration of people from the nearby areas of the project. Further, the setting up of Waste to Energy project will not lead to any increase in local population as people from the neighboring areas will be recruited for the job. Thus, there will be no change in the demographic pattern of the area. This is a positive impact of the proposed WtE project.

4.2.7.5 Increase in availability of power

The Waste to Energy plant at Bawana will result to capacity addition in the power sector. Due to increase in population and increasing economic activities the National Capital Region is facing short supply of power and the peak demand reaches a new height during summer. To meet its own demand, the Union Territory has depend on supplies from surplus states where the power supply is greater than its own consumption. The setting up of the Waste to Energy plant at Bawana will increase the availability of power to the Delhi DISCOMs for supply to the consumers. This is a positive and direct impact of the project.

4.2.7.6 Increase in Revenue to the DISCOMs as well as to the local body

With the availability of additional power for distribution to the needy consumers in the national capital, the DISCOMs will be able to increase their renewable portfolio under RPO. Similarly, the income of the local body will also increase by higher collection of electricity taxes. Currently, GST Act has kept electricity out of its ambit while keeping the capital goods and services consumed by the sector under its coverage. Power generating companies are therefore not able to claim input tax credit — that is, they cannot pass on the tax they paid for inputs to the consumers. This is a positive impact of the project.

4.2.8 Construction Camp

Although most of the laborers will be from local areas, certain number of temporary labor will be staying at construction site. Unhygienic situation may develop at the camp if proper sanitary facilities and waste disposal system are not adopted. All the necessary facilities will be provided by the appointed contractor at the construction camp including drinking water and maintaining sanitary conditions

4.2.9 Occupational Health & Safety

Adequate safety precautions will be provided like PPE, guarding of dangerous machine parts, maintenance of equipment as hoists and lifts etc., and adequate provision of different types of fire extinguishers will be made. All workers will be restricted to enter the sensitive area of the plant. All applicable rules and regulations pertaining to workplace health and welfare of workers will be adhered to.

4.2.10 Solid Waste Management

Impact: The construction waste includes debris, concrete, bricks (often recycled and reused at the site), steel and other metals, pallets, packaging and paper products, fluorescent tubes, wood etc. The waste may contaminate air, water, soil and impair aesthetics of surrounding if not handled properly.

Mitigation Measures

All wastes generated during the construction phase will be collected and segregated for disposal as per norms. The waste will be collected time to time during construction phase and disposed accordingly. C&D waste will be managed as per C&D Waste Management Rule, 2016. After due waste segregation, recyclable wastes will be sold off to scrap dealers and vendors, while inert wastes will be disposed of in landfills. Hazardous wastes will be disposed off as per the provisions of the Hazardous Wastes Management Rules, 2016.

4.2.11 Transport and Traffic

Impact: During construction phase, construction labor and construction materials carrying vehicles will approach the project site. Since most of the construction labors will be hired from local areas, there will not be significant impact due to labor movement on traffic.

Mitigation

Through careful planning, the movement of the heavy vehicles will be scheduled to reduce load on existing traffic such that the peak hours will be avoided. It shall also be ensured that all the vehicles to the site will be handled in such a way that there is no waiting time along the access roads.

4.3 IMPACT ASSESSMENT DURING OPERATION PHASE

4.3.1 Land Environment

Impact: During the operation phase of the project, the soil may get polluted/ contaminated from littering of various kinds of municipal wastes, leakage of leachates and due to fly ash or bottom ash.

Mitigation Measures

To avoid soil pollution, a well-planned solid waste management system will be established for the project. Only covered trucks will be allowed to enter the site for unloading of municipal solid waste materials in the project. MSW will be kept in an impermeable RCC pit which will be covered, enclosed and shaded. The leachates from underground MSW storage area will be collected through concrete drain and brought to leachate treatment plant through pipeline. Good housekeeping will further help to control the contamination of soil.

An ash management system will be adopted to minimize contamination from ash. Pneumatic fly ash handling system will be installed which convey the fly ash to the closed silo. The quenched bottom ash will be led to the bottom ash processing plant. The process involves segregation and screening for fine recovery. After the processing which are not recyclable will be sent to sanitary land fill. This reduces the amount of inert bottom to landfill and conserving natural resources.

4.3.2 Air Environment

4.3.2.1 Impact on air quality due to traffic

Fugitive emission will take place from vehicular movement and handling of fly ash. The dust emissions are likely to be confined to the place of generation only. The traffic will be managed in a way that it will not impact air quality.

Mitigation Measures for Fugitive Emission

- Vehicles having PUC will be allowed to enter the premises.

- The pneumatic ash handling unit will be covered in the proposed plant.
- Sprinkling of water, especially during summer season in ash handling area of the project.
- A proper ventilation system in the enclosed dusty areas & foul smelling areas will be adopted in the industry.

Stack Emission

The Municipal Solid Waste (MSW) to Energy generating plant will have emissions in form of SO_2, NO_x, Particulates, CO, Dioxin, Furan and other gaseous pollutants.
For assessing the impact of stack emission, air quality modeling has been carried out.
The details of air quality modeling are given below:

4.3.2.2 Air Quality Modeling

The main point sources of air pollution due to the operation of the proposed project will be stack attached with the boiler. Predictions have been carried out for SO_2, NO_x and PM emissions from the stack.

Meteorology:

AERMOD requires steady and horizontally homogeneous hourly surface and upper air meteorological observations from site specific surface meteorological tower and upper air sounding (rawindsonde data) respectively. The vertical mixing of air pollutants in the model strongly depends on the depth and stratification of planetary boundary layer which in-turn is governed by the sensible heat flux, large scale vertical motion, horizontal advection and entrainment at the boundary layer top. AERMOD requires these two input files of meteorology as a file of scalar values (SFC file) and a file of multi-level values (PFL file).
The meteorological preprocessor of AERMOD calculates these PBL parameters viz. friction velocity, Monin–Obukhov length, convective velocity scale, temperature scale, mixing height, surface heat flux by using surface characteristics in the form of surface roughness and Bowen ratio in combination with standard meteorological observations (wind speed, wind direction, temperature and cloud cover). These parameters are then passed through a meteorological preprocessor AERMET present in AERMOD to calculate vertical profiles of wind speed, lateral and vertical and lateral turbulent fluctuations, and potential temperature gradient.
Offline processing of prognostic regional weather forecasting model (WRF-ARW) data is carried out to provide the boundary condition meteorology. To obtain the meteorological data WRF-ARW non hydrostatic mesoscale model simulation, using global data set from NCEPFNL Operational Global Analysis data of 1° ×1° resolution have been used as model

initial and lateral boundary conditions at 6 hourly intervals at the edge of the model domain. The static geographical input data which includes MODIS, GWD, SSIB and VARSSO data have been used.

In this case Mesoscale Model Interface program (MMIF) is suitably used to process the prognostic meteorological data from WRF output and generate the required surface and upper air meteorological information for the study of dispersion of different pollutants with Aermod dispersion model.

MMIF was compiled on Linux platform and WRF-ARW results were processed to obtain the required meteorological files (derived by prognostic high-resolution simulations) which provides the necessary upper air profile information and the surface characteristics parameter required for AERMOD geophysical and meteorological input.

Stack and Emission Details:

Major pollutants emitted from the power plant will be in the form of SO2, NOx and PM from the boiler. The emission data used for the proposed units is based on the norms prescribed by MoEF&CC vide notification dated 7th December, 2015. The results of the isopleths for 1-hourly, 24-hourly, Monthly incremental concentrations are presented in **Table 4.5.** The stack and emission rate details are given in **Table 4.3 & Table 4.4.**

Table 4.3:-Stack Details of Proposed Project

Stack	Unit	Value
Capacity	MW	30
Stack Diameter (ID)	m	3.7
No. of Stack	--	1.0
Stack Height	m	60
Exit Gas Temp	^{0}C	140-150
Ambient Temp	K	298
Exit Gas Velocity (max)	m/s	20

Table 4.4: - Emission rate of proposed project

Proposed Stack	Flue gas Flow Rate	Emission Rate
	(Nm^3/sec)	(g/s)
SO_2	215.042	3.19

NO_x	215.012	12.78
PM	215.162	0.64

Predicted GLC due to the Project:

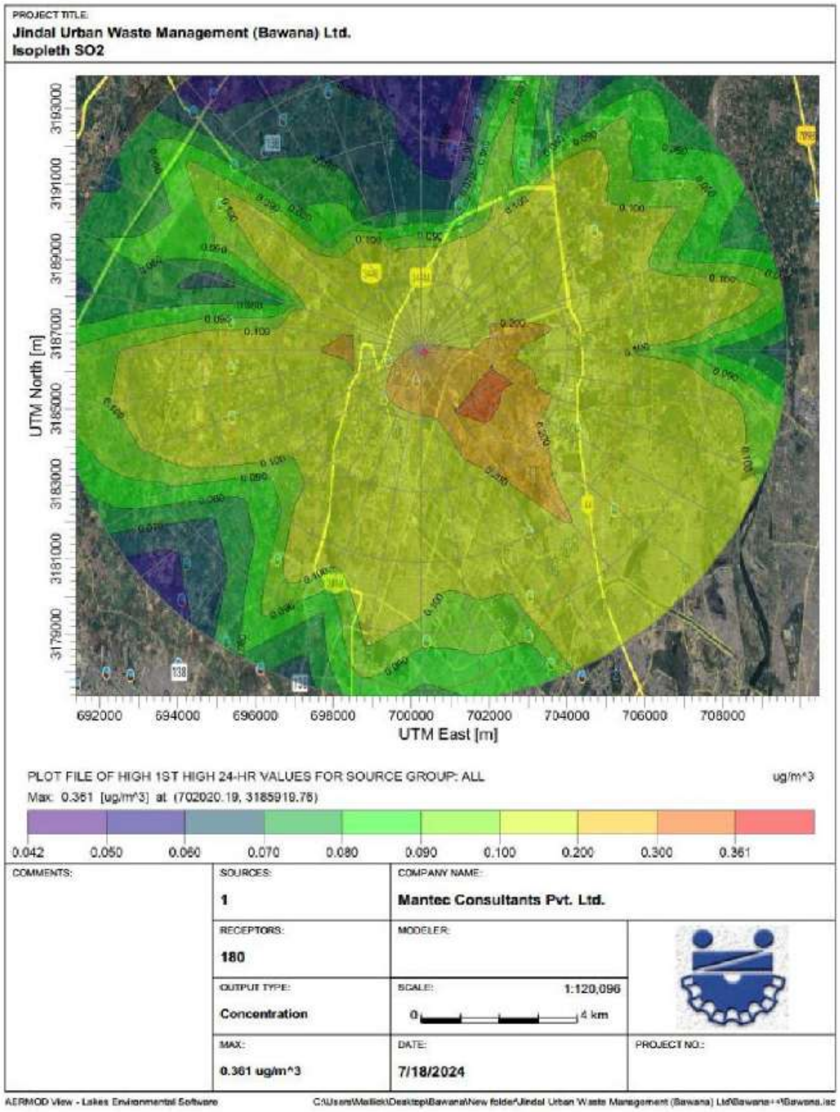
The contribution to ground-level concentrations (GLCs) for pollutants such as SO_2, NO_X, and PM was predicted over the study area for the proposed stacks under the worst-case emission scenario. The maximum GLC predictions, based on total emissions from the stacks, were obtained using the AERMOD model. To assess the overall air quality scenario near the project area, the incremental concentrations from AERMOD were added to the background concentrations which include emissions from all non-project-related sources. The resultant total concentrations were then compared to the National Ambient Air Quality Standards (NAAQS) to ensure necessary regulatory compliance. The isopleths (1-Hourly) of SO_2, NO_X and PM for the composite emission with worst case scenario operations has been presented in **Figure 4.1, Figure 4.2** and **Figure 4.3,** respectively. The predicted concentration for SO_2, NO_X and PM is given in **Table 4.5** and the predicted GLC's due to the proposed project has been presented in **Table 4.6.**

Table 4.5: Predicted Concentration of SO_2, NO_X and PM

Averaging Period	SO_2		NO_X		PM	
	Unit	Peak	Unit	Peak	Unit	Peak
1-Hour	µg/m³	2.58473	µg/m³	10.35514	µg/m³	0.51857
24-Hour	µg/m³	0.36093	µg/m³	1.44599	µg/m³	0.07241
Month	µg/m³	0.13483	µg/m³	0.54017	µg/m³	0.02705

Table No. 4.6:-Predicted GLC's

Cumulative impact (24 Hours)					
Sl. No.		**Parameters**	**Baseline (µg/m³)**	**Incremental (µg/m³)**	**Cumulative (µg/m³)**
1.	**Project site**	SO_2	18.0	0.36093	18.36
2.		NO_x	32.0	1.44599	33.45
3.		PM	380.0	0.07241	380.07



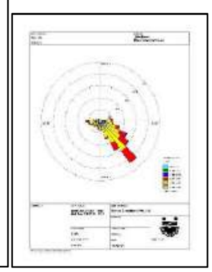
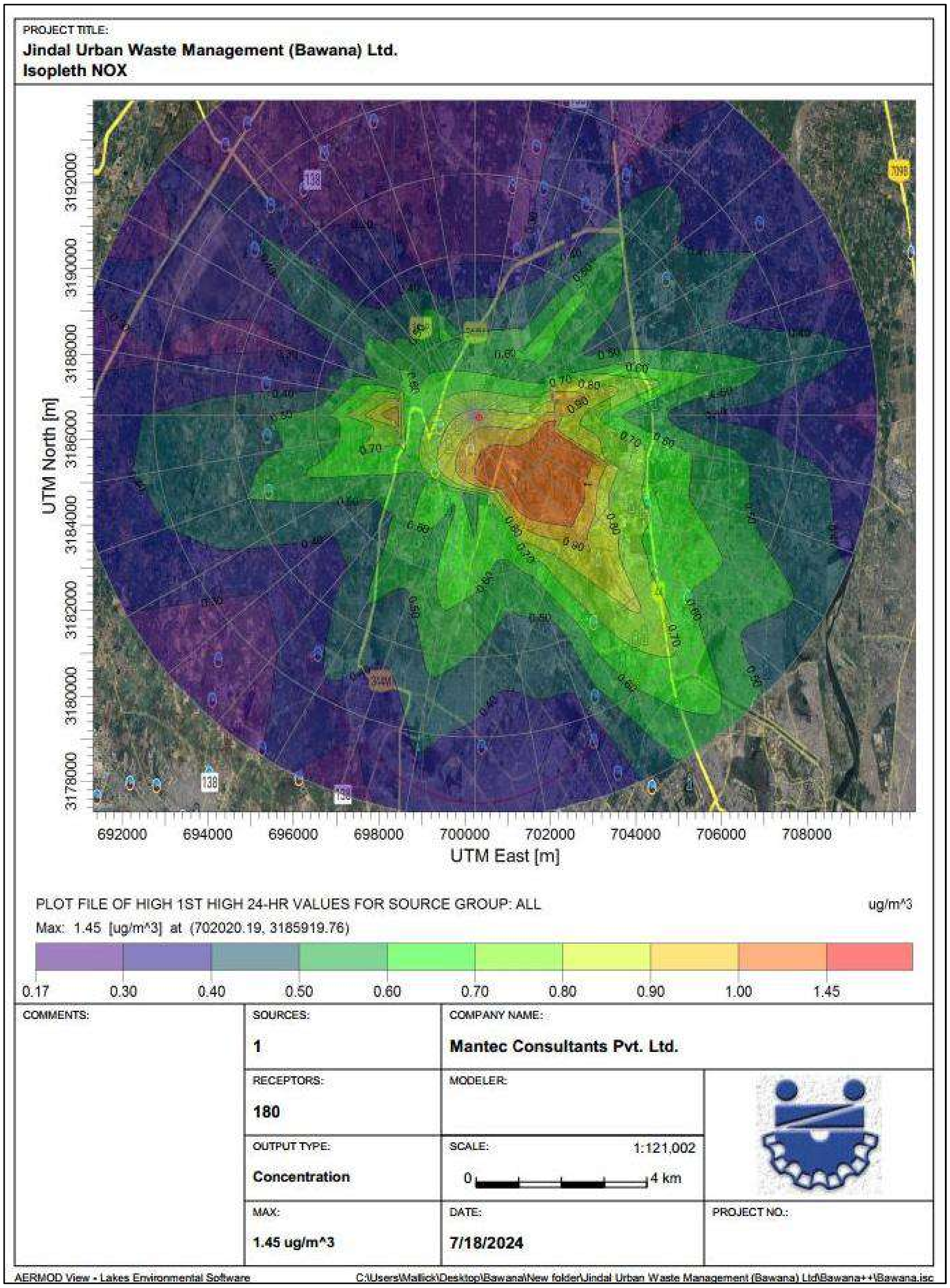


Figure 4.1: Isopleth of SO_2 Concentration due to Operation of Proposed Project



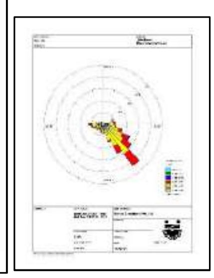
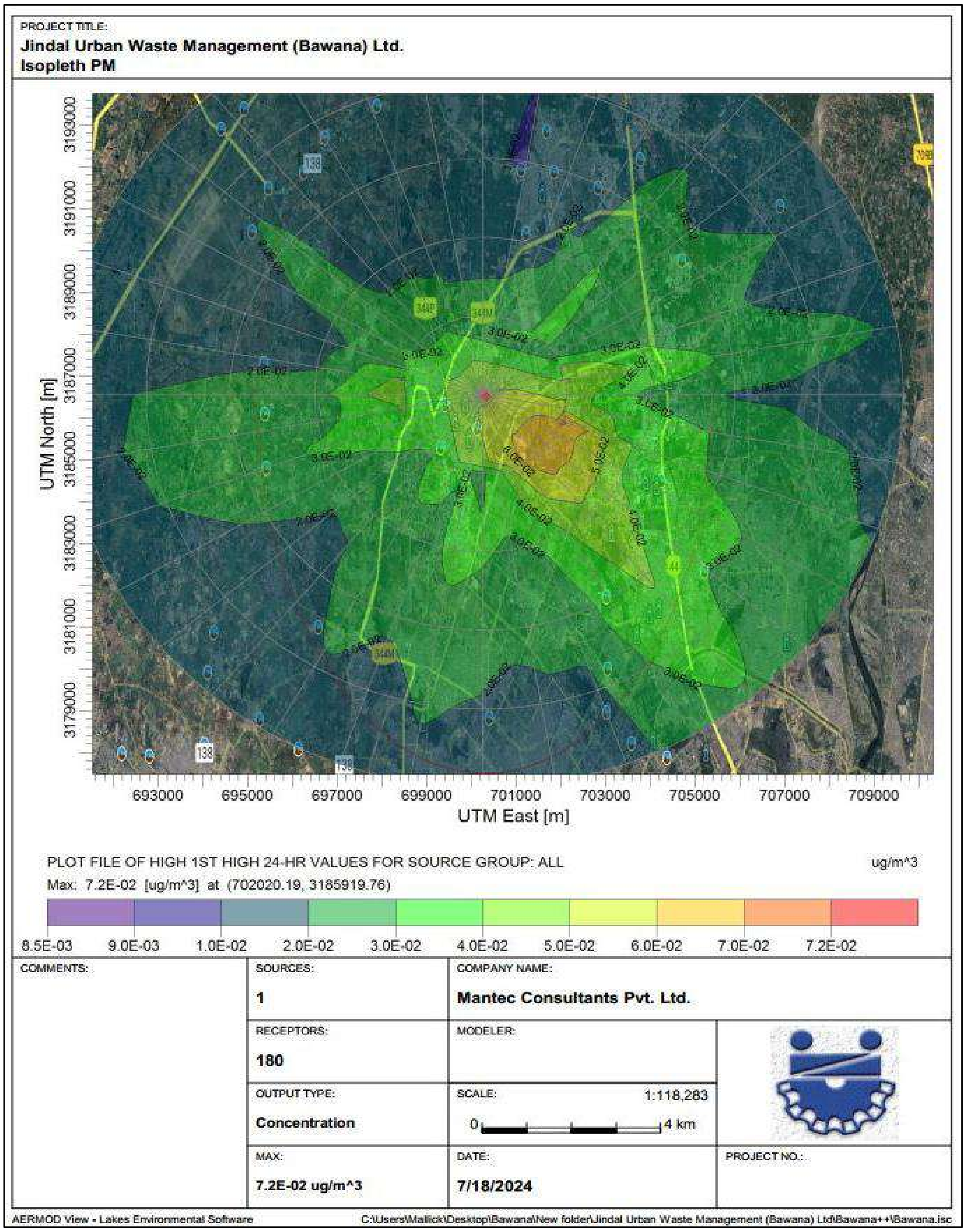


Figure 4.2: Isopleth of NOx Concentration due to Operation of Proposed Project



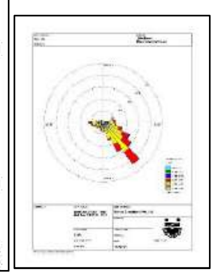


Figure 4.3: Isopleth of PM Concentration due to Operation of Proposed Project

Conclusion

The maximum predicted GLC's for parameters SO_2, NO_X & PM are observed to be 0.361µg/m³, 1.45µg/m³ and 0.072µg/m³. When the incremental GLC's are superimposed over the baseline concentrations, the resultant concentrations are well within the stipulated limits of NAAQS 2009 standards.

4.3.2.3 AIR POLLUTION SOURCE AND PROPOSED CONTROL SYSTEM:

The details of air pollution control systems for proposed project are described in chapter 2. These measures are well proven to keep the emissions within limits.

Following table describes the effect of various pollutants and their control system:

Table No. 4.7: Effect of Various Gases on Health and Proposed Control Measures

Emissions	Source	Effect on Health	Proposed Control System
Nitrogen oxides (NO_X)	• The nitrogen content of the fuel. • Reaction of nitrogen and oxygen in the high temperature zone of boiler.	• Acidification contributes to the formation of ambient ozone. • Poisons the blood if inhaled.	• SNCR in the boiler is advised to control the NOx formation.
Sulphur di-oxide (SO_2)	• The Sulphur content of the fuel. Sulphur present in the fuel is the main cause of the formation of SO_X mainly in the form of SO_2. • The combustion process: temperature, oxygen concentration and duration.	• Acidification • Health effects due to inhalation.	• The same is carried by the flue gas in the reactor tower where the treatment of hydrated lime causes the removal of the SO_X from the flue gas.

Emissions	Source	Effect on Health	Proposed Control System
Carbon dioxide (CO_2)	• The carbon content of the fuel. • CO_2 is the prime component of flue gas. Same is formed by the oxidation of the carbon in the fuel.	• Contributes to the greenhouse effect.	• Generally, WtE project is having the lower contribution to the CO_2 with respect to the MSW dumping (MSW at dumping site generated 1610 kg of CO_2 per ton of waste, whereas the incineration produces only 220 kg CO_2 for the same mass of waste.)
Carbon Monoxide (CO)	• In the combustion process, CO forms when the air supply is less than the stoichiometric requirement.	• Harmful to the cardiovascular system.	• Supply of air will be maintained above stoichiometric air requirement to prevent incomplete combustion of carbon.
Volatile Organic Compound (VOC)	• The combustion process: created when the oxygen supply is scarce.	• Carcinogenic contributes to the formation of secondary Air pollutants. • Methane is a VOC that contributes to the greenhouse effect.	• Supply of air will be maintained above stoichiometric air requirement to prevent incomplete combustion of carbon. • Methane formation occurs due to waste dumped at the landfill site that has the potential of the 1,610 of CO_2 equivalent. When the same is treated & used in WtE plant, it will get reduced to 220 of CO_2 equivalent.

Emissions	Source	Effect on Health	Proposed Control System
Particulate Matter	• The ash content of the waste. • The combustion processes.	• Harmful if inhaled.	• Use of bag filter for Capture of particulate matter.
Heavy Metals (Cd, Pb, Hg etc.)	• Fuel: The heavy metal content of the MSW/ RDF	• Most heavy metals are toxic to human.	• Activated carbon doses in the FGCS to capture the heavy metals & control the emissions well in the limit as per the SWM Rules, 2016.
Hydrogen chloride (HCl)	• Generally formed by combustion of the chloride present in the kitchen waste after reaction with Hydrogen.	• Acidification.	• It is controlled by the injection of lime in the FGCS, which removes all the acidic gases.
Dioxins & Furans	• The PVC content in the waste, i.e. the Chlorinated material in the fuel. • It is formed by the oxidation of the PVC in the furnace.	• Can cause cancer while accumulating in Fatty tissues in human.	• For the complete destruction of dioxins and furans: a. Proper segregation of waste in pre-processing section. b. Reduction in moisture is ensured in storage pit and drying zone of boiler. c. Maintained temperature more than 950 ^{0}C with gas resistance time not less than 2 seconds. d. Injection of activated carbon in pollution control device.

4.3.2.4 STUDY ON WtE PLANT VS LANDFILL DISPOSAL OF MSW W.R.T AIR POLLUTION:

A study has been carried out to assess the air emissions from WtE (Waste to Energy) project and landfill disposal of MSW, and to compare how WtE project is environmentally more beneficial. Adoption of WtE technology for management of MSW is better than MSW landfill technology w.r.t various air emissions.

Air emission reductions can be achieved from improved solid waste management, right from waste collection and transportation to waste disposal. WtE plants avoid methane emissions and primarily emit CO_2 from biomass, resulting in a lower global warming impact compared to landfills. WtE plants require less land and contribute to energy generation, whereas landfills have long-term land use and environmental impacts. Landfills produce significant level of VOCs, PM and odors, while WtE plants have advanced technologies to control emissions like NOx, SO_2 and particulates.

Air emissions from a landfill site and a Waste to Energy (WtE) plant: -

Pollutant	Landfill	Waste to Energy (WtE) Plant
Methane (CH_4)	High emissions	No emissions
Carbon Dioxide (CO_2)	Moderate emissions	Moderate emissions
Particulate Matter (PM)	Moderate emissions	Low emissions (controlled)
VOCs	High emissions	Low emissions

Some of the benefits of WtE project implementation have been described below in brief:

- **Reduce in Land Demand**

The MSW increases with increase in population which in turn leads to demand for more space for MSW disposal. Construction of a WtE facility will significantly reduce the amount of waste sent into landfill. Existing MSW land fill site occupies nearly 0.13 Sq Km area. The MSW heap is more than 40m high.

- **MSW Pollutants:** MSW landfill site near the proposed WtE project site emits lot of pollutants (PM, Ammonia, VOC, NOx, SOx etc.) and bad odour is also released near the ground level. Ambient air sampling was carried out during March, April and May, 2023 and the results are attached as Annexure III.

WtE plant will considerably reduce these pollutants because of the below mentioned reasons:

- Most of the organic combustible material will burn and produce CO_2 only.
- The flue gases will be released through 60 m high stack at high velocities. This will reduce GLC considerably.

- **Useful utilization of MSW:**

MSW received at plant site is segregated and its useful part is separated for recycling or processing for making it useful as given below:

- Inert material for disposal to landfills (~10 % only).
- Recyclable material including metallic parts will be sent to recyclers vendor
- Fine compostable organic material will be used for conversion into stable compost for sale and balance material (~ 46%) will be processed for use in boilers as RDF (Refuse Derived Fuel) for energy generation.

- **Green House Gases Emission:**

GHG emissions released (directly or indirectly) or avoided by waste management projects are calculated applying the Incremental approach i.e. the project GHG emissions are compared to the GHG emission of a hypothetical baseline scenario without the project. As calculated GHG emission is considerably reduced (~more than 50% after 8 years onwards WtE project operation).

The above mentioned benefits derived from WtE project shows its urgent requirement for the "Society".

- **GHG emission reduction calculation**

The reduction of GHG emission due to the WtE facility is given in **Table 4.8.**

Table 4.8: Reduction of GHG emission due to the WtE facility

Year	Total emission w/o project (tCO_2e/y)	Waste received at WtE site (t/y)	Emissions from WtE (tCO_2e/y)	Reduction of GHG emission (tCO_2e/y)	Reduction (%)
Y1	403,855	1,095,000	443,209	-39,354	-9.74%
Y2	573,663	1,095,000	443,209	130,454	22.74%
Y3	687,488	1,095,000	443,209	244,279	35.53%
Y4	763,788	1,095,000	443,209	320,579	41.97%
Y5	814,933	1,095,000	443,209	371,724	45.61%
Y6	849,217	1,095,000	443,209	406,007	47.81%
Y7	872,198	1,095,000	443,209	428,988	49.18%
Y8	887,602	1,095,000	443,209	444,393	50.07%
Y9	897,928	1,095,000	443,209	454,719	50.64%
Y10	904,850	1,095,000	443,209	461,641	51.02%
Y11	909,490	1,095,000	443,209	466,281	51.27%
Y12	912,600	1,095,000	443,209	469,391	51.43%
Y13	914,685	1,095,000	443,209	471,476	51.55%
Y14	916,082	1,095,000	443,209	472,873	51.62%
Y15	917,019	1,095,000	443,209	473,810	51.67%
Y16	917,647	1,095,000	443,209	474,438	51.70%
Y17	918,068	1,095,000	443,209	474,859	51.72%
Y18	918,350	1,095,000	443,209	475,141	51.74%
Y19	918,539	1,095,000	443,209	475,330	51.75%
Y20	918,666	1,095,000	443,209	475,457	51.76%
Y21	918,751	1,095,000	443,209	475,542	51.76%
Y22	918,808	1,095,000	443,209	475,599	51.76%
Y23	918,846	1,095,000	443,209	475,637	51.76%
Y24	918,871	1,095,000	443,209	475,662	51.77%
Y25	918,889	1,095,000	443,209	475,680	51.77%

4.3.3 Water environment

4.3.3.1 Surface water

Impact: During the operation phase, source of water supply will be blow down water from PPCL/treated STP water from DJB supply line is proposed for the project. No fresh water will be drawn from any other source. The main water pollution sources in the WtE plant will be collection area of leachate, blow down water from boiler & cooling tower, DM plant effluent, floor washings & sewage water.

Mitigation

A complete water system has been designed based on the Zero Liquid Discharge concept. The treated wastewater will be recycled and reused within the plant. Leachate from the plant will be treated in the leachate treatment plant (LTP). Blow down water from boiler, cooling tower and DM plant waste will be brought to the neutralization pit and after neutralization, it will be utilized for various purposes. The treated water from Leachate treatment plant will be recycled to DM Plant and reject water for quenching of bottom ash. Thus, no effluent is proposed to be discharged outside the premises. Sewage water will also be routed to the leachate treatment plant for further treatment. Detailed water pollution control system is given in **Chapter-2.** For the project, air-cooled cooling tower system will be constructed.

4.3.3.2 Groundwater

Impact: The ground water will not be utilized for plant use or for any purpose. Ground water impact during operation phase arises typically due to percolation of wastewater from drains and pits & process chemicals.

Mitigation measures

All the drains, effluent collecting system and neutralization pit will be properly concretized to make it impervious for reducing chances of contamination of ground water.

4.3.3.3 Noise Environment

Impact: During the operation phase of the proposed project, the main noise generating sources would be turbo-generator, boilers feed pumps, air compressor, cooling tower & other rotating equipment. These equipment will be housed in cluster/single building of different dimensions made of different materials or installed in open or under sheds in project.

Mitigation Measures

The noise levels of all the equipment will be less than 85 dB (A) limit at a distance of 1 m, except at turbine and boiler feed pump area. Persons handling noisy equipment or working in noisy places will be provided with earplugs and earmuffs.

All rotating items shall be well lubricated and provided with enclosures as far as possible to reduce noise transmission. Vibration isolators will be provided to reduce vibration and noise wherever possible.

In general, noise generating items such as fans, blowers, compressors, pumps, motors etc. will be so specified as to limit their speeds to generate minimum noise levels. Static and dynamic balancing of equipment will be insisted upon and will be verified during inspection and installation.

The insulation provided for prevention of loss of heat and personnel safety shall also act as noise attenuator.

The foundations structures of all the equipment will be designed keeping in view the requirement of noise abatement.

Central control room(s) provided for operation and supervision of plant and equipment will be air-conditioned, insulated and free from plant noise. Necessary enclosures will also be provided on the working platforms/areas to provide local protection in high noise level areas of the project.

In addition, greenbelts will be developed around the site to further attenuate noise level.

4.3.3.4 Ecological Impact & Mitigation measures

The project site has herb, shrubs, and some tree plantation. The Western Yamuna canal is flowing the adjacent of the site. In the 10 Km buffer of study area, pond, agricultural land, reserve forest, residential and industrial areas are present.

Impact

The vehicular movement would cause noise pollution and dust pollution which may affect the flora and fauna of the project and nearby area. As described above, effective noise and air pollution control measures including water spray system for suppression of fugitive dust will be adopted, Hence the impact on would be negligible.

Mitigation measures

- The project is based on ZLD concept and there will be no effluent discharge from the plant. Since, there is no major aquatic system in the area, the chances of impact on aquatic ecology would be insignificant.
- A Greenbelt Development Plan has been proposed in 40% of the total project area, equivalent to 6 acres (2.43 hectares) of land. Plantation will be done in consultation with the local Forest Department. Detailed greenbelt development plan has been prepared which has been described in **Chapter 10.**
- The excavated soil from the project site should be kept separately and can be used to boost restoration and green plantation activity.
- Planting fruit bearing tree for avifauna and other faunal species.
- Western Yamuna Canal is flowing Adjacent to the project site. Utmost precaution should be taken to ensure no leakage or discharge of effluent takes place,
- All vehicles inside the project site should maintain speed limit and will not blow horn unless it is required.
- Awareness will be given to workers about the importance and conservation of terrestrial ecology and biodiversity.
- Extensive plantation should be undertaken in an around the project site.

4.3.3.5 SOCIO-ECONOMIC IMPACT OF THE PROJECT

Following likely impacts of the project are envisaged:

4.3.3.5.1 Impact on Demographic Scenario of the Project Area.

There will be no change in the demographic pattern of the study area including sex ratio as there will be no in-migration or out migration of people from the nearby areas of the project. Further, the setting up of Waste to Energy project will not lead to any increase in local population as people from the neighboring areas will only be recruited for the job. Thus, there will be no change in the demographic pattern of the area. This is a positive impact of the proposed WtE project.

There will be no significant increase in overall population of the study area as preferably local people will be recruited for employment. Hence, there will be no significant impact on the population composition in the study area. Since, there will be no significant change in population, the overall sex ratio will remain more or less the same.

4.3.3.5.2 Employment Opportunities for Job Seekers

The proposed project would generate direct and indirect employment. The employment opportunities will be for skilled, semi-skilled and unskilled workers both during construction and operation phase of the project. This will lead to generation of employment at local level. Creation of employment opportunities for job seekers in the region is a positive impact of the proposed project. The benefits of employment to the job seekers are expected to include, at a household and individual level, with improvement in socio-economic and health status, improvement in their living condition, and the benefits from greater household expenditure on education & healthcare resources. The employment opportunities to be generated at the construction and operation phase has been shown below:

During the Operational Phase

- Number of Employment Opportunities (Contract): 156
- Number of Employment Opportunities (On Roll): 86
- Total Number of Employment Opportunities during the Operational Phase (On Roll + Contract): 242

4.3.3.5.3 Impact on Law & Order

No major law & order problem is envisaged due to the proposed project. It is expected that the workers will attend to their duties from their residences and return to their homes after the day's work.

4.3.3.5.4 Impact on Aesthetic Beauty of the Area

The dumping of solid wastes in the open areas has created aesthetic problems as the beauty of the place has got destroyed. Besides, the above the waste at the Bhalswa landfill is a source of food for various rodents like rats, flies, mosquitoes and the like. Hence, it is a potential source of many diseases. The toxic hazardous substances in the waste are harmful to human and animal health. The plastics if eaten by cows could be fatal. The Solid waste can pollute water and their burning can lead to air pollution. The proposed project would help in reducing these associated problems of landfill site.

4.3.3.5.5 Impact on Health

The proposed Waste-to-Energy (WtE) project would significantly improve the health and hygienic conditions of the area compared to landfill site. Implementing WtE project would mitigate the associated environmental problems commonly found at landfill sites.

4.3.3.6 Increase in Availability of Power

The Waste to Energy plant at Bawana will result to capacity addition in the power sector. Due to increase in population and increasing economic activities the National Capital Region is facing short supply of power and the peak demand reaches a new height during summer. To meet its own demand, the Union Territory have been depend on supplies from surplus states where the power supply is greater than its own consumption. The setting up of the Waste to Energy plant at Bawana will increase the availability of power to the Delhi DISCOMs for supply to the consumers. This is a positive and direct impact of the project.

4.3.3.7 Increase in Revenue to the DISCOMs as well as to the local body

With the availability of additional power for distribution to the needy consumers in the national capital, the DISCOMs will be able to increase their renewable portfolio under RPO. Similarly, the income of the local body will also increase by higher collection of electricity taxes. Currently, GST Act has kept electricity out of its ambit while keeping the capital goods and services consumed by the sector under its coverage. Power generating companies are therefore not able to claim input tax credit — that is, they cannot pass on the tax they paid for inputs to the consumers. This is a positive impact of the project.

4.3.4 Solid Waste

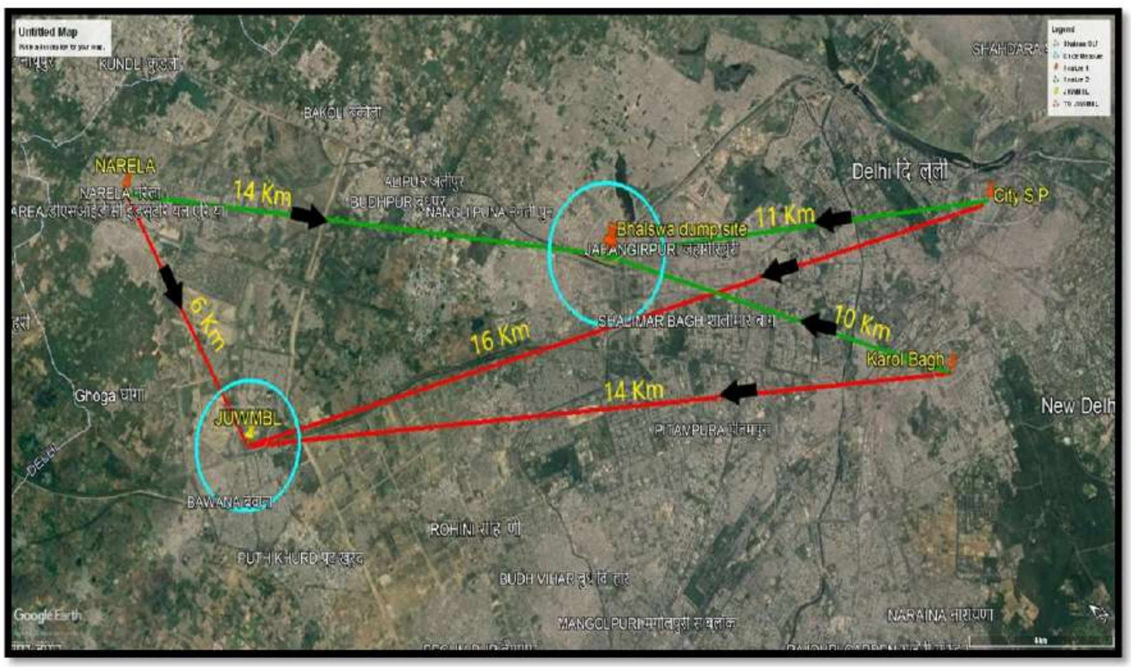
Impact- Fly and bottom ash are the major solid waste generated from "WtE" project. Fly & bottom ash generated will be properly handled to avoid environmental consequences.

Mitigation

The quenched bottom ash will be led to the bottom ash processing plant which is similar to C&D plant. The process involves segregation and screening for fine recovery. This reduces the amount of inert bottom to landfill and conserving natural resources. After the processing which are not recyclable will be sent to sanitary land fill of the project. Fly ash will be sent to the SLF. Hazardous waste will be handled as per Hazardous Waste Management Rules, 2016. Sludge from the leachate treatment plant will be dried and used as manure within the project premises.

4.3.5 Transport Linkage and Traffic

Impact: Currently, approximately 2400 TPD waste is collected from S.P, Karol Bagh, and Narela Zones of the City, and it is disposed of at the Bhalswa landfill site. The distances from City SP to Bhalswa landfill, Karol Bagh, and Narela are approximately 11 km, 10 km, and 14 km, respectively. The average transportation distance is around 12 km from these three zones to the Bhalswa landfill. The details are given in the below map.



Upon the establishment of the Waste-to-Energy (WtE) facility, the waste from the mentioned zones will be redirected to the facility. The distances from City SP, Karol Bagh, and Narela to the WtE facility are approximately 16 km, 14 km, and 6 km, respectively. The average transportation distance will still be around 12 km from these three zones to the WtE facility.

Mitigation Measures

Through careful planning, the movement of the heavy vehicles will be scheduled to reduce load on existing traffic such that the peak hours will be avoided. It shall also be ensured that all the vehicles to the site will be handled in such a way that there is no waiting time along the access roads.

4.3.6 CUMULATIVE ENVIRONMENTAL IMPACT ASSESSMENT STUDY OF THE EXISTING AND PROPOSED PROJECT

This section discusses the Cumulative Impact Assessment (CIA) of industries in the Bawana Industrial Area, one of North-West Delhi's largest industrial hubs. Developed by the Delhi State Industrial and Infrastructure Development Corporation (DSIIDC), this area hosts various manufacturing and service industries contributing to the local economy. The assessment evaluates the combined environmental, social and economic implications of existing projects within 15km radius and the proposed WtE project, focusing on air and water quality, noise levels, waste management practices and socio-economic benefits. Primary data from key projects and secondary sources like Environmental Impact Assessment (EIA) reports form the basis of this comprehensive analysis, aiming to facilitate informed decision-making for sustainable development and mitigate potential adverse effects on the environment and local communities.

Key projects assessed include the existing 24 MW Waste-to-Energy (WtE) plant by Delhi Municipal Solid Waste Solutions Limited (DMSWSL), the Treatment Storage Disposal Facility (TSDF) operated by Tamil Nadu Waste Management Limited and the Pragati Power Corporation Limited (PPCL) gas power station. The proposed 30 MW WtE project by Jindal Urban Waste Management aims to convert 3000 tons per day (TPD) of municipal solid waste into energy. Each project’s impacts and mitigation measures have been detailed, addressing air pollution, water pollution, noise and waste management practices. Mitigation strategies include advanced pollution control technologies, regular maintenance and comprehensive waste treatment processes, ensuring compliance with environmental standards and minimizing the cumulative impact on the environment and local communities.

The detailed Cumulative Impact Assessment study of the existing industries within 15 km radius have been annexed as **Annexure-XIII.**

4.3.7 IMPACT MATRIX

Various activities from the project are likely to have an impact on the environmental constituents during its construction as well as operational phase. An impact assessment matrix has been made based on EIA manual of MoEF&CC for Thermal Power Plant. The matrix is given in **Table 4.9.**

Table 4.9: Impact Assessment Matrix

			Construction/Establishment							Operation and Maintenance						
Environment	Component	Project Activities / Parameter factor	Civil works such as Earth moving and building of structures including temporary structures	Heavy Equipment operations	Disposal of construction wastes	Generation of sewerage	Influx of construction workers	Deforestation	Transportation of MSW	Movement of Energy Reserve	Crushing of coal, storage and handling/ stock piling	Operation of power source and generator facilities	Abstraction of water	Operation of cooling system	Storage of chemicals /Flammables	Waste management (fly ash, sludge from water treatment plants, boiler ETP etc.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Physical	Soil	Erosion Risks	√	x	x	x	x	√	x	x	x	x	x	x	x	x
		Soil Quality/Contamination	x	x	√	√	x	x	x	√	√	x	x	x	√	√
	Resources	Fuels/Electricity	√	√	x	x	√	x	√	√	√	√	√	√	x	x
		Construction material-stone, aggregates	√	x	x	x	√	x	x	x	x	x	x	x	x	x

		Land especially **undeveloped or agricultural land**	√	x	√	x	√	x	x	x	x	x	x	x	x	x
	Water	**Interpretation or Alteration of River Beds**	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Alteration of Hydraulic Regime	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Alteration of surface run-off and interflow	√	x	x	x	x	√	x	x	x	x	x	x	x	x
		Alteration of aquifers water quality	x	x	√	x	x	√	x	x	x	x	x	x	x	x
		Temperature	x	x	x	x	x	√	x	x	x	√	x	√	x	x
	Air	**Air Quality**	√	√	x	√	x	x	√	√	√	√	x	x	x	√
		Noise	√	√	x	x	x	x	√	√	√	√	x	x	x	x
		Climate	x	x	x	x			√	x	x	x	x	x	x	x

Biological	Terrestrial Flora	Effect on grass & flowers	√	x	√	x	x	√	x	x	x	x	x	x	x	x
		Effect on trees & shrubs	√	x	x	x	√	√	x	x	x	x	x	x	x	x
		Effect on farmland	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Endangered species	x	x	x	x	x	√	x	x	x	x	x	x	x	x
	Aquatic Biota	Habitat removal	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Contamination of habitats	x	x	x	√	x	x	x	x	x	x	x	x	x	x
		Reduction of aquatic biota	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Terrestrial Fauna	Fragmentation of terrestrial habitats	√	x	x	x	x	x	x	x	x	x	x	x	x	x
		Disturbance of habitats by noise or vibration	√	√	x	x	x	x	√	√	√	√	x	x	x	x
		Reduction of Biodiversity	√	x	x	x	x	√	x	x	x	x	x	x	x	x

Social	Economy	Creation of new economic activities	√	x	x	x	x	x	√	√	x	x	x	x	x	x
		Commercial value of properties	√	x	x	x	√	x	x	x	x	x	x	x	x	x
		Conflict due to negotiation and/ compensation payments	x	x	x	x	√	x	x	x	x	x	x	x	x	x
		Generation of temporary and permanent jobs	√	√	x	x	x	x	√	√	x	x	x	x	x	x
		Effect on crops	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Reduction of farmland productivity	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Income for the state and private sector	√	√	x	x	√	x	x	x	x	√	x	x	x	x

		Electricity tarrifs	x	x	x	x	x	x	x	x	x	√	x	x	x	x
		Savings for consumers & private consumers	x	x	x	x	√	x	x	x	x	x	x	x	x	x
		Savings in foreign currency for the state	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Education	Training in new technologies	x	x	x	x	√	x	x	x	x	√	x	x	x	x
		Training in new skills to workers	x	x	x	x	√	x	x	x	x	√	x	x	x	x
	Public Order	Political Conflicts	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		Unrest, Demonstrations & social conflicts	√	x	√	x	√	√	x	x	x	x	x	x	x	x
	Infrastructure	Conflicts with projects of urban, commercial	√	x	√	x	√	[illegible]	x	x	x	x	x	x	√	x

	development														
Security and Safety	**Increase in Crime**	x	x	x	x	√	x	x	x	x	x	x	x	x	x
	Accidents caused by	√	√	x	x	√	√	√	√	x	x	x	x	x	x
Health	**Temporary**	x	x	√	√	x	x	x	√	√	x	x	x	x	x
	Acute	x	x	x	x	x	x	x	x	x	x	x	x	x	√
	Chronic	x	x	x	x	x	x	x	x	√	x	x	x	√	x
Cultural	**Land Use**	√	x	√	x	x	x	x	x	x	x	x	x	x	x
	Recreation	x	x	√	√	x	√	x	x	x	x	x	x	x	x
	Aesthetics and human interest	√	x	√	√	x	√	x	x	√	x	x	x	x	x
	Cultural Status	x	x	x	x	√	x	x	x	x	x	x	x	x	x

Note: Implementation of proposed project would improve cleanliness of the city and enhance aesthetics.

CHAPTER 5. ANALYSIS OF ALTERNATIVES

This chapter describes the analysis of alternatives with respect to site, fuel and technology to assess their environmental compatibility. Accordingly, environment compatible site, fuel and technology have been considered for analysis of alternatives for the proposed project.

5.1 ALTERNATIVE FOR SITE SELECTION HIRING

Three alternative sites were analyzed by considering techno-economic and environmental aspects. The details of the present site with respect to the site selection criteria are given in **Table 5.1.** All three sites are shown in Delhi Map as **Figure: 5.1.**

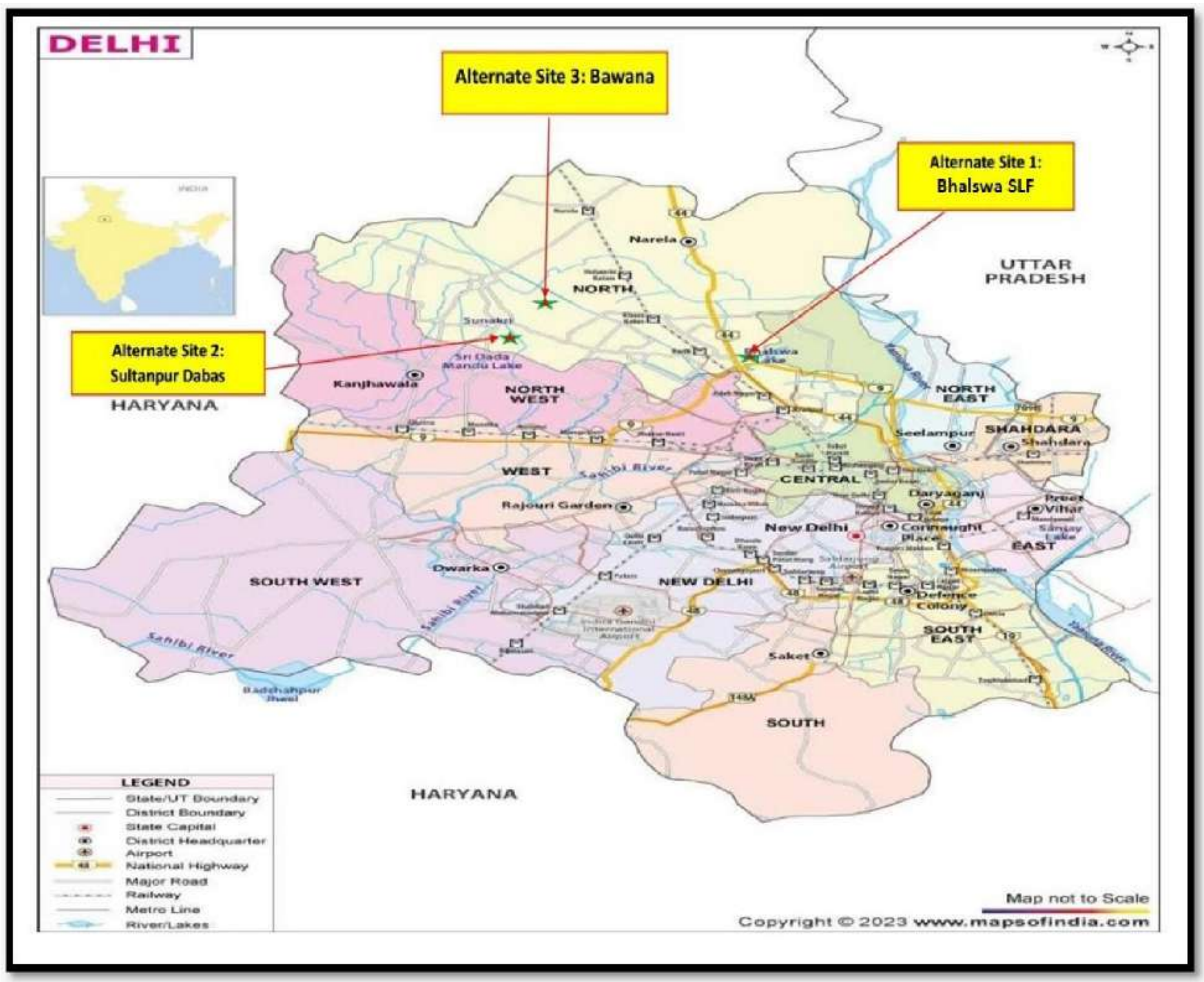


Figure 5.1: Alternate Sites Map

Table 5.1: Site Selection Criteria

S. No.	Parameters	Alternate Site-1 (Bawana)	Alternate Site-2 (Sultanpur Dabas)	Alternate Site-3 (Bhalswa SLF)
1.	Availability of land	Land parcel of approximately 35 acres (effective area 18-20 acres) is available under possession of MCD. The proposed site is in DSIIDC industrial area. Proposed project site has been earmarked for Solid Waste Management facility by DDA in **Zonal Development Plan of Zone "P1" Narela**.	Approximately 49 acres land area is available at Sultanpur Dabas.	The third option available with MCD is Bhalswa landfill site which is approx. 50 m high. This site is located in a high-risk prone area due to exceeding height of landfill. Soil properties are not suitable for establishing an industry & recovery of land is also not feasible. **Hence, the site is not suitable for developing the WtE project.**
2.	Distance from reliable water source.	Water source will be available from PPCL which is at the distance of approx. 1 km from the project site. Also, Narela STP is approx. 6 km away.	Narela STP is located approx. 13km (aerial distance) away. Hence, there will be technical difficulties in laying of water pipeline.	Approx. 5 km from Coronation Pillar STP.

S. No.	Parameters	Alternate Site-1 (Bawana)	Alternate Site-2 (Sultanpur Dabas)	Alternate Site-3 (Bhalswa SLF)
3.	Distance from Fuel source.	MSW of 3 zones namely Karol Bagh, City SP and Narela Zones are to be handled, distance of which are approx. 8-13 km (aerial distance).	Fuel sources are approx. 12-22 km (aerial distance) away.	Fuel sources are approx. 10-15 km (aerial distance) away.
4.	Distance from Sub-station for power evacuation	Power evacuation will be done through 220/66 kV Bawana Substation which is located at distance of an approx. 1-1.5 km.	TPDDL Sub-station for power evacuation is located approx. 4 -5 km away.	Sub-station for power evacuation is located approx. 3 -4 km away.
5.	**Environmental Considerations**			
i.	Land resource.	Keeping in view of suitability of soil, nearness of required resources and the land being located in DSIIDC industrial area, MCD has selected this site for constructing WtE plant.	Approximately 49 acres land is available which is earmarked for an ESLF by MCD for disposing the inert and other processing rejects.	Land suitable for construction not available.
ii.	Impact on traffic of Delhi.	Less impact on traffic.	Less impact on traffic	Due to long distance from the project site, transportation of MSW will have more impact on the traffic of Delhi.

S. No.	Parameters	Alternate Site-1 (Bawana)	Alternate Site-2 (Sultanpur Dabas)	Alternate Site-3 (Bhalswa SLF)
iii.	Type of land and R&R issue	Govt. land earmarked for Solid Waste Management facility by DDA in **Zonal Development Plan of Zone "P1" Narela** and no R&R issue involved.	Govt. land no R&R issue involved.	Govt. landfill site and no R&R issue involved.
iv.	Tree felling	No Tree felling	Tree felling involved	No tree felling
v.	Distance from Ecological Sensitive Area	1. Bhalswa Lake: 12 km, E 2. Yamuna River: Approx. 13 Km, E 3. Yamuna Biodiversity Park: Approx. 15 Km, E	1. Bhalswa Lake: Approx. 13 km, E 2. Yamuna River: Approx. 18 Km, E 3. Yamuna Biodiversity Park: Approx. 17 Km, E	4. Bhalswa Lake: Approx. 1 km, E 5. Yamuna River: Approx. 7 Km, E *6.* Yamuna Biodiversity Park: Approx. 5 Km, E
6.	Project cost	660 Cr.	690 Cr.	Not viable
7.	Conclusion	**Suitable for WtE**	**Suitable for ESLF.**	Not suitable

Bawana site is environmentally and techno-economically suitable for establishing the proposed Waste to Energy Project due to following reasons:

1. **Land Availability:** Authorized land is available with the MCD for setting up the WtE Project. The land is earmarked for Solid Waste Management facility by **DDA in Zonal Development Plan of Zone "P1" Narela**.

2. **Nearness to water source:** Water Source i.e., the reject Blow Down Water (BDW) of the Pragati Power Corporation Limited (PPCL) is available at a distance of approx. 1.0 Km to meet the operational water requirement of the project.
3. **Nearness to fuel source:** This site is situated in the center of North-West, Delhi, resulting in minimum travel distance for supply the fuel. Further, the project site has good road connectivity via NH-44 and SH-18.

All the requirements such as land, water and fuel (MSW) availability make the proposed site more suitable for setting up the green field WtE project.

5.2 ALTERNATIVE TO FUEL

Normally, a thermal power plant utilizes coal/natural gas as fuel for power generation. However, this project relates to the "WtE" in which municipal solid waste shall be utilized as fuel. The quality of available MSW has a direct bearing on energy output of the plant.

5.2.1 Waste Characteristic

The quality of the Municipal waste, i.e. calorific value is a vital consideration for power generation projects. Both actual and reported Gross Calorific Value (GCV) can vary widely due to various reasons such as:

- Seasonal variation due to climatic conditions.
- Zonal variation due to lifestyle impact-more GCV due to presence of more combustibles in wastes from affluent colonies.
- Mixing of sweepings, silts & C&D wastes.
- Sampling and analysis error.
- Absence of standardized methodology for preparation of waste samples for analysis (as received, air dried, oven dried).

Seasonal variations are possible wherein moisture in waste is higher than average in rainy season. Excess moisture will get removed during processing as leachate. This will not affect the GCV of feed to boilers.

Component wise weight and percentage of each component is shown in **Table 5.2.**

Table 5.2: Composition of MSW

S. No.	Component	Weight of Component (Kg)	Percentage of Component (%)
1	Kitchen Waste	37.47	1.51
2	Vegetable Chhilka/ Maize Chhilka	814.86	32.86
3	Fruits/Lemon Chhilka	265.42	10.70
4	Dry Sugar Canes	16.39	0.66
5	Coconut Shell/hair	39.60	1.59
6	Straw/Hey	0.00	0.00
7	Flowers	0.00	0.000
8	Green leaves/Green Matter	85.10	3.43
9	Dry leaves/Dry Matter	95.54	3.85
10	Wooden Pieces	86.31	3.48
11	Broom	1.65	0.07
12	Cardboard (wooden)	25.16	1.01
13	Paper/Cardboard	98.30	3.96
14	Textile/Cotton/Jute	165.62	6.68
15	Rubber/Leather/Tyre	11.92	0.48
16	**Plastic Waste**	**TOTAL = 342.98**	**13.83**
	Category-I	20.83	0.84
	Category-II	258.66	10.43
	Category-III	62.49	2.52
	Category-IV	0	0
	Non-Packaging/Other Plastic	1	0.04
17	Metals	12.43	0.50
18	Glass	11.90	0.48
19	Inert and other	167.52	6.75
20	Sand/soil/earth	45.10	1.82
21	Stones/brick/concrete	155.57	6.27
22	Ceramic and other	0.63	0.03
23	Human Hair	0.53	0.02
24	Batteries	0	0
25	Hazardous waste (if any)	0	0
TOTAL		**2480**	**100**

Note: *Any change in fuel and combustion technology will be communicated to MOEF&CC. MSW characterization is done by M/s Photron Laboratories Pvt. Ltd.*

5.3 ALTERNATIVE TECHNOLOGIES FOR "WtE" PROJECTS

The chapter 3.3 of MSW Management Manual of CPHEEO states: -

Waste to energy (WtE) refers to the process of generating energy in the form of heat or electricity from MSW. Energy from MSW can be achieved through:

1. Thermal process like incineration or combustion of refuse derived fuel (RDF).
2. Biological processes like bio methanation and further conversion into electrical power or automotive fuel (compressed biogas).

In addition to the above, Gasification and plasma technologies for recovery of energy from waste are also available. However, these are not fully mature and are also capital intensive.

A Comparative study of different "WtE" technologies for power generation is summarized below:

Table No.-5.3: Comparison of "WtE" Technologies

Technology	Suitability against criteria			Deployment Status	Track Record
	Mandatory	Strongly advisable	Desirable		
Mass Incineration	Yes, if GCV is > 1,000 kcal/Kg &Chlorinated plastics removed	Yes, with removal of chlorinated plastics	Yes, but not at the historical cost	Widely in China and to some extent in USA	Technically successful but financial viability is heavily policy dependent
RDF incineration	Yes	Yes	Yes but not at the historical cost	Widely in Europe and now in China too	India: high investment cost, Okhla WtE plant is operating on RDF combustion model technology.
Other advance thermal	Yes	No (Commercially	No	Pilot and few commercial projects in USA,	Not proven yet.

Technology	Suitability against criteria			Deployment Status	Track Record
	Mandatory	Strongly advisable	Desirable		
technologies		not developed yet)		Canada, UK, Germany, Spain, Japan and India	
Biotechnologies	Yes	No (Commercially not developed yet)	No	In many countries including India but technology yet to be proven (Sholapur project under stabilization)	Successful in Technology demonstration but very little information on commercial success

The RDF incineration technology has been selected because it can process MSW scientifically with economic and environmental benefits for the citizens of Delhi. It is already a proven technology.

5.4 ALTERNATIVE TECHNOLOGY FOR FLUE GAS CLEANING SYSTEM

The flue gas treatment facilities are required to meet the emission norms of SWM Rules, 2016. The different technologies for control of various pollutants of the flue gas are described in the following **Table 5.4.**

Table No. 5.4: Comparative study of the equipment/technologies for removing different pollutants

	Equipment's / Technologies									
Parameters	**Cyclone Separator**	**Venturi Scrubber**	**ESP**	**Fabric Filter**	**Dry System**	**Semi dry system**	**Wet System**	**SNCR**	**SCR**	**Activated Carbon**
Particulate matter (dust)	√	√	√	√						
HCl					√	√	√			
SO_2					√	√	√			
SO_3					√	√	√			
HF					√	√	√			
NOx								√	√	√
Total dioxins & furans				√						√
Cd +Th + their compounds	√	√	√	√			√			√
Hg and its compounds										√
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V+ their Compounds	√	√	√	√			√			√

For the proposed project, the technology selected for control of different pollutants are given below:

Table No. 5.5: Selection of Flue Gas Control Technologies

Flue gas constituent	Selected Technology	Description
NOx removal	SNCR	SCR is strictly to adhere low NOx, however, the SNCR can meet the required level of the NOx as per MoEF&CC.
Gaseous contaminants removal	Dry reactor/Semi-Dry Reactor	Dry & Semi-dry are abiding the SWM Rules, 2016
Removal of mercury, Dioxin and Furan	Activated carbon	Activated Carbon is used for removal of mercury, dioxins and Furan
Particle removal & dioxin	Bag filter	Bag filters are effective for removing particulate emissions.

5.5 ALTERNATIVE CONDENSER COOLING SYSTEM

High pressure steam is expanded in the turbine and condensed in the condenser at the lowest possible pressure for extracting maximum possible work from the thermal energy contained in the steam. Generally, water-cooled condensers are most favorable for condensing steam. Hot water is cooled by the cooling tower & heat is rejected to atmosphere by evaporation of water. Thus, over a time span the concentration of the salt level in the cooling tower sump increases. This requires periodic blow down to maintain the concentration of total dissolved solids (TDS) within limit. Higher concentration of the TDS in circulating water will lead to the scaling on the surface of condenser thus decreasing the performance. TDS in the circulating water is normally not allowed to exceed the range of 2,500-3,000 ppm in the circuiting water. The amount of blow down is governed by the concentration of the dissolved salts in the make-up water. It is proposed to use the sewage water for the power generation. It has been found that treatment cost of the sewage water for use in the cooling tower becomes non-techno economical viable. The comparative evaluation of Air-Cooled Condenser (ACC) and Water-Cooled Condenser (WCC) is shown in **Table 5.6 & 5.7.**

Table No. 5.6 Comparison of ACC & WCC

Particulars	ACC	WCC
Cooling media	Air	Water
Vacuum at STG exhaust (atm)	>0.18	>0.10
System efficiency	Lower	Higher
Application	Scarcity of water	Abundant water
	High treatment cost of water (Sewage water)	Water quality good
Investment	High	Low
Operating cost	Low	High
Auxiliary power	Low	High

In the other project, it has been studied that the life cycle costing for similar type of water properties yields more attractive for air cooled condenser than water cooled condenser. It is therefore proposed to adopt ACC for the project. As per the MoEF&CC notification dated 7th December, 2015 "new plants to be installed after 1st January, 2017 shall have to meet specific water consumption up to maximum of 2.5 m^3/MWh and achieve zero water discharge" which would be met through adoption of ACC.

Table 5.7: Types of Fin for ACC

CRITERIA	KL TYPE	EXTRUDED TYPE	G-TYPE
Corrosion	Tube Protected against corrosion	Tube protected against corrosion	Provides perfect fit between fin & tube
Vibration	Resistant against vibration	Fins have extra rigidity	Comparatively Lower
Thermal Performance	High thermal performance and stress resistance with atmospheric corrosion protection	Heat transfer remains constant	Varies. have comparatively less performance than other
Temperature Operation	KL can be replaced by any other type of fins (Can be used up to 320°C)	Can be used up to 300°C	Can be used up to 400°C

It can be seen from the table that the KL type of fins is more corrosion resistant, having high thermal performance and resistant against vibration. Considering all the above points, the KL option has been recommended for proposed project.

5.6 ALTERNATIVE LEACHATE TREATMENT TECHNOLOGY

For treatment of leachate, two major technologies namely Conventional Treatment with RO and Multi Effect Evaporator (MEE) are available for industrial application. The comparative evaluations are given in **Table: 5.8.**

Table: 5.8 Comparison between Conventional Treatment with RO and Thermal Treatment Technology

Particulars	Conventional Treatment with RO Technology	Thermal Treatment Technology (MEE/ MVR)
Application	Suitable for primary treatment of wastewater, focusing on the removal of solids, organic matter, and some dissolved substance.	Advanced evaporation technologies suitable for concentrating solutions or treating specific wastewater streams.
Steam requirement	Not required	High
Power Consumption	Low	High
Operation mode	Manual/Automation	Automation
Investment	High	Low
Operating cost	Low	High
Employment	Skilled and semi-skilled	Highly skilled
Footprint area	More area required	Comparatively less
Maintenance	Low	High
Operational Margin	High	Low

It can be seen from the above comparisons and also considering the fluctuation in leachate quality parameters, Conventional Treatment with RO Technology has been recommended for the proposed project in view of its operational margin, low operational & maintenance cost, low power consumption and easy to handle.

CHAPTER 6. ENVIRONMENTAL MONITORING PROGRAM

6.1 INTRODUCTION

The monitoring program aims to verify that the mitigation measures outlined in the monitoring plan, according to CPCB guidelines and their updates, effectively deliver the intended benefits to the target area. To ensure the effective implementation of the monitoring program and gauge the efficiency of the mitigation measures, monitoring shall be undertaken both during the construction and operation phase of the project.

6.2 PERFORMANCE INDICATORS (PIs)

The physical and biological components of the environment which are of particular significance, are listed below:

- Air quality
- Water quality
- Noise levels
- Solid Waste Management
- Plantation / survival rate

The proposed Environmental Monitoring Plan is given in **Tables 6.1 & 6.2.** For construction and operation phase, respectively**.**

Table 6.1: Environmental Monitoring Plan (Construction Phase)

S. No.	Aspect	Parameters	Frequency	Location	Estimated Cost (Rs) for one year
1	Ground Water Monitoring	As per drinking water standard	Quarterly	At three locations, nearby hot spots.	1,80,000
2	Noise	Equivalent noise pressure level	Quarterly	At three locations, nearby Plant boundary	24,000
3	Ambient Air quality	As per NAAQS parameter PM_{10}, $PM_{2.5}$, SO_2 and NO_2	Monthly	At one location, onsite Plant boundary	48,000
4	Soil	pH, Bulk Density, Soil texture, Nitrogen, Available Phosphorus, Potassium, Calcium, Magnesium, Sodium, Electrical Conductivity, Organic Matter, Chloride	Quarterly	3 locations in the project impact area	96,000
Total					**3,48,000**

Table 6.2: Environmental Monitoring Plan (Operation Phase)

Aspect	Parameter	Frequency	Location	Agency /Equipment Used	Estimated Cost (Rs.) for one year
Ambient Air Quality	PM_{10}, $PM_{2.5}$, SO_2, NO_2, Hg	Quarterly	At one location, onsite Plant boundary	Through NABL approved lab.	48,000
	PM_{10}, $PM_{2.5}$, SO_2, NO_2.	Continuous online monitoring	At one location, at site	Continuous automatic ambient air quality Monitoring station	Installation and maintenance cost already included in the EMP Budget
Stack Emission	PM, SO_2, NO_x, CO	Continuous online monitoring	Flue stack	Continuous online stack monitors.	Installation and maintenance cost already included in the EMP Budget
	PM, SO_2, NOx, CO, Heavy Metal, Dioxin & Furans etc.	Monthly	Flue stack	Through NABL approved lab.	9,00,000
Ground water quality	Physical, chemical and biological parameters including heavy metals	Quarterly	At three locations, nearby hot spots.	Through NABL approved lab.	1,80,000
Plant effluents	Physical and chemical properties including heavy metals.	Quarterly	Before recycling.	Through NABL approved lab.	16,000
Noise level	Noise	Quarterly	Single location near plant boundary	Through NABL approved lab.	8,000

Health survey of employees	Health status	Annual	All employees of MSW handling area, power generation plant.	Through government approved hospital/ doctors.	2,00,000
Total					**13,52,000**

6.3 DATA MANAGEMENT

The monitoring shall be carried out through MoEF&CC/ NABL approved laboratory. All results shall be maintained at the project site in soft form. Proper analysis of monitored data will be done for its correctness and will be compared with regulatory standards.

6.4 ENVIRONMENTAL REPORTING

The environment management cell will be established for overseeing the environmental aspects of the operation unit. The results of the analysis shall be intimated to the project head. Any deviation from regulatory standard results shall be investigated and proper corrective actions shall be undertaken.

A complaint register shall also be maintained to note any complaints from the staff and visitors in the project or any other stakeholder of the project. Corrective actions taken against the complaints shall also be noted.

CHAPTER-7 ADDITIONAL STUDIES

7.1 PUBLIC HEARING

Public hearing shall be carried out as per the provisions of EIA Notification, 2006 and its amendments. Issues raised during the public hearing and their compliance along with action plan shall be incorporated in the final EIA report.

7.2 RISK ASSESMENT

Hazard analysis involves the identification and quantification of the various hazards (unsafe conditions) that exist in the power plant. On the other hand, risk analysis deals with the assessment and computation of risks to the equipment in the plant and personnel due to accidents resulting from the hazards present in the plant. Risk analysis follows an extensive hazard analysis. It involves the identification and assessment of risks the neighboring populations are exposed to as a result of hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of population etc. Much of this information is difficult to get or generate. Consequently, the risk analysis is often confined to maximum credible accident studies.

In the sections below, the identification of various hazards, probable risks in the WtE plant, maximum credible accident analysis, consequence analysis are addressed which gives a broad identification of risks involved in the plant. The Disaster Management Plan (DMP) and emergency response system.

7.3 APPROACH THE STUDY

Risk involves the occurrence or potential occurrence of some accidents consisting of an event or sequence of events. The risk assessment study covers the following:

- Identification of potential hazard areas;
- Identification of representative failure cases;
- Visualization of the resulting scenarios in terms of fire (thermal radiation) and explosion;
- Assess the overall damage potential of the identified hazardous events and the impact zones from the accidental scenarios;

- Assess the overall suitability of the site from hazard minimization and disaster mitigation point of view;
- Furnish specific recommendations on the minimization of the worst accident possibilities; and
- Advisory suggestions on the current Disaster Management Plan (DMP), On-site and Off-site Emergency Plan, which includes Occupational and Health Safety Plan.

7.4 RISK ASSESSMENT

The Objectives for carrying out the Risk Assessment Study are:

- Identify hazards associated with operation and handling of hazardous chemical in the facility.
- Estimate the risks associated with the project facility by combining consequences of `undesired events like fire, explosion, toxic chemical and frequency of occurrence of such events.
- Benchmark the risk against PNGRB (Petroleum and Natural Gas Regulatory Board) risk acceptance criteria and demonstrate that the risk is within ALARP (As Low As reasonably Practicable) or broadly acceptable region or whichever the case may be.
- Conclude and Suggest Risk Mitigation Measures/Recommendations
- Disaster Management Plan

The Risk Assessment study involves following aspects:

- **Hazard Identification:** Study of all critical areas with a view to identify potential hazards which could trigger loss causing events such as release of hazardous material, fire, vapor cloud explosions, toxic exposure etc. resulting in damages outside and/ or inside the facility.
- **Scenario Selection:** Identification of Maximum Credible Loss Accident Scenarios leading to undesired events such as fire, VCE, toxicity exposure etc.
- **Consequence Modeling:** Consequence modeling of the identified failure scenarios using PHAST software. This involves calculating the impact distances for fires, explosions, etc. and contour mapping of the impact zone on the plant layout.
- **Frequency Estimation:** Estimation of frequency of occurrence of the identified Maximum Credible Loss Case Scenarios using various databases.
- **Risk Assessment:** Assessment of Risk based on consequence analysis and frequency of

occurrence of MCA (Maximum Credible Accident) and comparing the risk with against risk acceptance Criteria.

- **Conclusion & Recommendation:** Based on the study, conclusions are drawn and recommendations are made with a view to minimize risks associated with the facility.
- Disaster Management Plan and Emergency response system.

7.4.1 HAZARD IDENIFICATION

Effective management of a Risk Assessment study requires enumeration and selection of incidents or scenarios. Enumeration attempts to ensure that no significant incidents are overlooked; selection tries to reduce the incident outcome cases studied to a manageable number.

These incidents can be classified in two categories:

- Loss of containment of material -
- Sudden release of energy and failure to contain it

There are several ways by which loss of containment can occur in either category. For example, fire of waste materials can be of any size, from a small fire to large major fire. There can be electrical shock at the power plant and can be fatal for limited number of workman. The boiler explosion scenario cannot also be ruled out.

The size and intensity of damage can be ascertained in terms of fire due to the storage of fuel, MSW (municipal solid waste) and electrical shock due to operation and maintenance of the power plant at the said industrial facility. The data & information are required related to following aspects:-

- Various Inventory at the site.
- MSW (municipal solid waste)
- Composition / calorific value of waste materials present.
- Climatic conditions (temperature, atmospheric pressure, wind speed and direction etc).
- Storage of Fuel (LDO).
- Handling of Toxic material
- Boiler Hazard

The goal of risk assessment is to limit the total number of incident outcome cases, to be studied to a manageable size, without introducing bias or losing resolution through overlooking significant incidents or incident outcomes. The purpose of incident selection is to construct an appropriate set of incidents for the study from the Initial list that has been generated by the enumeration process. An appropriate set of incidents is the minimum number of incidents needed to satisfy the requirements of the study and adequately represent the spectrum of incidents enumerated.

From the generation of waste to its transportation and unloading at "WtE Bawana" project site, workers engaged in solid waste are exposed to substantial levels of physical, chemical, and biological toxins.

7.4.2 PROCESS DESCRIPTION OF POWER GENERATION:

The description of process involved in the generation of electricity from municipal waste is given below:

- MSW receiving
- Pre-Segregation and preparation of RDF
- Combustion of RDF in boiler
- Heat Recovery & Steam Generation
- Power Generation:
- Flue Gas Cleaning System
- Leachate Treatment

(For detailed process description refer chapter 2)

7.4.3 DIFFERENT HAZARDS AND ITS CONTROLS MEASURES

The various hazards and control measures are briefly described in the **Table 7.1:-**

Table 7.1: Different Hazards and Its Controls Measures

S. No.	Types of Hazards	Consequences	Mitigation measures
Hazards during handling of MSW and transportation to the site			
1.	Vehicle Accident	1. The vehicle carrying the MSW has the potential to	1. All the vehicles used for MSW waste collection shall be regularly

	Hazard	meet with an accident during the transit due to various reasons: • Road Condition • Bad weather • Drunk – driver • Vehicle condition 2. A defective vehicle condition can lead to accidental fire of MSW.	maintained & driven by trained drivers, led by supervisors. Special precautions should be taken while the vehicle moves to elevation to avoid accidents. 2. The GPS system installation will support the facility to track the movement of the vehicle and drivers. 3. 3. The vehicle should be equipped with fire extinguisher, also the vehicle engine to be fitted with flame arrestor.
2	Health Hazards of employees / workman engaged at the MSW site for segregation of materials/exposure to toxic.	1. The employees/ workman may get exposed to various types of hazardous material which may cause illness and adverse health effects.	1. All the employees shall be trained and provided with adequate PPE to protect from health hazards. 2. Separate care will be taken for the workmen employed at hazardous location. 3. 3. It is suggested that proper ventilation to be provided wherever working place is a closed system.
3	Biological Hazards	1. MSW are potential source of vector/bacterial diseases.	1. All the employees shall be trained and provided with adequate PPE to protect from health hazards. 2. 2. Also, periodical medical check-up shall be conducted to assess

			health status and also early detection of any ailment.
Hazards During Storage of MSW at Site			
1	Hazards (fire, dust explosion and toxic gas formation) due to MSW storage	1 Potential hazards associated with the feed materials themselves include fire, dust explosion and toxic gas formation. For example, where feed materials such as biomass wood are stored in large piles, there is potential for self-heating. Potential toxic gas hazards such as carbon monoxide formation in relation to self-heating, particularly in confined spaces may occur.	1 Safeguards include maintaining dry storage conditions and minimization of inventory levels to give relatively short storage times. 2 Proper emergency management plan will be prepared and periodical mock drill shall be conducted to check the effectiveness of preparedness and controls. 3 Adequate firefighting system/PPEs/detection of hot spot/ monitoring of carbon monoxide levels.
2	Hazards during the Storage of MSW	1.Contaminated water run-off during the monsoon or flooding	1.Provision of concrete drainage system around the storage facility
3	Health Hazard	1 Health hazard to the workman handling the waste.	1. Maximum waste will be handled by the machines. 2. All the workman employed will be monitored medically and clinically. 3. Adequate hygiene measures will be provided for the workman employed at the site. 4. Use of Proper PPEs and SOPs
HAZARDS OF POWER PLANT			

1	Electrical Hazards during power generation	1.Electrical shock	1. Safe design and construction practices will be followed during the entire phase of construction. 2 All the workman shall be trained and provided with appropriate PPE 3 LOTO will be practiced. 4. Certified Electrical components will be used as per Hazardous Area Classification.
2.	Boiler Explosion	Boiler explosion occur due to following: a) Failure of pressure part of the steam and boiler tube b) Failure of safety valve c) Corrosion of critical parts of boiler d) Fuel/ Air Explosion in the boiler called "Fire box explosion"	1 Regular inspection and purging of boiler 2. Regular checkup of safety valve. 3. The replacement of corroded/damaged boiler tube.
3.	Fire in oil handling area	Fire hazard has been considered for oil handling area. This may occur due to leakage of pipe or rupture of oil storage tank.	1. Provision of firefighting equipment and water sprinklers. 2. Regular checkup and maintenance of pipelines.

7.4.4 WEATHER CONDITIONS

The impact of hazard incidents are dependent among other things on the prevailing meteorological conditions. This section describes the influence of these conditions.

Table 7.2: Weather Conditions

S. No.	Wind Speed(m/s)	Pasquill Stability
1.	2	F
2.	3	D
3.	5	D

7.4.5 Pasquill stability

One of the most important characteristics of atmosphere is its stability. Stability of atmosphere is its tendency to resist vertical motion or to suppress existing turbulence. This tendency directly influences the ability of atmosphere to disperse pollutants released from the facilities. In most dispersion scenarios, the relevant atmospheric layer is that nearest to the ground, varying in thickness from a few meters to a few thousand meters. Turbulence induced by buoyancy forces in the atmosphere is closely related to the vertical temperature gradient.

Temperature normally decreases with increasing height in the atmosphere. The rate at which the temperature of air decreases with height is called Environmental Lapse Rate (ELR). It varies from time to time and place to place. The atmosphere is considered to be stable, neutral or unstable according to ELR is less than, equal to or greater than Dry Adiabatic Lapse Rate (DALR), which is a constant value of 0.98°C/100 meters.

Pasquill stability parameter, based on Pasquill – Gifford categorization, is a meteorological parameter, which describes the stability of atmosphere, i.e., the degree of convective turbulence. Pasquill has defined six stability classes ranging from \`A' (extremely unstable) to \`F' (stable). Wind speeds, intensity of solar radiation (daytime insulation) and night time cloud cover have been identified as prime factors defining these stability categories.

Table 7.3: Pasquill stability classes

Surface Wind	Day time solar radiation.			Night time cloud cover		
Speed(m/s)	Strong	Moderate	Slight	Thin< 40%	Medium	Overcast >80%
< 2	A	A-B	B	-	-	D
2-3	A-B	B	C	E	F	D
3-5	B	B-C	C	D	E	D
5-6	C	C-D	D	D	D	D
>6	C	D	D	D	D	D

When the atmosphere is unstable and wind speed is moderate or high or gusty, rapid dispersion of pollutants will occur. Under these conditions, pollutant concentration in air will be moderate or low and the material will be dispersed rapidly. When the atmosphere is stable and wind speed is low, dispersion of material will be limited and pollutant concentration in air will be high.

Stability category for this study is identified based on the cloud amount, day time solar radiation and wind speed.

7.4.6 Risk Assessment for Boiler/Furnace

LDO is used widely as a heating fuel in boilers and care is essential in preventing explosive pockets forming within lines and box particularly during start-up/shutdown. RDF Fuel is then used during normal operation for steam generation in boiler.

A boiler explosion is a catastrophic failure of a boiler. Boiler explosions are of two kinds. One kind is a failure of the pressure parts of the steam and water sides. There can be many different causes, such as failure of the safety valve, corrosion of critical parts of the boiler, or low water level. Corrosion along the edges of welding joints was a common cause of early boiler explosions. The second kind is a fuel/air explosion in the furnace, which would more properly be termed a firebox explosion. Firebox explosions in solid-fuel-fired boilers are rare, but firebox explosions in gas or oil-fired boilers are still a potential hazard.

The risk associated with the boiler/furnace hazards and its explosion damage are given below:

7.4.7 Basic Cause of Boiler Furnace Explosions (fire box explosion)

The basic cause of furnace explosions is the ignition of an accumulated combustible mixture within the confined space of the furnace or the associated boiler passes, ducts and fans which convey the gases of combustion to the stack. A dangerous combustible mixture within the boiler-furnace enclosure consists of the accumulation of an excessive quantity of combustibles mixed with air in proportions which will result in rapid or uncontrolled combustion when an ignition source is supplied. A furnace explosion may result from ignition of this accumulation if the quantity of combustible mixture and the proportion of air to fuel are such that an explosive force is created within the boiler-furnace enclosure. The magnitude and intensity of the explosion will depend upon both the relative quantity of combustibles which has accumulated and the proportion of air which is mixed therewith at the moment of ignition. Explosions, including "furnace puffs," are the result of improper procedures by operating personnel, improper design of equipment or control systems, or equipment or control system malfunction.

Numerous situations can arise in connection with the operation of a boiler-furnace which will produce explosive conditions. The most common experiences are: (a) An interruption of the fuel or air supply or ignition energy to the burners, sufficient to result in momentary loss of flames, followed by restoration and delayed re-ignition of an accumulation. (b) Fuel leakage into an idle furnace and the ignition of the accumulation by a spark or other source of ignition. (c) Repeated unsuccessful attempts to light off without appropriate purging, resulting in the accumulation of an explosive mixture. (d) The accumulation of an explosive mixture of fuel and air as a result of loss of flame or incomplete combustion at one or more burners in the presence of other burners operating normally or during lighting of additional burners. (e) The accumulation of an explosive mixture of fuel and air as a result of a complete furnace flameout and the ignition of the accumulation by a spark or other ignition source, such as attempting to light burner(s). (f) Purging with too high an air flow which stirs up combustibles smoldering in hoppers.

The conditions favorable to a boiler-furnace explosion above are typical examples, and an examination of numerous reports of boiler-furnace explosions suggests that the occurrence of small explosions, furnace puffs or near-misses has been far more frequent than is usually recognized. (Reference NFPA-85E)

7.4.8 Basic Cause of Boiler Explosions

A boiler explosion is a catastrophic failure of a boiler. Boiler explosions are of two kinds. One kind is a failure of the pressure parts of the steam and water sides. There can be many different causes, such as failure of the safety valve, corrosion of critical parts of the boiler, or low water level. Corrosion along the edges of welding joints was a common cause of early boiler explosions. There are many causes for boiler explosions such as poor water treatment causing scaling and overheating of the plates, low water level, a stuck safety valve, or even a furnace explosion that in turn, if severe enough, can cause a boiler explosion. Poor operator training resulting in neglect or other mishandling of the boiler has been a frequent cause of explosions since the beginning of the industrial revolution. The inspection records of various sources in the U.S., UK, and Europe showed that the most frequent cause of boiler explosions was weakening of boilers through simple rusting. The principal causes of explosions, in fact the only causes, are deficiency of strength in the shell or other parts of the boilers, over-pressure and over-heating. Deficiency of strength in steam boilers may be due to original defects, bad workmanship, deterioration from use or mismanagement.

Boiler explosions are always due to the fact that some part of the boiler is, for some reason, too weak to withstand the pressure to which it is subjected. This may be due to one of two causes: Either the boiler is not strong enough to safely carry its proper working pressure, or else the pressure has been allowed to rise above the usual point by the sticking of the safety valves, or some similar cause.

Boiler explosion can lead to overpressure/blast waves near the premises which can lead to structural damage for particular overpressure level.

The following damage criteria may be distinguished with respect to the peak overpressures resulting from a blast wave:

Table 7.4: Damage Due To Overpressures

Peak Overpressure, bar	Damage Type
0.83	Total destruction
0.30	Heavy damage, nearly complete destruction of houses (Heavy Damage)
0.27	Cladding of light industrial building ruptures
0.2	Steel frame buildings distorted and pulled from foundations
0.16	Lower limit of serious structural damage
0.14	Partial collapse of walls and roofs of houses (Medium Damage)
0.027	Limited minor structural damage
0.01	Typical pressure of glass breakage (Light Damage; Individuals should be reasonably safe inside a reinforced structure away from windows or lying on the ground if outdoors)

7.4.9 Impact contours of Boiler explosion

The influence zone of boiler explosion has been assessed using Phast software Bleve Model. The impact distance and contour map are given in **Table 7.5, Table 7.6** and **Figure. 7.1,7.2,7.3.**

The impact contour google-earth of the project is given in **Figure. 7.4**

Inputs considered for consequence analysis:

Bolier drumVolume = 21.28 m^3 (for single boiler), No. of Boiler = 2, Temperature: 400 deg C and Pressure : 42 kgf/cm^2.

Table 7.5: Damage Distance for Boiler Explosion

Scenario Considered	Case	Weather	Damage Distance (m) for various overpressure		
			0.3 bar	0.1 bar	0.02bar
Boiler Explosion	Catastrophic Rupture	2F	23.9523	46.5502	155.084
		3D	23.9523	46.5502	155.084
		5D	23.9523	46.5502	155.084

Table No. 7.6: Criteria applied in risk analysis to estimate the effects on human beings

Peak Over Pressure	Fatalities indoors (%)	Fatalities outdoors (%)
Greater than 0.3	100	100
In between 0.3 and 0.1	2.5	0
Less than 0.1	0	0

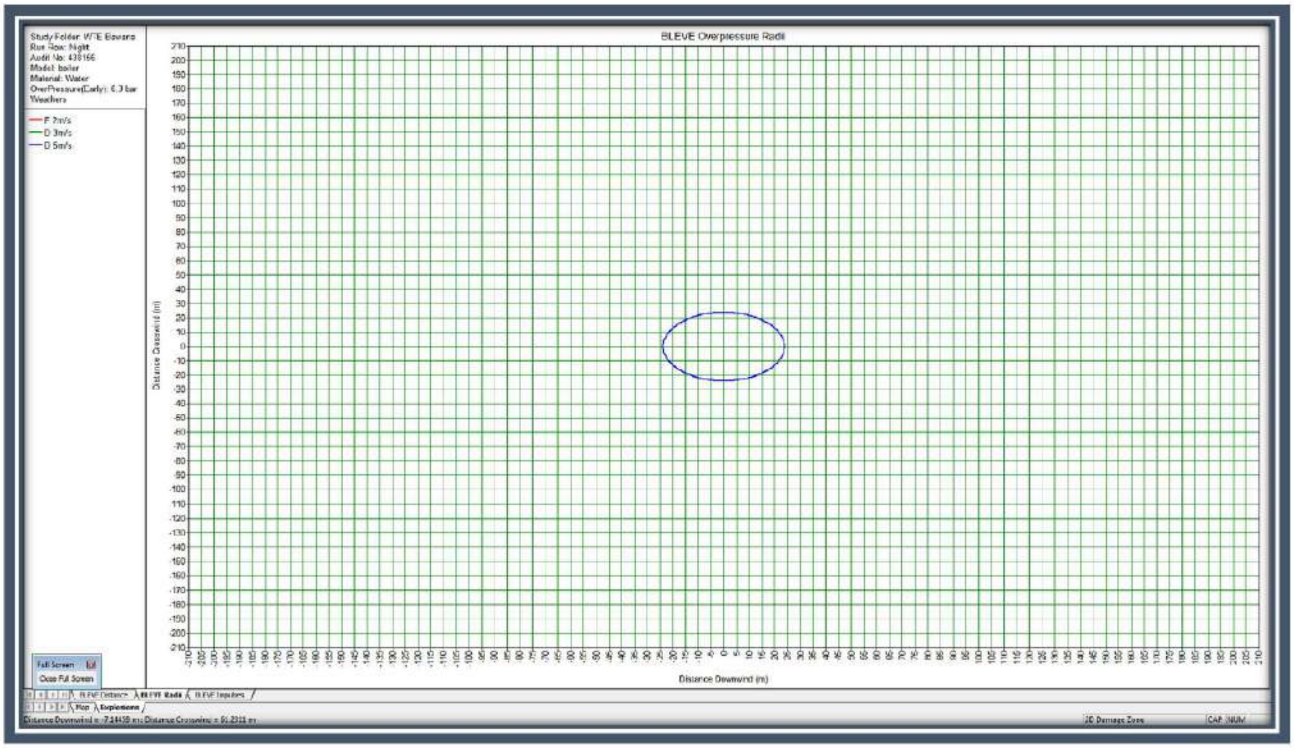


Fig.7.1 Contour map of boiler explosion at pressure 0.3 bar

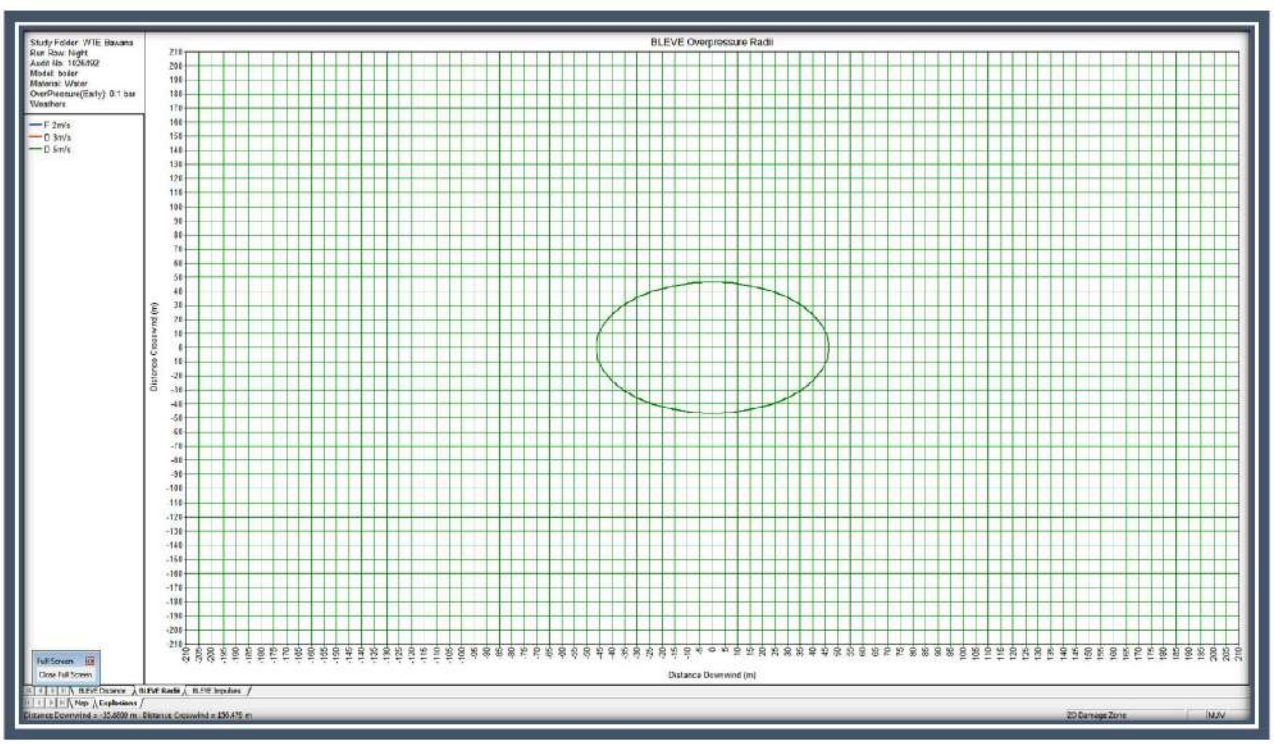


Fig.7.2 The contour map of boiler explosion at pressure 0.1 bar

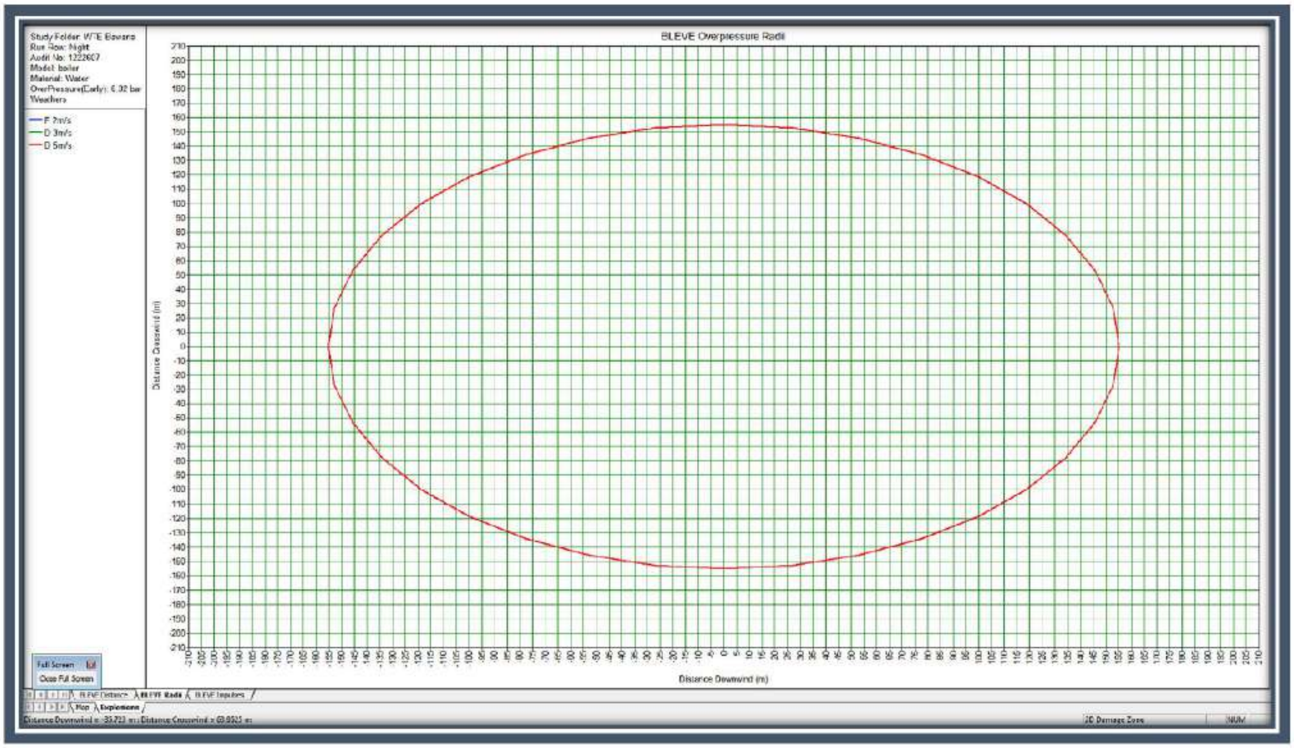


Fig.7.3 The contour map of boiler explosion at pressure 0.02 bar

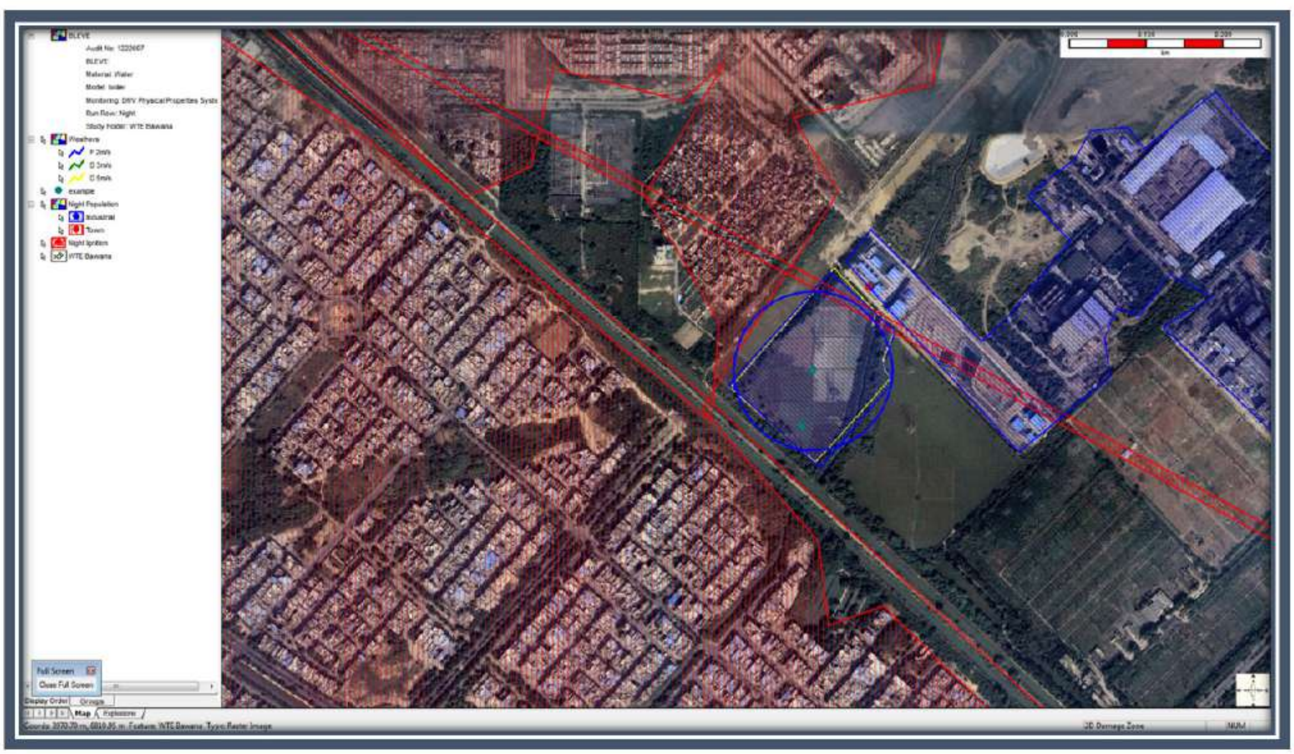


Fig. 7.4 Damage Contour for BLEVE Scenario at WtE Bawana for Boiler

7.4.10 Consequence Analysis

Following are the chemicals handled in the plant

- LDO

Hazards associated with the use of this chemicals are

- Fire

7.4.11 Consequence Analysis for LDO

LDO shall be used in the facility for startup of boiler and it would be stored in 25 KL storage tank at WtE Bawana site. Being a class B flammable product, if loss of containment of LDO occurs either via leak or rupture of tank can lead to fire.

7.4.12 Damage Criteria

In consequence analysis, use is made of a number of calculation models to estimate the physical effects of an accident (spill of hazardous material) and to predict the damage (lethality, injury, material destruction) of the effects. The calculations can roughly be divided in three major groups:

a) *Determination of the source strength parameters;*
b) *Determination of the consequential effects;*
c) *Determination of the damage or damage distances.*

The basic physical model consists of the following:

Source Strength Parameters

- Calculation of the outflow of liquid out of a tank or pipe, in case of rupture.
- Calculation, in case of liquid outflow, of the instantaneous flash evaporation and of the dimensions of the remaining liquid pool.
- Calculation of the evaporation rate, as a function of volatility of the material, pool dimensions and wind velocity.
- Source strength equals pump capacities etc in some cases

Consequential effects

- Dispersion of gaseous material in the atmosphere as a function of source strength, relative density of the gas, weather conditions and topographical situation of the surrounding area.

- Intensity of heat radiation [in kW/ m^2] due to a fire, as a function of the distance to the source.
- Concentration of gaseous material in the atmosphere, due to the dispersion of evaporated chemical. The latter can be either explosive or toxic.

It may be obvious, that the types of models that must be used in a specific risk study strongly depend upon the type of material involved:

- Gas, vapour, liquid, solid?
- Inflammable, explosive, toxic, toxic combustion products?
- Stored at high/low temperatures or pressure?
- Controlled outflow (pump capacity) or catastrophic failure?

Selection of Damage Criteria

The damage criteria give the relation between extent of the physical effects (exposure) and the percentage of the people that will be killed or injured due to those effects. The knowledge about these relations depends strongly on the nature of the exposure. For instance, much more is known about the damage caused by heat radiation, than about the damage due to toxic exposure, and for these toxic effects, the knowledge differs strongly between different materials. In Consequence Analysis studies, possible effects/outcomes due to handling of flammable material are:

1. Heat radiation, from a jet, pool fire or flash fire.
2. Explosion

The consequences caused by exposure to heat radiation are function of:

- The radiation energy onto the human body [kW/m^2];
- The exposure duration [sec];
- The protection of the skin tissue (clothed or naked body).

The limits for 1% of the exposed people to be killed due to heat radiation, and for second-degree burns are given in the table below:

Table-7.7: Damages to Human Life Due to Heat Radiation

Exposure Duration	Radiation energy 1% lethality, kW/m^2	Radiation energy for 2nd degree burns, kW/m^2	Radiation energy for first degree burns, kW/m^2
10 Sec	21.2	16	12.5
20 Sec	9.3	7.0	4.0

Since in practical situations, only the people outside will be exposed to heat radiation. In case of a fire, it is reasonable to assume the protection by clothing. It can be assumed that the people would be able to find a cover shield against thermal radiation in 10 sec.

Furthermore, 100% lethality may be assumed for all people suffering from direct contact with flames, such as flash fire or a jet flame. The effects due to relatively lesser incident radiation intensity are given below **Table 7.8**:

Table 7.8: Effects Due To Incident Radiation Intensity

Radiation Intensity (kW/m^2)	Casualty Threshold
0.7	Equivalent to Solar Radiation
1.6	No discomfort for long exposure
4.0	Sufficient to cause pain within 20 sec. Blistering of skin (first degree burns are likely)
9.33	Pain threshold reached after 8 sec. Second degree burns after 20 sec. 1% lethality.
12.7	0% lethality
18.47	50% lethality
36.56	99% lethality

Vapour cloud explosion in the present case is very rare in class B product like LDO.

Following Table distances show the damage distances due to flammable 25 KL chemical LDO.

Table 7.9: Consequence Analysis for Flash Fire Scenario

S. No.	Scenarios considered (Catastrophic Rupture)	Pasquill stability class	LFL concentration PPM	Flash fire At LFL concentration distance (m)	Consequence Analysis at (4 kW/m²)	Consequence Analysis at (12.5 kW/m²)	Maximum Pool Radius (in meter)
1.	LDO Storage Tank	2F	7000	12.8215	98.1026	42.2282	39.4986
		3D		13.0782	104.925	43.0245	39.4863
		5D		14.0853	113.67	45.739	39.4778

Table 7.10: Frequency of occurrence of events

Event	Base Frequency per year
Minor Leak from LDO Tank	1.20E-05
Major Leak from LDO Tank	7.10E-06
Catastrophic Rupture LDO Tank	4.70E-07

(Reference OGP guidelines)

7.4.12.1 Damage Contours

This section shows the damage area on vicinity map due to various scenarios:

Fig. 7.5 Damage Contour for Flash Fire Scenario due to rupture at LDO Tank

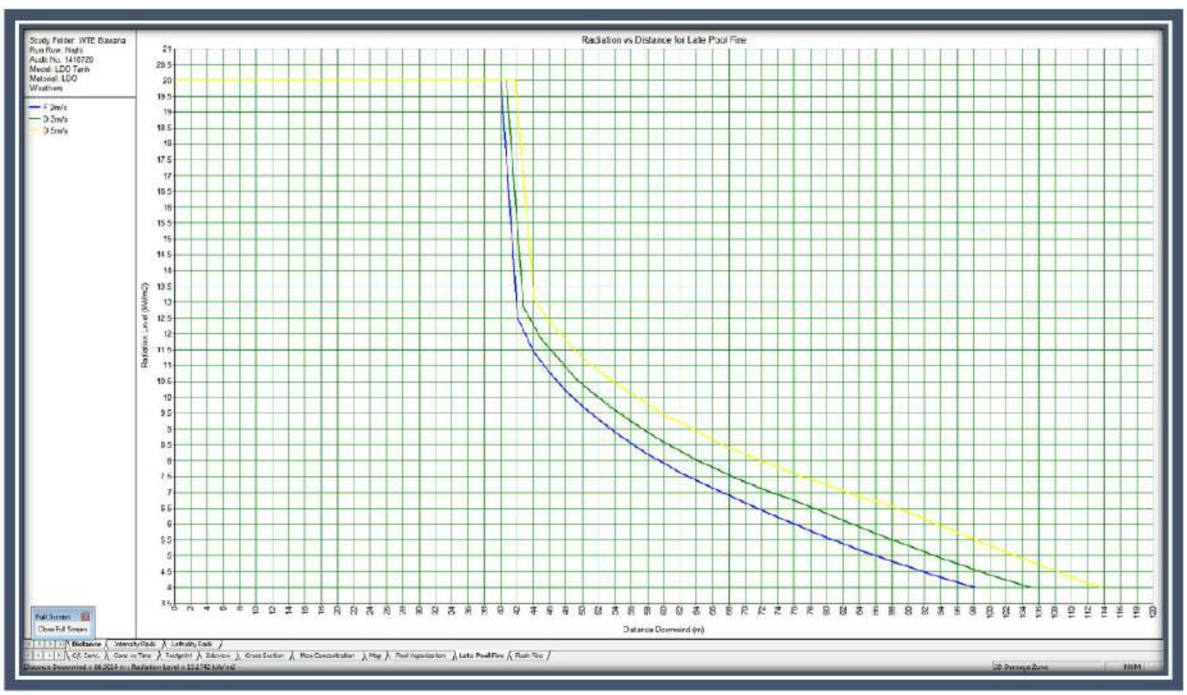


Fig 7.6 Damage Contour for late Pool Fire Scenario due to rupture at LDO Tank

Risk Criteria

Individual risks are the key measure of risk acceptability for this type of study.

Risks to the public can be considered to be broadly acceptable (or negligible) if below 10^{-6} per year (one in 1 million per year). Although risks of up to 10^{-4} per year (1 in 10,000 per year) may be considered acceptable *if* shown to be As Low As Reasonably Practicable (ALARP), it is recommended that 10^{-5} per year (1 in 100,000 per year) is adopted for this study as the maximum tolerable criterion.

Risks to workers can be considered to be broadly acceptable (or negligible) if below 10^{-5} per year and where risks of up to 10^{-3} per year (1 in 1000 per year) may be considered acceptable if ALARP.

After assessment of the risk, it is found that risk to worker and public from the site is in the Broadly Acceptable Region i.e., 10^{-6} per year (one in 1 million per year) which is broadly acceptable or negligible.

The overall worst-case scenario for M/s Jindal Urban Waste Management (Bawana) Limited is shown below:

Fig 7.7 Overall worst-case scenario for M/s Jindal Urban Waste Management (Bawana) Limited for LDO

Location Specific Individual Risk (LSIR)

The Location specific individual risk (LSIR) is risk to a person who is standing at that point 365 days a year and 24 hours a day. The maximum LSIR in the units is given below-

Table 7.11: Location Specific Individual Risk (LSIR)

S. No.	Unit	Maximum LSIR
1.	M/s Jindal Urban Waste Management (Bawana) Limited	1.36E-06Avg/ Year

Individual Risk to Worker (ISIR)/Individual Risk per Annum (IRPA)

The personnel in Plants are expected to work 8-hour shift as well as general shift. The actual risk to a person i.e., "Individual Specific Individual Risk (ISIR)" would be far less after accounting for the time fraction a person is expected to spend at a location.

$ISIR_{Area}$ = LSIR X (8/24) $_{(8\ hours\ shift)}$ X (Time spent by and individual/8 hours)

The maximum ISIR in the unit is listed in table below:

Table 7.12: Maximum Individual Risk per Annum (IRPA)

S. No.	Unit	Maximum ISIR	Risk Category
1.	M/s Jindal Urban Waste Management (Bawana) Limited	4.53E-07Avg/ Year	Broadly Acceptable Region

ALARP summary & comparison of Individual risk with acceptability criteria

The objective of this RA study is to assess the risk levels at M/s Jindal Urban Waste Management (Bawana) Limited with reference to the defined risk acceptability criteria and recommend measures to maintain the risk level to Broadly Acceptable Region. The comparison of maximum individual risk with the risk acceptability criteria is shown below:

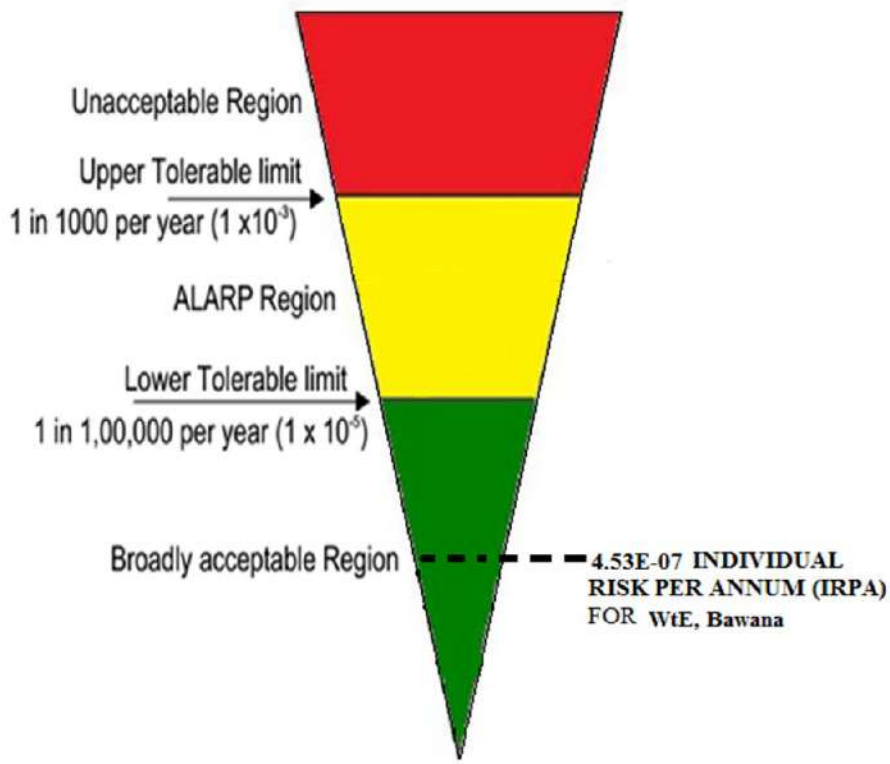


Fig 7.8 Individual Risk per Annum (IRPA) for M/s Jindal Urban Waste Management (Bawana) Limited

Societal Risk

Assessment of societal risks is even more important than assessment of individual risk because they involve the likelihood of multiple fatalities. Societal risk is the risk to any person or group of persons who are not connected to project facilities and are outside the facility fence line.

Table 7.13: Societal Risk

S. No.	Unit	Maximum Societal Risk
1.	M/s Jindal Urban Waste Management (Bawana) Limited	1.36E-06Avg/ Year

F-N CURVE:

It is helpful to consider group risk in the demonstration that risks are Broadly Acceptable Region. This allows consideration to be given to events, which, although low in frequency, may cause multiple injuries or fatalities. Group risk can be presented in the form of a plot of cumulative frequency versus number of fatalities (F-N curve).

F = Frequency (experienced or predicted)

N = No. of multiple fatalities

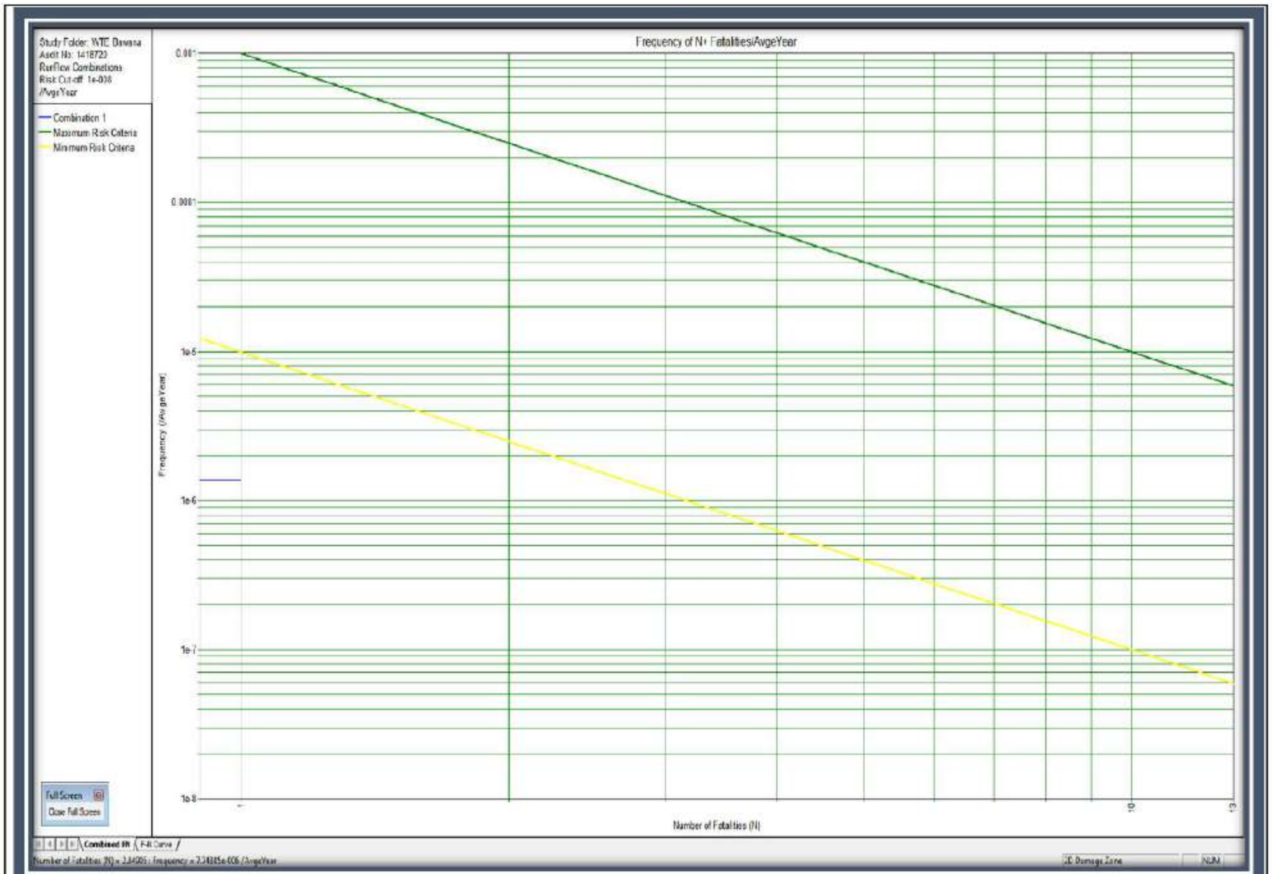


Fig 7.9 Graph showing F-N curve for M/s Jindal Urban Waste Management (Bawana) Limited

From the above figure, it is observed that the calculated F-N curve for project site falls within the **Broadly Acceptable Region**.

7.4.13 CONCLUSION AND RECOMMENDATION

7.4.13.1 CONCLUSION

1. Individual Risk: It is found to be in acceptable region as per PNGRB IRPA Triangle.
2. Societal Risk: It is found to be in acceptable region as per UK HSE Criteria.

3. The Risk Assessment study is carried out by using LDO (storage: 25 KL).
4. Boiler explosion scenario shows that for light damage (0.02 bar overpressure; no fatalities), medium damage (0.1 bar overpressure, 2.5% fatality indoor and no fatalities outdoors) and heavy damage (0.3 bar overpressure; 100 % fatality) distances are 155.08m, 46.55m and 29.95 m respectively at 2F weather condition.
5. The chemical handled in the facility is flammable; in the view of this special precaution like PPE, mask etc. to be taken while handling the chemicals.

7.4.13.2 RECOMMENDATIONS/RISK CONTROL MEASURES SUGGESTED

The following risk control measures are considered

- The facility handle flammable material. Proper PPEs to be provided to all worker while handling the chemicals. Proper ventilation of the covered spaces to be provided to avoid the accumulation of the vapors of chemicals.
- Trained workman and staff and also ensuring periodical refreshers course to them.
- Conducting periodical inspection, maintenance of equipments/connections like flanges, valves, vehicles, site conditions and ensure high degree of safety commitment
- Fire water pumps shall installed along with adequate water storage capacity
- Ensure Inspection and Maintenance of Pipelines of Boiler and other related equipments/instruments/connections like safety device, water level indicator, flanges etc. to avoid boiler explosion
- Special precautions like SOP to be considered during start-up and shut down failure of which may lead to fire box explosion/boiler explosion.
- Periodical inspection and calibration of various types of electronic instruments shall be followed.
- Ensure effective monitoring of the power plant safety.
- Effective housekeeping to be maintained in the plant.
- MSDS of the chemicals should be present at strategic locations and worker should be well trained to handle that chemical with appropriate PPE.
- Gas monitoring equipments to be connected to the alarm (flammable oil).
- Periodic Inspection and Maintenance of Fire Alarm & Fire Detection System to ensure its working when in need.

- Periodic rehearsal of mock drill to ensure readiness to handle any emergency situation.
- All safety precautions (SOP etc.) to be followed in any type of operation in the plant to avoid accidental situation.
- Special precautions like no use of match boxes, cigarette lighters etc. also be followed to avoid fire in LDO storage area, loading/unloading of LDO tanker area.
- SOP to be followed during loading/unloading of LDO to storage tank. LDO Tankers to be fitted with flame arrestors. Earthing/bonding during loading/unloading to be considered to avoid any static charge generation.
- As per NFPA-85E, it is believed that improved instrumentation, safety interlocks and protective devices, proper operating sequences and a clearer understanding of the problem by both designers and operators can greatly reduce the risks and actual incidence of furnace/boiler explosions.

7.5 DISASTER MANAGEMENT PLAN

Disaster is a catastrophic situation in which the day-to-day patterns of the life are,in many instances, suddenly disrupted and people are plunged in to helplessness and suffering and as a result need protection, clothing, shelter, medical and social care and other necessities of life, such as –

i) Disaster resulting from natural phenomena likes earthquake, volcanic eruptions, storm, surges, cyclones, tropical storms, floods, landslides, forest fires, and massive insect infestation. Also in this group, severe drought that will cause a creeping disaster leading to famine, disease, and death.

ii) Second group includes disastrous events which are man-made, or by man's impact on environment, such as armed conflict, industrial accidents, factory fires, explosions and escape of toxic gases or chemical substances, river pollution, mining or other structural collapses; air, sea, rail and transport accidents, aircrafts crashes, collisions of vehicles carrying inflammable liquids and dam failure.

Following sections describe various hazards associated with this project and other disaster situation including Emergency Response Plan.

7.5.1 IDENTIFICATION OF HAZARDS

The major emergency situations arising out of the various hazards identified within the facility are listed **Table No.7.14**:-

Table No. 7.14: IDENTIFIED EMERGENCY SITUATIONS

S. No.	Situation	Location	Department
1	Accident during vehicle movement	Plant gates/Plant	Security
2	Fire in LDO storage tank	LDO Yard	Store
3	Electrical fire (Overloaded circuits)	Electrical cables (Plant)	Electrical
4	Bursting of airline & receivers	Comp. House	Mechanical
5	Bursting of steam line /valve	Boiler area	Operation

7.11.1 PLANT HAZARDS & CONTROLS

1. LDO storage & electrical panels shall be provided with Foam sprinkling system, water sprinkling system & CO2 flooding system respectively to control fire hazard.
2. All storage tanks shall be provided with proper Breather valves.
3. All equipment including storage tanks, pumps, vessels etc. shall be provided with double earthing.
4. Earth Continuity shall be tested at periodical intervals. Earth pits are maintained as per the prescribed standards.
5. All pressure vessels, cranes & lifting tools & tackles shall be tested regularly by competent person as per Factories Rules for fitness tests.
6. All buildings and structures shall be provided with lightning arrestors.
7. All electrical panel rooms and transformers shall be equipped with Smoke detection & CO2 flooding system which should be hooked to centralized alarm panels.
8. All electrical panel rooms shall be maintained in positive pressure with the help of Air Pressurization Units to avoid entry of flammable vapour inside the electrical rooms.
9. A well-defined work permit system shall be in place to carry out hot works, work at heights, confined space jobs and other critical jobs.
10. All storage tanks shall be provided with Dyke walls of appropriate capacity for proper containment in the event of leak.

11. Firefighting capabil
12. ities including Fire Hydrant Facilities, Spray system, Fire extinguishers, Fire suits, Self-Contained Breathing Apparatus etc.
13. Periodical inspection and calibration of various types of electronic instruments shall be followed.
14. Safety surveillance shall be ensured through a dedicated team of experienced EHS personals. They observe unsafe conditions and act also ensure necessary actions should be taken to address them.
15. Fire Fighting Drills, Mock Drills shall be conducted from time to time
16. New recruits shall be trained for half day on Safety on second day of joining.
17. Training shall be conducted as per the training calendar covering all employees. Basic Firefighting, First-aid, SCBA, Fire drills & Material safety data sheets is part of safety training.
18. Safety inspections shall be conducted on monthly interval and observations are attended without any delay.
19. Spark arrestors shall be in place for the purpose of vehicles entering in TR hall for MSW unloading.
20. Security guards shall be manned at all two gates of plant and have thorough vigil on movement.
21. One emergency vehicle round the clock shall be stationed at main gate.

Above measures will be followed in case of expansion project too.

Table: 7.15 Schedule of Checking & Calibration of Equipments

S. No.	Equipment/Details	Schedule
1.	Inspection & cleaning of Fire Extinguishers, PPE etc.	Fortnightly/Monthly
2.	Inspection of Hydrant / Monito	Weekly/Monthly
3.	Inspection of Fire Fighting & Safety Equipment	Monthly
4.	Pressure Testing of Fire Water Line	Regularly
5.	Hydro testing of Fire Hoses	Once in a 3 Year (As per IS2190:2010)
6.	Hydro testing of Fire Extinguishers	Once in 3/5 Year (As per IS2190:2010)

S. No.	Equipment/Details	Schedule
7.	Housekeeping	Daily
8.	Near miss Reporting	Regular Basis.
9.	Monitoring of Accidents	Monthly
10.	Safety Committee Meeting	Quarterly
11.	Testing of electrical and hand operated fire siren	Quarterly
12.	Inspection of detection system	Monthly
13.	Safety Checks	Periodically
14.	Training on HSE to employees and contract Labours	Periodically
15.	Safety Round of the Plant	Daily
16.	Updation of First Aid Box	Monthly
17.	Calibration of Pressure Gauges in hydrant line	Yearly
18.	Health checkup of employees & labours	Annually

Table 7.16: Disaster Drills along with frequency and Status

S. No.	Activities	Frequency
1	Fire Mock Drill	Quarterly
2	On-Site Disaster Drill	Half Yearly

7.5.2 OTHER DISASTERS

Apart from the emergencies arising due to storage of hazardous chemicals, the other likely emergencies are:

7.5.3 Fire and Explosion Due to Electrical Failures

i. Short-circuiting due to loose wiring.
ii. Use of non-industrial fittings.
iii. Static electricity as a result of improper bonding/ grounding to tanks, tanker & pipelines etc.

7.5.4 Fire and Explosion Due to Vehicles

i. Exhaust of vehicle, if effective spark arrestors are not provided.

ii. Spark from the loose contact on vehicle batteries.

7.5.5 Fire and Explosion Due to Others

i) Lighted scented sticks (agarbatti) in a truck.

ii) Lightning.

iii) Smoking in prohibited zones.

iv) Dry Grass Fire.

v) Hot surfaces like steam lines etc.

7.5.6 Water / Food Poisoning

Symptoms, sudden discomfort, affect the digestive system shortly after the consumption of water, tea or food.

7.5.7 Natural Disasters

i) Earthquake

ii) Flood or Collapse of civil structure

7.5.8 Emergency Response Plan

Emergency Response Plan shall be included in Onsite emergency preparedness plan for proposed plant. The brief of onsite emergency plan is described below:-

7.5.8.1 Emergency Siren/Alarm. Emergency siren is need to be there at proposed plant.

7.5.8.2 Declaration of Minor Emergency

Any minor emergency situation will get announced automatically if any MCP (Manual Call Point) is broken. The local sounders in that zone and the main siren will start sounding as soon as the MCP is actuated or any smoke sensor in certain areas are actuated due to detection of smoke. The Security personnel at the gate has a mute button which he will press after allowing the sounder alarms to run up to 90 seconds (one and half minute)

Minor emergency can also be declared by the security person on receiving a confirmed message (for those areas where MCP is not available), by pressing the alarm button three times for 30 seconds, with an interval of ten seconds in between.

7.5.8.3 Declaration of Major Emergency

A major emergency will be declared on the decision of the Incident Controller or on the advice of the Site Main Controller. This will serve to alert the neighboring community and the Industries to get prepared for action on receiving specific communication from the Site.

Major Emergency situation will be announced by the security person at the gate by pressing the Alarm/by using PA system.

7.5.8.4 All clear Siren

The all clear siren will serve to communicate that the emergency situation is over and the Core-group / key persons may go back to their work place. This siren is sounded by the security person when he receives the instruction for sounding the same by pressing the Alarm button and allowing the sounder alarm to run for up to (one minute only)

Same emergency response system will be followed in case of expansion of project.

7.5.9 EMERGENCY CONTROL CENTER (ECC)

The Head of the Project (HOP), who is designated as the Chief Incident controller, on receipt of information regarding the emergency inside the plant premises will go to the Emergency Control Centre (ECC) and will assume overall responsibilities for the Factory/ Storage site and its personnel. Emergency control center should be provided with External & Internal telephones for the purpose of communication during the emergencies.

1. Layout of Fire Hydrant System
2. List of Key Personnel with Contact numbers
3. List of External Agencies & Member of Mutual Aid with Contact numbers.
4. List of Chemicals
5. Material Safety Data Sheets of chemicals (MSDS)
6. List of Fire Fighting Equipment of the location
7. A copy of On-site Emergency plan
8. Stationary (white papers, pencils, erasers etc)
9. White board with duster & marker pen
10. Table & chairs for meeting

Same will be followed in case of expansion project too.

7.5.9.1 Key Persons and their Responsibilities

7.5.9.2 Action by Security Personnel at the Main Gate:

a) On receiving confirmed information about an emergency on phone or by running caller/PA system/Walkie-talkie (not through MCP) switch-on the local emergency siren and carry out their specified duties.
b) Inform Shift Engineer and Shift Electrician through Walkie Talkie.
c) Communicate Operation Head, Maintenance Head, HR- Head, Admin. & Security Head & EHS Head through Phone.
d) One person rushed to the site with a walkie-talkie.

7.5.9.3 Duties of Site Main Controller: Plant Head

Site main controller (Plant Head) is responsible for overall organization and strategy of the emergency response, coordinates logistical efforts and has the authority for the final decision in any emergency action. Plant Head of Waste to Energy (WtE) Project at Narela-Bawana site is the Main Site Controller with the specific responsibilities as follows:

a) Assume control of the Emergency Control Center (ECC).
b) Implement the Emergency Plan and plan against the escalation.
c) Maintain contact with Local Authorities and Mutual Aid Partners.
d) Receive updates on control measures taken by the Emergency Coordinator.
e) Assess the situation and direct actions to minimize damage and loss of life
f) Declare the emergency "under control" and authorize the "all clear" signal

7.5.9.4 Duties of Incident Controller: Head Operation Alternate Shift Engineer on Duty

a) On hearing the Emergency Siren he will rush to the site of emergency.
b) He will immediately take over the charge of the site from the Area. Supervisor and instruct him to carry out other duties.
c) Carry out the listed actions as per the need of the situation.
d) Direct for plant shut-down operations (if needed) to control the emergency.
e) Mobilize all resources available including man, equipment, information etc. to control the

situation and prevent it from further aggravating.

f) Instruct the First Aid, Fire Fighting & other persons at the site to carry out various tasks.

g) Most important of all arrange for rescue of any injured / affected / trapped persons and prompt medical aid.

- Control the spread of fire / further enhancement of situation –
- Stopping power to the area.
- By cooling the area around the site by spraying water
- By removing the material around the fire site.

h) Call for more supply of firefighting equipment / emergency equipments, if required.

i) Prevent unauthorized crowding of persons. Ensure control of other operations including isolation from the affected area.

j) Guide the Emergency Crew in their actions for fighting fire / combating the toxic gas release and keep a close watch.

k) Arrange for Medical aid, Stretcher, First Aid, Ambulance, and Doctor.

l) Maintain contact with the Main Gate Control through the security guard at site and one more person stationed as messenger.

m) If he feels the situation can turn into a major Emergency he will contact the Emergency Controller and with his consents instruct Main Gate Security for the Major Emergency alarm (PA system).

n) Inform Fire Brigade, Hospital etc. as per requirement through ECC / Main

o) Gate Security.

p) Once the emergency situation is under control, he will inform to the security through walkie talkie for the all clear siren.

7.5.9.5 Duties of Emergency Controller- Admin & Security Head:

a) Rush to Gate, ensure only the right people are allowed to enter the premises.

b) Capture Head Count related information in consultation with Time Office & Security Department.

c) Arrange for transportation of personnel like firefighting personnel, plant operating personnel, security personnel and causalities /affected persons inside or outside the factory premises.

d) Arrange to communicate adequately with the Police station, Fire brigade and other Authorities as directed by main site controller. Attend all telephone calls from press/govt. agencies.

e) Arrange for canteen facilities for personnel on duty as well as in the affected area. Ensure that Medical aid is rendered.
f) In case of a need, inform the neighboring industries about the state of emergency and action required to be taken by them.
g) Make sure that personnel actually required to control the Emergency situation should only be present there. No unwanted personnel should crowd around the affected area.
h) Ensure security and safety of plant property during the period of emergency.
i) Keep a watch on outsider / insider to avoid further loss of property / material.
j) Maintain vigilance at the site of emergency for at least one hour after emergency is brought under control.
k) Maintain constant contact with the ECC and Main Site Controller and be available for instructions.
l) To coordinate with corporate mass communication staff to prepare a written statement, this would only be shared with the external agencies like Press, Police, other govt. agencies etc.
m) Maintain contact with the Emergency Control Centre and be available for instructions.
n) Will inform to all nearby hospitals for medical aid for sufferers and fire station for fire brigade.

7.5.9.6 Duties of Maintenance Head:

a) Rush to the site & assess the gravity of the situation with a view to rendering all maintenance help as may be necessary for isolation of vulnerable equipment.
b) Ensure starting and un-interrupted running of Fire Water pump. Provide services of Mechanic & Electrician at site.
c) Isolate power supply to the affected area, if required.
d) In the event of a power failure at the time of emergency, ensure running of D.G. Sets and un-interrupted supply to the firewater pump.
e) Provide for emergency lighting, if needed.
f) Co-ordinate any civil jobs required to be done by contractor’s labour, if necessary.
g) Maintain constant contact with the ECC and Main Site Controller and be available for instructions.

7.5.9.7 Duties of Emergency Coordinator- EHS Head:

a) Rush to the site of emergency & assess the situation with regard to firefighting and safety and extend help to Main Site Controller.

b) Arrange for supply of suitable additional Safety / Emergency and Fire equipment as may be required.

c) Keep in touch with other "Key personnel" and render advise / assistance as required.

d) Organize formal investigation of the accident and assist in filing reports for statutory requirements.

e) Maintain contact with the Emergency Control Centre and be available for instructions.

7.5.9.8 Duties of Utility Operator

a) As soon as hear the Emergency Siren, rush to the fire pump house-3.

b) Ensure the proper running of fire pumps and keep the constant watch on the pressure of the system it should be always in between 5 Kg/cm^2 to 7 Kg/cm^2 .

c) Keep watch on the water level of water storage reservoir.

d) In case of power failure run the diesel driven engine.

7.5.10 ACTIVITIES DURING THE EMERGENCY: - Following activities will be followed at the time of emergency.

7.5.10.1 General

Action by personnel who notice the emergency

- Shout Fire! Fire! Fire! Or Help! Help!
- He will inform area supervisor and Security at Gate
- Break MCP at the nearest location
- Keep himself safe and try to mitigate the situation if he is confident to do it himself On hearing the emergency siren, the plant emergency key personnel should carry out the following operations immediately: -
- Area Officer/ Supervisor start the fire fighting / emergency rescue operation with the help of firefighting team.
- Shift Engineer rushes to the site and take the charge from Site controller.

- Site Key personnel start their action as per their responsibility.

7.5.10.2 Remedial Action in case of Fire / Explosion

- Approach the Fire in upwind direction.
- Keep the safe distance while combating the Fire / Explosion.
- Attempt to extinguish fire with the help appropriate Fire extinguishers and sand.
- All pipeline and tank valves should be closed and all the operations inside the Plant should be stopped. Isolate the fuel from the source of fire.
- Isolate the electrical supply, if needed.
- In case of large fire, use the hydrant system & spray water with nozzle after ensuring complete isolation of electric circuit in case of electrical fire.
- In case of fire in diesel use appropriate AFFF foam.
- Keep the surrounding tanks / containers etc. in cool condition by using water spray system.

Table: 7.17, Following Firefighting facility for proposed plant during emergency

S. No.	Fire Fighting Equipments	Quantity/Availability
1.	Water tanks	2X500 KL
2.	Fire Engines	04
3.	AFFF Foam	200
4.	DCP type fire extinguisher (9kgs,25kgs,75kgs)	45 (05 Kg)
5.	CO2 type fire extinguisher	55 (4.5 & 22.5 Kg)
6.	Sand Bucket	56
7.	Jockey Pumps	02
8.	Water cum foam monitors	05
9.	Firefighting nozzles	50
10.	Hose pipe	100
11.	Fire Hose Box	50
12.	Fire Blanket	06
13.	Electric type fire siren	16
14.	Hand siren	02
15.	Water Nozzle	50
16.	Oxygen cylinder	01

Table: 7.18, List of PPEs Available at Site

S. No.	List of Personal Protective Equipment	Quantity/Availability
1.	Safety Helmet	700
2.	Safety Shoes	650
3.	Safety Goggles	650
4.	Safety belt	36
5.	Resuscitators	04
6.	Fire Proximity Suit	04
7.	Water Jel Blanket	12
8.	Stretcher	03
9.	Hand Gloves	2000

7.5.10.3 Remedial Action in case of Water / Food Poisoning

Symptoms, sudden discomfort, affect the digestive system shortly after the consumption of water, tea or food.

Remedial Action

- Person observing the symptoms should inform the EHS / Admin Head.
- Emergency Controller after discussion with Site main Controller to announce the necessary instructions to concerned persons.
- Employees trained in first aid who are not victims, should render first aid assistance to the affected persons.
- Security guard at gate should allow entry / exit of rescue vehicle/ ambulances.

7.5.10.4 Off Site Emergency – Vehicular Accidents

- Company Owned Vehicles

In-case of any vehicular Accident off site, the intimation received from any source at security gate or any other responsible person such as Head Operation, Head Admin & Security, he will immediately report Site main controller and Incident Controller. Emergency Controller (Head Admin & Security) will rush to the site and send ambulance with first Aider for providing necessary first Aid & shifting to Injured Person/s. After reaching the site he will report to Site Main Controller and Brief about the Incident and Site Main Controller in turn will instruct to Incident Controller to inform the Local Authorities such as police, Distt. Administration if required. In-case of Transport Vehicles, Head Admin & Security will inform to concerned Transporters In-charge to reach the site to provide necessary help & support to victims. All Injured Person will shift to civil Hospital for necessary further Treatment.

7.5.10.5 Remedial Actions in case of Natural Disasters

7.5.10.6 Earthquake

Safety factor accounting for earthquake has been considered for the design of civil foundations for the plant. To reduce earthquake risk, unit needs to be examining for its strengths and weaknesses, and systematically take actions, which reduce or eliminate the weaknesses.

As soon as indication of earthquake starts all the moving parts inside Plant should be stopped. Plant personnel should not stand near or below the tanks & should try to reach at open space & wait for next instruction from Main Site Controller. In case of receipt of ALL CLEAR signal cautiously needs to enter in a plant as any disturbed material due to shock may fall down.

7.5.10.7 Flood or Collapse of Civil Structure

a. All pipeline & tank valves should be closed & all the operations inside Plant should be stopped. The intensity of operations should be reduced or stopped; once the weather department announces possibility of storm or cyclone.
b. All the filled tank trucks should be evacuated to safer places.
c. Emergency controller / Main site Controller should contact district authorities: Collector and Police immediately for necessary help.
d. Persons inside the Plant should be evacuated as soon as possible & it is also important to access at higher elevation during flood.

7.5.10.8 Assembly Points

Immediately being aware of the emergency Plant Head shall rushes to Emergency Control Center to take charge of the incident. He will direct to declare an emergency based on type of emergency. Plant Head will decide safe close down of plant & will check all non- essential workers; visitors & contractors are evacuated to assembly points. Further he will ask HR Department & Admin. & Security Department to take charge of assembly points & to complete the head count & casualties assembled. Finally he will make arrangement to transfer them to other place as per instruction.

7.5.10.9 Safe Shut Down

As stated earlier during emergency Plant Head (Site Main Controller) will direct the safe close down of plant in consultation with incident controller, if necessary. So as to activate safe close down of plant.

7.5.10.10 Role of External Authorities

On consultation with Main Site Controller, Emergency Controller will consult with the External Agencies for further help and information. After safe close down of plant and evacuation of personnel at assembly points, he shall need to ensure search for causalities within affected area & arrangements for hospitalization of victims or any additional help, if required needs to be contact with the External Authorities. Details of External Authorities with telephone numbers are presented in below table.

Table:7.19 CONTACTS OF EXTERNAL EMERGENCY SERVICES

S. No	Departments	Name & Telephone numbers
a)	Fire Departments	DSIIDC Fire Station, Bawana, Address: Auchandi Bawana Rd, Asthal Colony, Bawana, Delhi, 110039 Phone: 011 2775 2222
b)	Police station	Police Station Bawana (Delhi) DSIIDC Industrial Area, Vijay Nagar, Bawana, Delhi, 110039 Phone: 011 2775 2534
c)	Municipal and provincial agencies	Office of Deputy Commissioner, Narela New Delhi. Contact No.: 011-27283262 Mob: 8929521817 E-Mail ID: dc-narela@mcd.nic.in
d)	Hospital	ESIC Hospital, **Azadpur** Medical Officer Incharge, ESI Dispensary, C-2/35, Model Town-III, Azadpur, DELHI.
e)	Other relevant company facilities	DMSWML, PPCL and TSDF Bawana.

S. No	Departments	Name & Telephone numbers
f)	Mutual Aid organizations	Sandhyashi Hospital, B-48, Sector-05, DSIIDC Industrial Area, Bawana, Delhi, 110039

Communication with external emergency services:

A regular liaison with external emergency is maintained by the Head Security, Admin. & liaison. He shall obtain the required assistance from these agencies in case of any emergency.

7.5.11 MEDICAL RESOURCES

The medical management for the possible emergency situations essentially consists of treatment for burns and maybe some asphyxiation cases. They could cause burns injuries. All the relevant information would also be available at the facility to enable ready treatment of any casualty, should the unfortunate need arise. It is also proposed to circulate any important Health and Toxicology material available through the latest research to all Doctors.

7.6 WATER SHED DEVELOPMENT PLAN

7.6.1 Introduction

Watershed is defined as a hydro-geological unit of an area from which the rainwater drains through a single outlet. Watershed development refers to the conservation, regeneration, augmentation and sustainable use of all the natural resources with a special emphasis on soil and water with an aim to improve the productive potentials of the natural resource base of the watershed unit. Watershed management focuses upon adapting a comprehensive and integrated natural resource management planning process to ecological, economic and social sustainability within a watershed. It takes into account the planning for land and water to improve the interaction among water, plants, animals and human found within the watershed and also to strengthen their interdependence. Thus watershed management attempts to change the land use and water management practices within the watershed area to conserve and improve the natural resource base within the watershed area.

7.6.2 Background

The proposed waste-to-energy (WtE) project of Jindal Urban Waste Management (Bawana) Limited is an initiative of the Municipal Corporation of Delhi (MCD) for handling the issue of MSW in a more scientific way. It will handle approximately 3000 tons per day (TPD) of MSW to generate 30 megawatts (MW) of power. The site is in DSIIDC Industrial Area, Sector-5, Bawana and Delhi. The land is in possession of MCD.

The preparation of an Action Plan for Watershed Development for long term water and soil conservation in 10 km radius of area from the plant boundary area.

7.6.3 Objective

The study aims to restore the hydrological balance of study area by developing an integrated watershed plan. This approach will include collecting and storing rainwater in existing ponds and water bodies, and enhancing the infiltration of surface water into subsurface aquifers to minimize runoff. The strategy will be closely linked to conserving other natural resources, such as soil and vegetation, ultimately boosting land productivity. This approach will redefine the relationship between soil and water, introducing innovative water harvesting and conservation techniques, promoting sustainable land use practices, and enhancing vegetative cover. By leveraging these natural resources, action plan for watershed development has been prepared keeping in view the broad guidelines of the integrated Watershed Management. The plan broadly includes following aspects:

i. Preparation of comprehensive watershed development plan in the project buffer area to improve availability of water.
ii. Preparation of plan for rehabilitating existing water bodies and other water harvesting structures to increase water storage facilities to be used in lean season which can be used for local residents.
iii. Preparation of plan for planting fuel wood, fodder and agroforestry plantation to increase the green cover in the watersheds area.

7.6.4 Guidelines for preparation of watershed development plan.

The plan has been prepared with the approach broadly covering the guidelines suggested under the Common Guidelines for Watershed Development in the country prepared by National Rain fed Area Authority:

- Collection of primary data from the stakeholders,
- Conduction of interview through participatory interactions with locals,
- Secondary data collection from published journals, reports of government department and other organization,
- The technical inputs in the form of resource maps and cadastral maps were collected,
- For Map Preparation GIS and other relevant methods were used.

7.6.4.1 Description of Watershed area

There are a total of seven watersheds in Delhi. The watershed surrounding the plant within 10 km radius encompasses portions of three watersheds, identified by the codes 2C5F4, 2C5F1, and 2C5F5, as illustrated in **Figure 7.10.**

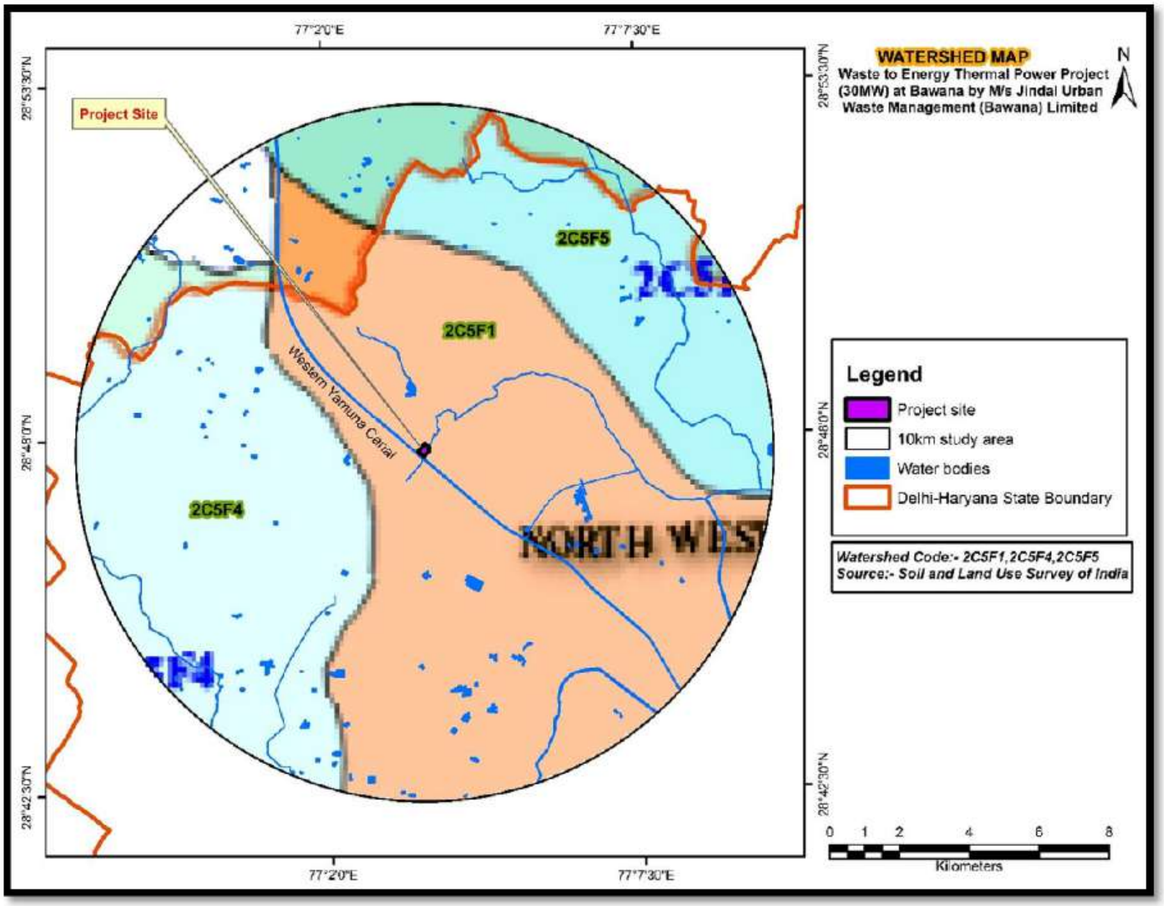


Figure 7.10: Water shade areas covering the project site in 10 Km radius

7.6.4.2 Agro-climate Conditions

Delhi falls under the Trans-Gangetic Plains agro-climatic zone and is characterized by:

- Semi-arid climate with hot summers and cold winters.
- Average annual rainfall ranging from 40 cm to 68 cm (Source IMD).
- Predominantly sandy loam soils.
- Western Yamuna Canal and tube well irrigation are the main sources of water.

Bawana, located in North West Delhi, experiences a semi-arid climate with significant variations in temperature throughout the year. Summers are scorching with average highs exceeding 45°C, while winters are cold with lows around 5°C. Being an industrial area, Bawana can experience even higher land surface temperatures compared to other parts of Delhi.

7.6.4.3 Land Productivity in Agro-Climatic Zone of Study area

As per the Economic Survey of Delhi Report 2021-22. The land productivity in Delhi has been experiencing significant changes due to rapid urbanization and shifting occupational patterns. The area under agricultural use has steadily declined, leading to a reduction in traditional crop production. However, there has been an increase in the cultivation of vegetables, reflecting the adaptation to the limited available land in one of India's fastest-growing mega cities. The gross cropped area in Delhi increased from 35,178 hectares in 2012-13 to an estimated 47,850 hectares in 2021-22, indicating a shift towards more intensive land use practices. Despite the reduced area for food-grain crops, the cropping intensity has increased, showcasing efforts to maximize land productivity under constrained conditions. This trend underscores the importance of efficient land management and innovative agricultural practices to sustain productivity in urban settings.

7.6.4.3.1 Soil

The study area's soil composition is characterized as Sandy Loam, which is known for its balanced mixture of sand, silt and clay particles, offering good drainage. pH value ranges from 6.22 to 7.66. Additionally, organic matter content was measured between 1.23% to 1.74%, indicating moderate levels that contribute to soil fertility and structure.

7.6.4.3.2 Physiography, Relief and Drainage

The territory encompasses physiographic zones within the Yamuna basin, specifically the flood plains. These flood plains are characterized by (a) recent river deposits, (b) lower alluvial plains, and (c) upper alluvial plains. The study area is part of the Bawana Distributary Drainage system, which ultimately drains into the Yamuna River. However, during periods of heavy rain and high floods in the Yamuna River, the drainage system becomes less effective due to the area's natural relief. Moreover, localized stagnation during the rainy season is exacerbated by relief and soil conditions, further compounded by blocked drainage paths caused by road, embankment, and canal construction. The drainage map of the area is given in **Figure 7.11.**

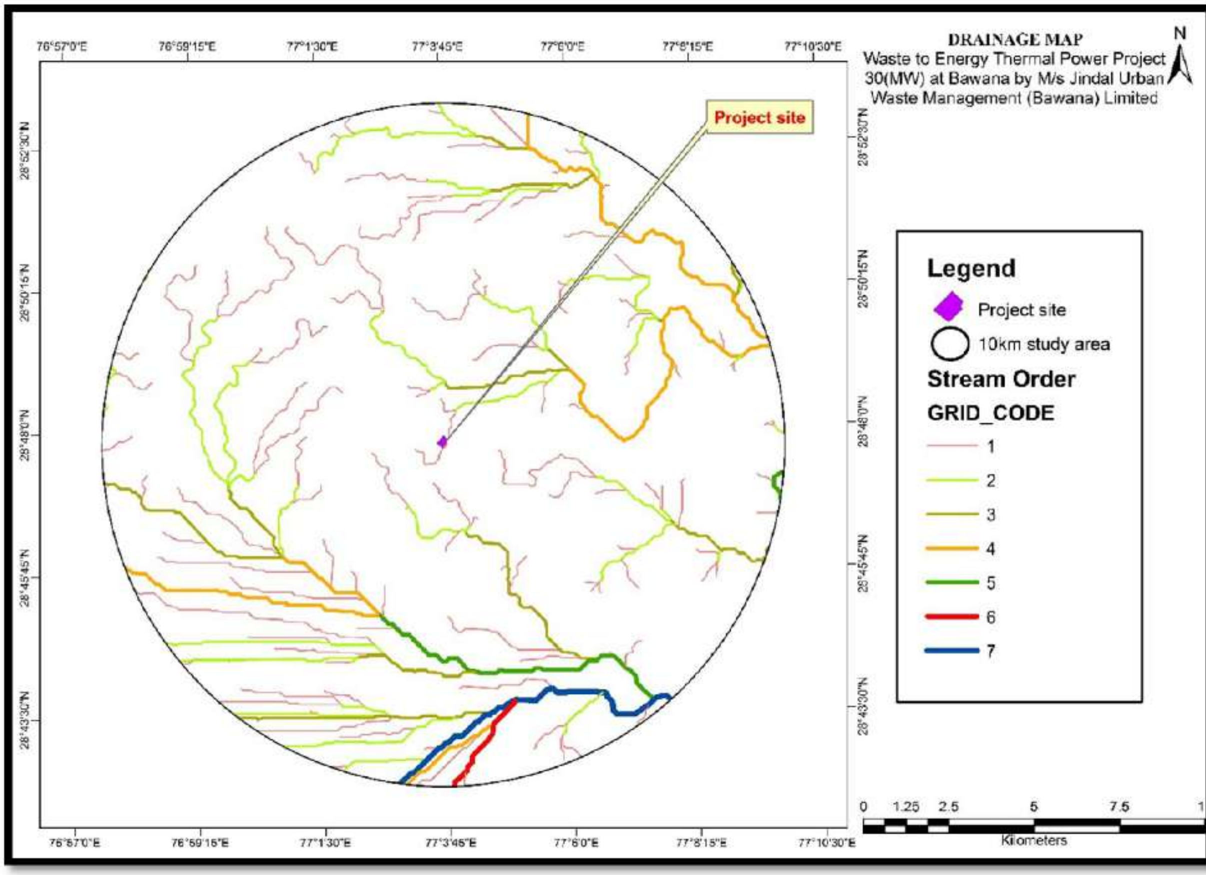


Figure 7.11: Drainage Pattern in the Study area

7.6.4.4 Land use/ Land Classification of watershed in 10 km area

The land use/land cover classes of the study area given in **Table 7.20.**

Table 7.20: Land use and land cover classification of the study area

Sr. No.	Class Name	Area in Hectares	Percentage
1	Agriculture	16977.59	53.21
2	Built-up	13375.82	41.92
3	Natural Veg	293.55	0.92
4	Water Body	220.80	0.69
5	Barren Land	1040.20	3.26
6	**Total**	**31907.97**	**100**

According to the land use and land cover classification, the predominant land use in all the watersheds is agriculture, followed by built-up areas. Vegetated land covers 0.92% of the area, while water bodies occupy 0.69%. The remaining land is classified as barren. **Figure 7.12** illustrates the land use map.

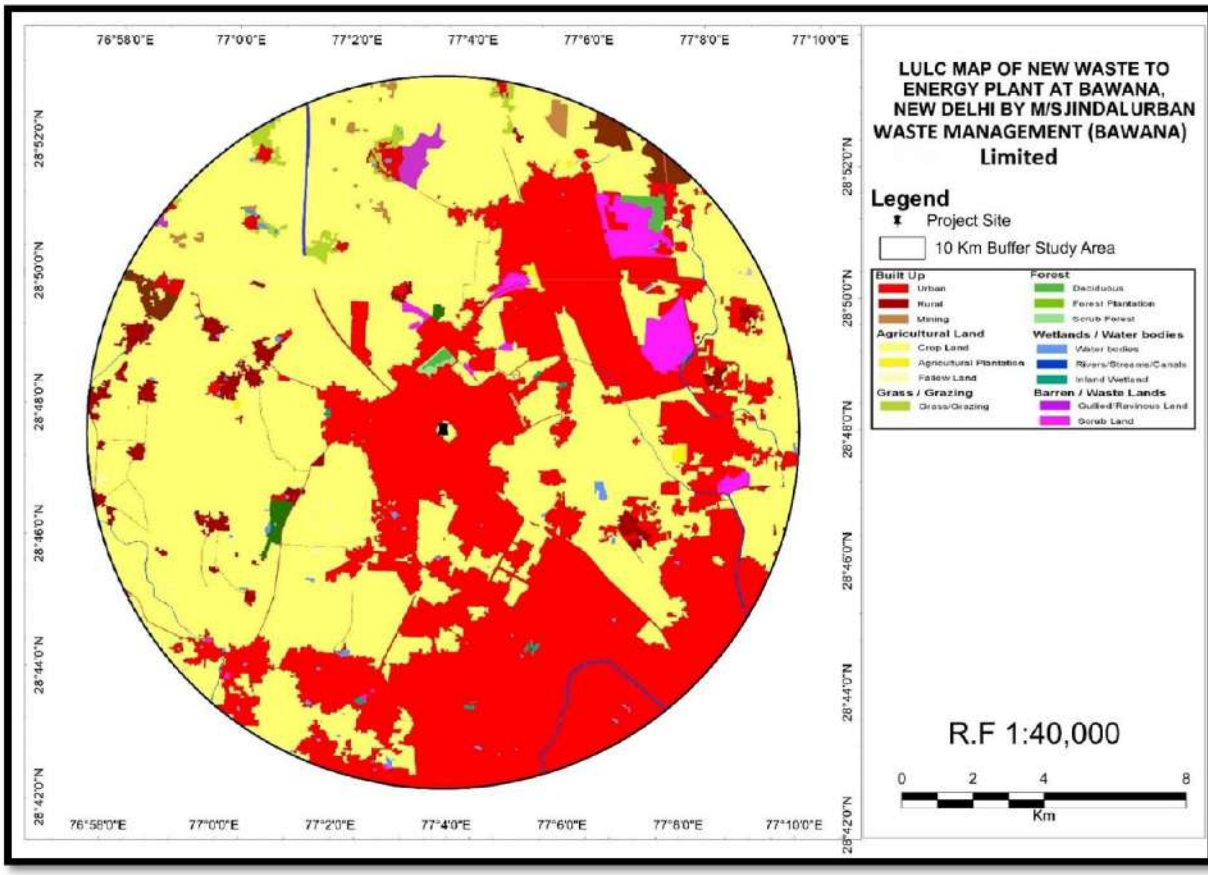


Figure 7.12: Landuse/Land over of the study area

7.6.4.4.1 Forest types and natural vegetation at regional level and in the study area

The vegetation in the state primarily consists of Tropical Dry Deciduous and Tropical Thorn Forest types. In the project area, there is predominantly shrubby growth of bushy plant species and perennial weeds. The upper layer is characterized by dominant species such as *Prosopis juliflora* and *Acacia nilotica*. Most of the woody species belong to the Tropical Thorny Forest and Open Scrub Forest types (Champion and Seth, 1968). According to Biogeographical zones and provinces (Rodger, Panwar, and Mathur, 2000), Delhi state falls under Zone 4: Semi-arid. The study area is specifically within Biogeographic province 4A: Semi-arid-Punjab Plains.

7.6.4.4.2 Water level of the study area:

The 10 km study area covers three different water level depth zone area: 0-5 mbgl (meter below ground level), 5-10 mbgl, and 10-20 mbgl. The exact location of the project falls under the 5-10 mbgl water level class. This strategic positioning allows for targeted interventions to manage and improve groundwater resources effectively. As this water level rises as per the season by 0-2 mbgl.

7.6.4.4.3 Categorization of study area as per ground water resource estimation, 2022:

The study area falls into three categories: Safe, Semi-Critical, and Over Exploited. According to this data, Semi-Critical and Critical areas need to be prioritized for groundwater recharge and prevention of over-exploitation. **The Figure 7.12** is showing the categorization of the study area.

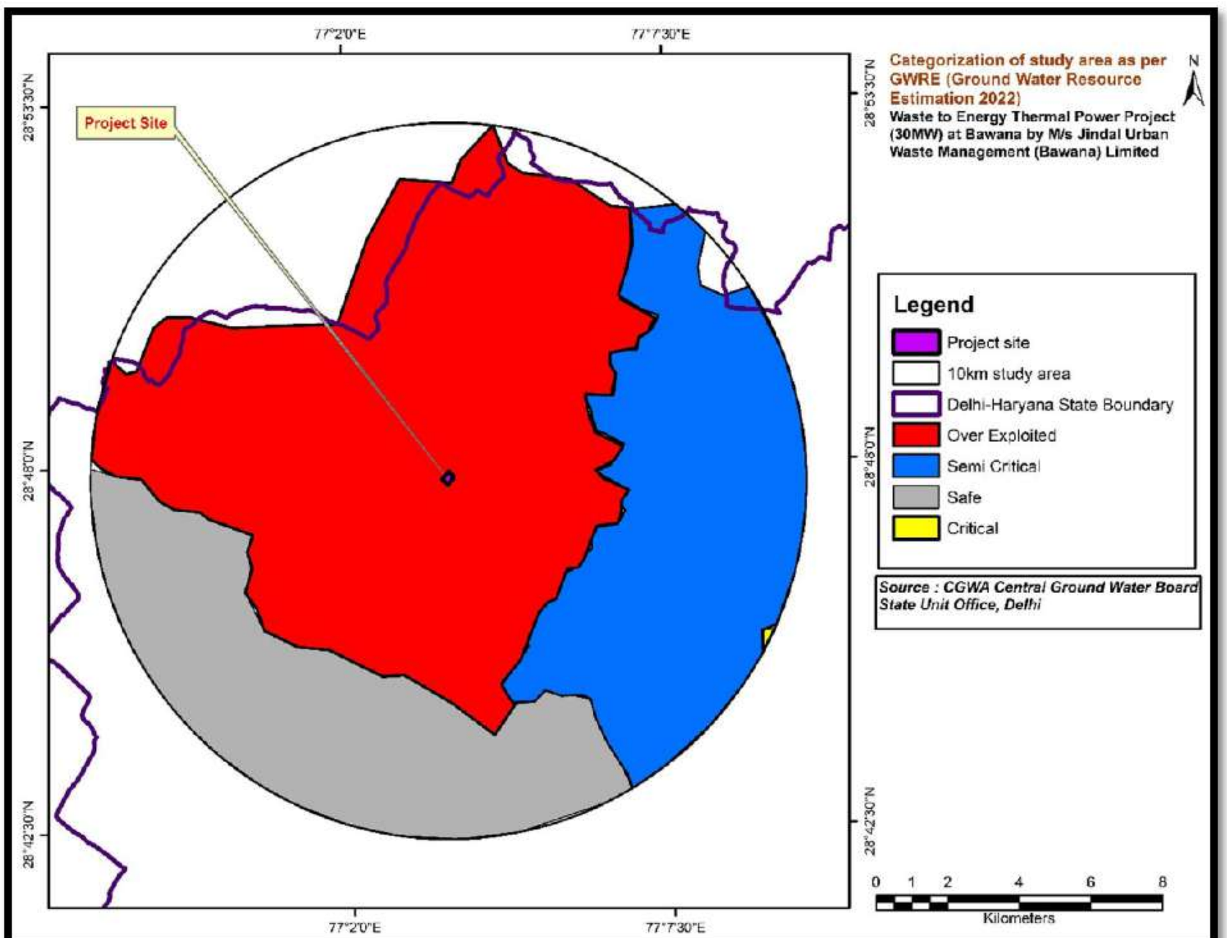


Figure 7.12: Categorization of the study area as per GWRE

7.6.4.5 Challenges in Watershed Development

The main problems of the area are:

- Lack of vegetation and forest cover causing opening of the soil and high rate of erosion resulted in thin top soil layer and poor soil health
- Ground water depletion due to water extraction from industrial area
- To reduce pollution and address other pressing environmental issues

7.6.4.5.1 Water Scarcity in the Study Area

The Bawana Industrial Area in Delhi, established in 1999, faces challenges in managing its water resources. Despite its initial goals of providing a well-regulated industrial space, unauthorized water usage and dependence on tankers have become a concern. Unregulated Water Use: While Bawana was designed for planned industrial development, it struggles with unauthorized water extraction through borewells. This puts stress on the local groundwater table.

- Dependence on Tankers: Many industries rely on private tanker suppliers due to factors like high water demand for specific processes and concerns about the quality of available water. This reliance on tankers creates an unregulated water supply chain.
- Impact on Residents: The unregulated water usage in Bawana Industrial Area can lead to water shortages for residents, especially during hot summer months.
- Various development works (diversion of storm water drains) and increase in built up area in ponds catchment have deprived the ponds from rainwater run-off. Due to administration lethargy, ponds land are being misused as playgrounds, parking spaces, solid waste dumps and discharge of waste water.
- Lowering of water table has taken its toll on these ponds. Couple of ponds still in use for economic and cultural reasons are either being filled with ground or canal water sources.
- Lack of general awareness among residents on the importance of ponds has led to destruction of pond lands.

These challenges require a multi-pronged approach that includes stricter regulations on water extraction, promoting water conservation practices within industries, and exploring alternative water sources.

7.6.4.5.2 Livelihood

Bawana, situated in North West Delhi, presents a unique juxtaposition of industrial activity, residential areas, and pockets of agriculture. This essay explores the socioeconomic conditions in Bawana, highlighting the diverse livelihood opportunities it offers and the challenges associated with its development.

7.6.4.5.3 Industrial Hub and Employment:

Bawana is a prominent industrial hub housing a multitude of industries like manufacturing, textiles, electronics, and food processing. These industries serve as a major source of employment for the local population. The workforce comprises both skilled professionals like machine operators and supervisors, and unskilled workers employed in assembly lines, packaging, material handling, and security.

7.6.4.5.4 Residential Growth and Service Sector:

The recent surge in residential projects in Bawana has led to a burgeoning demand for services. This has resulted in employment opportunities in sectors like transportation (taxis, rickshaws), retail (shops, vendors), and domestic work. These sectors have seen a rise in female participation in the workforce. Additionally, residents sometimes engage in home-based businesses like tailoring, embroidery, or food preparation, contributing to household income.

7.6.4.5.5 Informal Sector and Agriculture:

Bawana fosters a thriving informal sector that provides supplementary sources of income for residents. These sectors encompass small eateries, fruit and vegetable stalls, clothing vendors, and repair services. While not as prominent, agriculture also plays a minor role in the livelihood mix, with some residents cultivating crops on small patches of land.

7.6.4.6 Assessment and Measures to be taken for Watershed Development

Water Resources:

There is a need to develop storage capacities of naturally occurring water bodies (ponds, canal, etc.). The storage capacity of water bodies can be increased to store the water in Rainy season which can be used during lean Season.

- Western Yamuna Canal is the major water body which is flowing at a distance of approx. 32 m, in South-West direction from the project site.
- There are several ponds and most of them become dry in summer season and require further excavation.
- Some ponds are also connected with Canal drain/Nallah.

7.6.4.7 Assessment of potentials water bodies

There are 85 surface water bodies, 1 canal, and 1 drainage channel, 12 booster pumping stations (BPS) that pump water from canals and other water sources, and 65 tube wells in Bawana that supply water for irrigation, industrial use, and drinking. However, unauthorized borings and excessive water extraction are depleting the groundwater and stream reservoirs. (Source: Delhi Jal Board).

7.6.4.8 Issues to be addressed

Urban development, pollution, and groundwater depletion have significantly impacted several historically important and naturally fed ponds. Originally large and multi-purpose, many ponds have shrunk and become polluted over the years due to construction and the conversion of storm water channels into sewage carriers. This degradation has rendered some ponds dry and neglected. Certain ponds, once filled naturally, now rely on artificial refilling for annual rituals. Despite their historical and potential utility, many ponds are now used for other purposes or lie empty, highlighting the broader environmental challenges faced by urban areas.

7.6.4.9 Action plan for Watershed Development

Keeping the above options in view and considering the socio-economic condition of peripheral villages/ hamlets situated within 10 Kms radius of project site, edaphic / soil conditions, land holdings, rainfall, pattern of rainfall, climatic conditions and likely alteration due to plant, forest condition, barren/ unutilized land and related aspects, the following interventions are proposed in the study area.

- **Installation and Maintenance of Screens:** Screens should be installed to prevent solid waste from entering in the pond and ensure regular maintenance to maximize effectiveness.
- **Promotion of Rainwater Harvesting:** Encourage residents to adopt rainwater harvesting techniques to replenish groundwater and reduce reliance on extraction.
- **Restoration and De-silting:** Undertake de-silting and restoration efforts to increase the pond's water-holding capacity.
- **Rehabilitation of Storm water Channels:** Redirect sewage away from the pond and restore storm water channels to prevent contamination.
- **Aquifer Recharge Initiatives:** Implement measures to recharge groundwater levels, possibly through managed aquifer recharge techniques, following the guidelines of the NGT order in the case of Mahesh Chandra Saxena versus The Chief Secretary, Govt. of NCT of Delhi & Ors.
- **Revival of Historical Water Sources:** Explore feasibility of diverting rainwater and storing it in the Pond to meet local water needs.
- **Community Involvement:** Engage local communities in conservation efforts and historical preservation to ensure long-term sustainability.
- **Rejuvenating Water bodies through Treated Wastewater:** Amidst a severe water crisis, a survey by the Centre for Science and Environment (CSE) highlighted significant efforts to revive lakes and ponds across India as part of a broader strategy to combat water scarcity and ensure sustainable water management. This involves filling water bodies with treated wastewater previously wasted by mixing with sewage in nearby drains, which helps recharge groundwater. According to the Delhi Jal Board, the water level in six lakes, including Pappan kalan, Najafgarh, and Nilothi, has risen by 3-6 meters.
- **Cleaning of drains before monsoon:** This project involves the thorough cleaning of drains before the onset of the monsoon season. By removing debris, silt, and other obstructions, the project aims to ensure smooth water flow and prevent waterlogging and flooding. Properly maintained drains help in efficiently channeling rainwater, reducing the risk of

overflow and associated health hazards, and improving overall urban sanitation and resilience against monsoon rains.

- **Prohibition of disposal of municipal solid waste and plastic waste in canal:** This initiative aims to prevent the dumping of municipal solid waste and plastic waste into canals. By enforcing strict regulations and promoting responsible waste management practices, the project seeks to preserve canal ecosystems and water quality. Keeping canals free from waste helps maintain their function in drainage, irrigation, and as habitats for aquatic life. It also reduces the risk of clogging, contamination, and environmental degradation caused by improper waste disposal. Implementing this prohibition contributes to sustainable urban development and protects vital water resources for communities and ecosystems alike.
- **Plantation:** Strategic plantation need to be carried out along water bodies to prevent soil erosion, improve water infiltration.

These interventions aim to address specific issues such as pollution, water depletion, and misuse of water bodies, while promoting sustainable water management practices and community involvement.

7.6.4.10 Monitoring and Social Audit Watershed Development Programme

The implementation of various activities under watershed development plan should be regularly reviewed.

7.6.5 Conclusion

Watershed development is an isolated activity of water conservation. It involves comprehensive development of the natural resources of the area that are interconnected and interdependent like water, soil, plantations, pasture land, livestock, pisciculture, agriculture, and horticulture and above all the livelihood, food and health security of the human beings. It focuses upon the holistic development of the natural resource base and its productive potentials.

The Watershed Development Action Plan for Bawana presents a holistic strategy to tackle the pressing issues of water scarcity, groundwater depletion, and environmental degradation in the region. This plan emphasizes integrated water conservation and sustainable land use practices, aiming to restore the hydrological balance and improve the socio-economic conditions of local communities. Key initiatives include promoting rainwater harvesting, restoring and desilting water bodies, and regulating water usage, particularly in industrial areas, to prevent over-exploitation. Additionally, measures to control pollution and waste management are crucial to preserving water quality and protecting aquatic ecosystems. Community engagement and awareness programs are vital components, ensuring that residents are active participants in conservation efforts. Regular monitoring, social audits, and collaborative efforts among stakeholders, government authorities, and the community are essential for the plan's success, ensuring its long-term sustainability and the improved quality of life for Bawana's residents. The reference for the study is given in **Table 7.21.**

Table 7.21: References

- National Rainfed Area Authority. (n.d.). *Common guidelines for watershed development in the country*.
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CHAPTER 8. PROJECT BENEFITS

8. GENERAL

The Proposed Municipal Solid Waste (MSW) to Energy Project at Bawana, Delhi has been planned with a view to reduce the problem associated with disposal of unprocessed municipal waste into landfill, thereby complying with the various regulations of scientific management of MSW of Delhi as well as the objective and goal set for the country under the Swachh Bharat Mission (SBM).The major benefits of the Project are given below:

8.1 Environment benefits:

WtE projects are considered one of the most environment friendly technologies provided, due care is taken for control of air pollution.

State-of-the-art of technology has been proposed for Air pollution control through elaborate arrangement of multistage treatment and control and monitoring system. The water pollution treatment system is based on ZLD concept and no treated wastewater will be discharged from the plant during operation.

The odour mitigation measure involves storing the MSW in an enclosed area with a negative pressure with the airflow being routed through the boiler which prevents unpleasant odor from escaping into the atmosphere. Further, special inoculum will be used in MSW storage area for minimizing odor problem.

WtE project will eliminate the issues like Pollution from dumpsite/open burning of MSW that remain an area of high concern both for the regulators and society at large.

8.2 Conservation of Land Resources

The land requirement for WtE Project is much less than landfill method of Municipal Solid Waste Management. There is a paucity of land in Delhi and its surrounding area, so landfill option is not a viable solution. Further, it is not a sustainable option to simply dump MSW into landfill. The proposed project will reduce burden on land which is a scarce resource in Delhi.

8.3 Conservation of Fresh Water

It is proposed to utilize waste water from Pragati Power/ treated sewage water from Jal Board for the proposed project. Thus, no natural water resource or ground water resource will be utilized to meet its water requirement. Further, all the effluent water generated from the plant will be reused in the process. Thus, adoption of these measures of the project will lead to conservation of water.

8.4 Improvement in Sanitary and Hygienic condition

The project will utilize 3000 TPD of Municipal Solid Waste. Utilization of such a huge quantum of MSW in the "WtE" plant will improve the sanitary and hygienic condition for residents of NW Delhi.

Additionally, the project will enhance the city's environmental aesthetics by eliminating the need for large, unsightly landfill MSW mounds.

8.5 Improvement in Social Infrastructure

The project proponent will undertake various social infrastructure activities under CER and CSR. These activities will add to the existing infrastructure in the area.

8.6 Employment Potential

During construction and operation of the project, unskilled, semiskilled and skilled people would be required. The employment opportunities to be generated during construction and operation phases are given below:

<u>During the construction phase:</u>

Employment (On contract): 570 Nos

On Roll: 60Nos

Total (On Roll + On Contract): 630 Nos.

<u>During the operational phase:</u>

On contract: 156 Nos

On Roll: 86 Nos

Total (On Roll + On Contract): 242 Nos.

Thus, this project would create new job opportunities. Other sections of people would also be benefitted indirectly by the project through their business to supply the materials required in the project. This will improve the living standard of society.

8.7 Increase in Electricity Generation

Waste-to-Energy (WtE) is a source of renewable energy. It would contribute to the growing demand for renewable energy in carbon constrained world. This project will produce 30 MW electricity for approximately 25 years.

8.8 Increasing Green Cover in Bawana Area

The project has proposed to undertake plantation in plant premises and in surrounding area. Approx. 4860 of trees will be planted in 6 Acres (40% of the total land) of land @2000 trees per hectare. This would not only increase the green cover in the area but would also improve the local environment and aesthetics.

CHAPTER 9. ENVIRONMENT COST BENEFIT ANALYSIS

9.0 ENVIRONMENTAL COST BENEFIT ANALYSIS

An effort has been made in this Chapter to describe the environmental cost benefit analysis, both qualitative and quantitative wherever feasible. Tangible and intangible benefits, both have been taken into consideration in the analysis.

9.1 Environmental Benefits

9.1.1 Reduction in Municipal Solid Waste dumped at the Sanitary Landfill Site

The project will utilize 3000 TPD of MSW, thus preventing 3000 TPD of MSW going to the sanitary landfill site. Thus, this project would help in preventing pollution of air, water, and soil and other environmental issues associated with sanitary landfill sites.

This project will have huge indirect benefits as garbage free city which will help in achieving the objectives of Swachh Bharat mission. Apart from that, it will reduce the methane gas emission, a greenhouse gas that would otherwise occur from the decomposition of MSW.

9.1.2 Improvement in Ecology & Biodiversity through Greenbelt Development

A greenbelt development is envisaged in the project premises and surrounding environment which would help in increasing the green cover and flora and fauna of the area. This will have a positive impact in improving ecology and aesthetic of the area.

9.1.3 Increase in Employment Opportunities

The project will generate employment opportunities. The benefits of employment to the job seekers are expected to include, at a household and individual level, with improvement in socio-economic and health status, improvement in their living condition, and the benefits from greater household expenditure on education & healthcare resources. The employment opportunities to be generated at the construction and operation phase has been shown below:

During the Operational Phase

- Number of Employment Opportunities (Contract): 156
- Number of Employment Opportunities (On Roll): 86
- Total Number of Employment Opportunities during the Operational Phase (On Roll + Contract): 242

9.1.4 Improvement In Social Infrastructure

The project proponent will undertake various social infrastructure activities under CER and CSR. These activities will add to the existing infrastructure in the area.

9.2 Environment Management Cost

The total cost of the project is **Rs. 660 crores**. The project proponent has proposed to install various control measures for air, water, noise odour pollution. In addition, various mitigation and environmental improvement activities will be implemented. Total environment management cost of the project is **Rs. 99.2 Cr.** Detailed EMP cost with activity is provide in Chapter 10.

Further, the project proponent will undertake CER activities after public hearing apart from CSR activities in the area. The cost of these will be included in the final EIA report.

CHAPTER 10: ENVIRONMENTAL MANAGEMENT PLAN

10.1 INTRODUCTION

To prevent and mitigate environmental impact during the construction and operational phases of the project, it is crucial to identify and predict impacts and recommend mitigation measures. Consequently, the preparation of an Environmental Management Plan (EMP) becomes a significant component of the EIA report. It assists in identifying and describing specific actions to address environmental measures during the assessment process.

An EMP outlines the mitigation measures and monitoring for ensuring sustainable development in the project area.

10.2 CONTENTS OF EMP: -

The EMP covers the following aspects.

1. Summary of potential impacts and recommended mitigation measures of the proposal are given in **Table-10.1**.
2. The details of control measures for the purposed project are given in **Chapter 2.**
3. Description of monitoring programme to ensure compliance with relevant standards is given in **Chapter-6.**

Table No. 10.1: Summary of impacts and its mitigation measures

S. No.	Environmental components	Potential Impacts	Mitigation Measures Construction phase	Mitigation Measures Operational phase
1.	Soil	• Soil Contamination. • Due to solid waste generation. • Soil erosion.	Management of Solid Waste as per MSW Rules, 2016 and C&D Waste Management Rules, 2016. (a) Minimum land required for main plant and civil structures will be levelled to keep soil disturbance bare minimum. (b) The fertile part of soil from excavation area will be preserved for utilization during horticulture.	• Green belt will be developed. • Fly & bottom ash will be sent to the designated SLF by MCD to avoid soil contamination in the project • Management of waste as per Hazardous Waste Management Rules, 2016 and SWM Rules, 2016. • Good housekeeping practices in the Project site
2.	Air	Air pollution	• Sprinkling of water. • Use of PUC certified vehicles. • Transportation of material through covered vehicles only. • Regular maintenance of earth moving	• During the operations Installation of air pollution control devices (FGCS) for particulate matter and gaseous pollutants. • Odour: - For Odour control, sprinkling of

			equipment and other vehicles.	fragrance liquid through fogging nozzle. • Bio inoculum which is consortium of micro-organism called EM culture will be sprayed for effective odor control.
3.	Surface Water	Surface water contamination	• Adequate measures will be taken to avoid surface water contamination. • Excavation or levelling will be done during non-monsoon season only. • Construction of storm water drain to channelize all storm water to a settling pit. • Proper plan for management of construction waste. • Proper sanitation facilities will be provided to construction workers.	• All the effluents from various sections will be brought to the common collection pit for treatment and treated waste will be recycled and reused in the plant for various purposes in the premises. The water system will be based on ZERO Liquid Discharge concept and there will be no effluent discharge from the plant premises.

4.	Ground Water	Ground Water depletion and contamination	• Groundwater will not be extracted for construction purpose. Runoff water from construction site will be collected and reused.	• No ground water Extraction for operation of the plant. STP treated water from DJB will be the source of water supply for the proposed project, Hence, it will not be impacted. • All the drains will be properly cemented to avoid contamination of ground water.
5.	Traffic	Disruption of road traffic	• Trucks with trained drivers will be allowed for transporting construction materials at the site. Training will be imparted to drivers for handling of materials.	• Only trained driver will be allowed for transportation of material. • Training will be imparted to drivers. • Parking provision will be provided at site.
	Socio-economic	Positive impact on employment opportunity.	• Local people will be preferred for the workforce during the construction work.	• Local people will be preferred for the workforce during the operational phase.

			• The project would indirectly benefit the local population due to increased commercial activities.	• This project will provide the additional electricity to citizens to the grid.
	Health & safety	Occupational Hazard	• Providing the necessary PPE to workers. • Provision of First aid facility to workers. • Provide training to workers regarding health and safety.	• Periodic health checkup • Workers will be trained with respect to health and safety norms. • PPE will be provided to the workers. • Sandhyashi hospital, Jivan Hospital, Bawana MCD Hospital and Siddhartha Hospital is located nearby the project hence hospital facility is not required in the premises.
6	Ecology	Ecological disturbances	• No tree will be felled during construction. • Greenbelt will be carried out in the periphery of	• Stack emission will be maintained as per the stipulated standard.

			plant premises. This will help in mitigating potential ecological disturbances and also enhance the aesthetic view of the plant. • Greenbelt will be developed in an area of 24281.14 sq.m. with native species. The plantation/greenery programme will be carried out simultaneously with construction of the project.	The impact of flue gas emission on flora & fauna will be insignificant.

10.3 ENVIRONMENTAL MANAGEMENT PLAN (EMP) FOR CONSTRUCTION PHASE

Following EMP will be implemented during construction phase:

10.3.1 Land Environment

- All the debris generated during the construction phase will be disposed as per the relevant rules and regulations.
- The topsoil excavated will be first temporarily stored at an earmarked place during construction phase and reutilized during plantation.

10.3.2 Water Environment

- During construction phase, the runoff water from construction site will be collected in a pit and reused for dust suppression.
- Excavation activity during dry season and proper management of excavated soils.

- Clearing all debris from site as soon as construction is over.
- Providing proper sanitary facilities for construction labor.

10.3.3 Air Environment

The possible sources contributing to air pollution during construction are dust generation from earth work (during site clearance and preparation), emissions from the operation of construction equipment and machines; vehicles exhaust, unloading of material at the site and mixing of cement with other building materials.

Mitigation measure

Regular water sprinkling will be done to mitigate fugitive emissions. During the period of strong winds and in peak summer season i.e. May & June, frequency of water sprinkling will be increased.

All the vehicles carrying raw materials will be covered with tarpaulin sheet. It is proposed to provide adequate dust control systems, and loose material handling in covered sheds. Plantation will be done around the periphery of the project site.

All the vehicles will be maintained and serviced as per schedule and will have pollution under control certificate.

10.3.4 Noise Environment

The major activities which are likely to increase ambient noise levels during construction phase are foundation work, movement of vehicles carrying materials and loading & unloading activities, excavation machines, concrete mixer and other construction machines, concreting, hammering, etc.

Mitigation Measures

- Noise generating equipment will be operated during day time only.
- All the vehicles entering the project site will maintain speed limits and will not blow horns unless it is required.

- The workers involved in operating major noise generating equipment's will be provided with personal protective equipment like ear plugs/ear muffs etc.

10.3.5 Ecology

Greenbelt will be enhanced in the periphery of project premises and other vacant spaces within the site. Greenbelt will be developed in an area of 24281.14 sq.m. (6 Acre). Local native tree species will be selected for plantation. The green belt development programme will be carried out simultaneously with construction of the project.

Mitigation Measures

No tree cutting will be done.

10.3.6 Solid Waste Management

The construction waste includes debris, concrete (often recycled and reused at the site), steel and other metals, pallets, packaging and paper materials, fluorescent tubes, wood beams, etc.

Mitigation Measures

- A well-defined solid waste management plan will be adopted during construction phase including timely collection, segregation and disposal as per legal requirements. Storage facilities for any lubricant etc. will be provided under cover and the runoff from such areas will be collected separately.
- All waste generated during the construction phase will be collected and segregated for disposal as per norms.
- C&D waste will be managed as per C&D Waste Management Rules, 2016.

10.3.7 Construction Hutment

The temporary Hutments will be provided and the plant will be provided with clean drinking water, adequate toilet facilities and solid waste disposal system.

10.3.8 Occupational Health and Safety

Safety measures include provision of PPE, guarding of dangerous machine parts, and maintenance of equipment and adequate provision for different types of fire extinguishers at work site. All applicable rules and regulations pertaining to workplace Safety, Health and Welfare and welfare of workers will be adhered to.

10.3.9 Transport Linkage and Traffic

During construction phase, some impact is anticipated on the transport linkage of the area due to movement of vehicles for bringing men and material to the site.

Mitigation

Through careful planning, the movement of the heavy vehicles will be scheduled to reduce load on existing traffic such that the peak hours will be avoided. All the vehicles approaching the site will be managed in such a way that long waiting times along the access road is avoided.

10.4 ENVIRONMENTAL MANAGEMENT PLAN FOR OPERATION PHASE

10.4.1 Land Environment

During the operation phase of the project, the land may get polluted/ contaminated due to littering of municipal wastes, leakage of leachates and due to fly ash or bottom ash.

Mitigation Measures

- It is proposed to establish a well-planned solid waste collection, storage and segregation system at site to avoid soil pollution for the project.
- Only covered trucks will be allowed to enter the premises for unloading MSW. Good housekeeping practices will help minimize contamination of soil in the project site.
- The generated bottom ash will be brought to the bottom ash processing plant. After the processing, materials which are not recyclable will be sent to the specified Sanitary Landfill for this purpose.

10.4.2 Air Environment

Fugitive Emissions

Fugitive emission may take place due to vehicles movement and handling of fly ash.

Mitigation Measures

- Regular water sprinkling will be done in the ash handling area especially during dry season.
- Proper route management of the traffic will be done for smooth ingress and egress of increased traffic.
- Supervisors will be appointed to regulate the traffic at the project site and drivers will be properly trained.
- Speed breakers will be constructed within the site to slow down the traffic and to avoid accidents.
- Signposts will be erected at the sensitive locations to caution or provide information to road users.
- All vehicles having a PUC certificate will only be allowed.

Stack emission

- Stack emission pollution control devices, Flue gas cleaning system (FGCS) for particulate matter and gaseous pollutants will be installed. Details of FGCS are given in Chapter -2 of the report. Online stack emission monitoring devices will be installed and data will be displayed at the entry gate of the plant.

Odour Control

- MSW storage pit will be kept under negative pressure and the suction air will be sent to the Boiler.
- For odour control, sprinkling of fragrance liquid through fogging nozzle.
- Sprinkling of Bio-inoculum which is a consortium of microorganisms called EM culture will be used for effective odour control.

10.4.3 Water environment

During the operational phase, water demand of 625 KLD will be met from PPCL/Treated Sewage from DJB for Industrial use whereas domestic water of 7 KLD will be supplied by DJB. Approx. 360 KLD of wastewater including leachate and sewage will be generated which will be treated in the Effluent Treatment Plant (ETP).

Mitigation

- The Complete water system has been designed on Zero Liquid discharge concept and there will be no effluent discharge from premises.
- Effluents generated from DM plant and cooling system blow down etc. will be brought to neutralization pit. After neutralization, it will be used for FGCS cooling and service water for floor washing, sprinkling on road and other general purposes. The treated water from Leachate treatment plant will be recycled to DM Plant and rejects for quenching of bottom ash. Thus, no effluent is proposed to be discharged outside the premises.
- The leachate will be treated in leachate treatment plant based on conventional technology.

10.4.4 Noise Environment

During operation phase, the main noise generating sources will be turbines, generators, boilers feed pumps, air compressors, cooling tower, etc.

Mitigation Measures

- The various machines will be designed to keep noise level at 85 dB at a distance of one meter.
- High noise generating machinery will be provided proper enclosure to attenuate noise level.
- Persons handling noisy equipment or working in noisy places will be provided with ear plugs and earmuffs.
- To achieve the far field noise, various noise generating equipment will be fitted with appropriate devices to control the noise levels e.g. steam vent pipes shall be fitted with silencers.

10.4.5 Ecological Impact & Mitigation Measures

To minimize the ecological impact, following measures will be implemented:

- Air pollution control system will be designed to comply with regulatory emission standards, for the project. The predicted incremental values of air pollutants during operation of the plant are very low.
- Proper landscaping and greenery will be done in the plant premises to improve aesthetics.
- A Greenbelt Development Plan has been proposed in 40% of the total project area, equivalent to 6 acres (2.43 hectares) of land**.** Plantation will be done in consultation with local Forest Department.

10.4.6 Solid Waste Management

During operational phase, approx. 121 Kg of MSW will be generated which will be handled properly and utilized in-house in the Waste to Energy project as fuel.

Less than 20 % of Ash will be generated as Solid Waste from the WtE Plant. The ash generated will be utilized for various purposes and the unutilized ash will be sent to secured landfills site designated by MCD.

10.4.7 Transport Linkage and Traffic

Currently, approximately 2400 TPD waste is collected from S. P, Karol Bagh, and Narela Zones of the City, and it is disposed of at the Bhalswa landfill site. The distances from City SP to Bhalswa landfill, Karol Bagh, and Narela are approximately 11 km, 10 km, and 14 km, respectively. The average transportation distance is around 12 km from these three zones to the Bhalswa landfill.

Upon the establishment of the Waste-to-Energy (WtE) facility, the waste from the mentioned zones will be redirected to the facility. The distances from City SP, Karol Bagh, and Narela to the WtE facility are approximately 16 km, 14 km, and 6 km, respectively. The average transportation distance will still be around 12 km from these three zones to the WtE facility.

Consequently, the average distance travelled by waste in transportation will remain unchanged even after the WtE facility is operational. The fuel consumption for the transportation of Municipal Solid Waste (MSW) will also remain consistent, and there will be no additional impact on ambient Air Quality.

Mitigation Measures

Through careful planning, the movement of the heavy vehicles will be scheduled to reduce load on existing traffic such that the peak hours will be avoided. It shall also be ensured that all the vehicles to the site will be handled in such a way that there is no waiting time along the access roads.

10.5 EMP IMPLEMENTATION

During construction phase, water sprinkling at site, maintenance of vehicle and equipment, arrangement of water supply, provision of safe environment condition for labours, disposal of construction debris, proper management of waste generated from labour camp will be handled by construction group. Provision of acoustic enclosure, PPE, training to workers will be handled by EHS department of the company.

During the operation phase of the project, operation and maintenance of all the air, water and noise control system including FGCS, ash handling will be carried out by O&M Department in association with Environment Management Cell (EMC). Safety trainings to the workers, control of fire hazard, laboratory and green belt development will be handled by EMC in association with safety department.

For the effective and efficient functioning of air pollution control systems such as FGCS & SNCR, a maintenance Schedule has been framed, details of which are mentioned in **Table 10.2.**

Table 10.2: FGCS & SNCR Maintenance Schedule

Sr. No.	LOCATION	DESCRIPTION	PREVENTIVE MAINTENANCE SCHEDULE
1	FGCS	FLUIDISATION AIR BLOWER -1 FGCS	MONTHLY
2	FGCS	FLUIDISATION AIR BLOWER -2 FGCS	MONTHLY
3	FGCS	FLUIDISATION AIR BLOWER -3 FGCS	MONTHLY
4	FGCS	RAV AIR SLIDE-1 FGCS	MONTHLY
5	FGCS	RAV AIR SLIDE-2 FGCS	MONTHLY
6	FGCS	RAV-BELOW SCREW CONV. GCT FGCS	MONTHLY
7	FGCS	RAV-BELOW SCREW CONV. T/R FGCS	MONTHLY
8	FGCS	SCREW CONVEYOR GCT FGCS	MONTHLY
9	FGCS	SCREW CONVEYOR TURBO REACTOR FGCS	MONTHLY
10	FGCS	TRANSPORT BLOWER-1 TURBO REACTOR FGCS	MONTHLY
11	FGCS	TRANSPORT BLOWER-2 TURBO REACTOR FGCS	MONTHLY
12	FGCS	CAGE & BAG INSPECTION	QUATERLY
13	FGCS	CAGE & BAG REPLACEMENT	AS PER REQUIREMENT
14	ASH SILO	FLUDIZATION BLOWER-1 ASH SILO	MONTHLY
15	ASH SILO	FLUDIZATION BLOWER-2 ASH SILO	MONTHLY
16	ASH SILO	FLUDIZATION BLOWER-3 ASH SILO	MONTHLY
17	ASH SILO	UN LOADING DEVICE ASH SILO	MONTHLY
18	ASH SILO	UNLOADING RAV-1 ASH SILO	MONTHLY
19	SORBENT DOSING SYSTEM	DE DUSTING FILTER FAN HOC SILO	BI-MONTHLY
20	SORBENT DOSING SYSTEM	DE DUSTING FILTER FAN LIME SILO	BI-MONTHLY
21	SORBENT DOSING SYSTEM	HOC LOADING RAV	MONTHLY
22	SORBENT DOSING SYSTEM	TRANSPORT BLOWER HOC LOADING RAV	MONTHLY

Sr. No.	LOCATION	DESCRIPTION	PREVENTIVE MAINTENANCE SCHEDULE
23	SORBENT DOSING SYSTEM	LIME LOADING RAV	MONTHLY
24	SORBENT DOSING SYSTEM	TRANSPORT BLOWER LIME LOADING RAV	MONTHLY
25	SORBENT DOSING SYSTEM	RAV (HOC SILO)-1 FGCS ADIS	MONTHLY
26	SORBENT DOSING SYSTEM	RAV (HOC SILO)-2 FGCS ADIS	MONTHLY
27	SORBENT DOSING SYSTEM	RAV (LIME SILO)-1 FGCS ADIS	MONTHLY
28	SORBENT DOSING SYSTEM	RAV (LIME SILO)-2 FGCS ADIS	MONTHLY
29	SORBENT DOSING SYSTEM	SCREW CONV. (HOC SILO)-1 FGCS ADIS	MONTHLY
30	SORBENT DOSING SYSTEM	SCREW CONV. (HOC SILO)-2 FGCS ADIS	MONTHLY
31	SORBENT DOSING SYSTEM	TRANSPORT BLOWER-1 FGCS ADIS	MONTHLY
32	SORBENT DOSING SYSTEM	TRANSPORT BLOWER-2 FGCS ADIS	MONTHLY
33	SORBENT DOSING SYSTEM	TRANSPORT BLOWER-3 FGCS ADIS	MONTHLY
34	SNCR	SNCR BUCKET ELEVATOR	MONTHLY
35	SNCR	BLENDER	MONTHLY
36	SNCR	UREA SHIFTING PUMP-1&2	MONTHLY
37	SNCR	UREA DELIVERY PUMP-1&2	MONTHLY
38	SNCR	SEAWAGE PUMP	MONTHLY

10.5 INSTITUTIONAL ARRANGEMENT

The Environment Management Cell plays a crucial role in ensuring sustainable practices, compliance with regulations, and harmonizing economic, environmental, and social aspects. Environment Management Cell will be created for the smooth functioning of environmental issues. The hierarchy of the Environment Management Cell is given below in Figure 10.1:

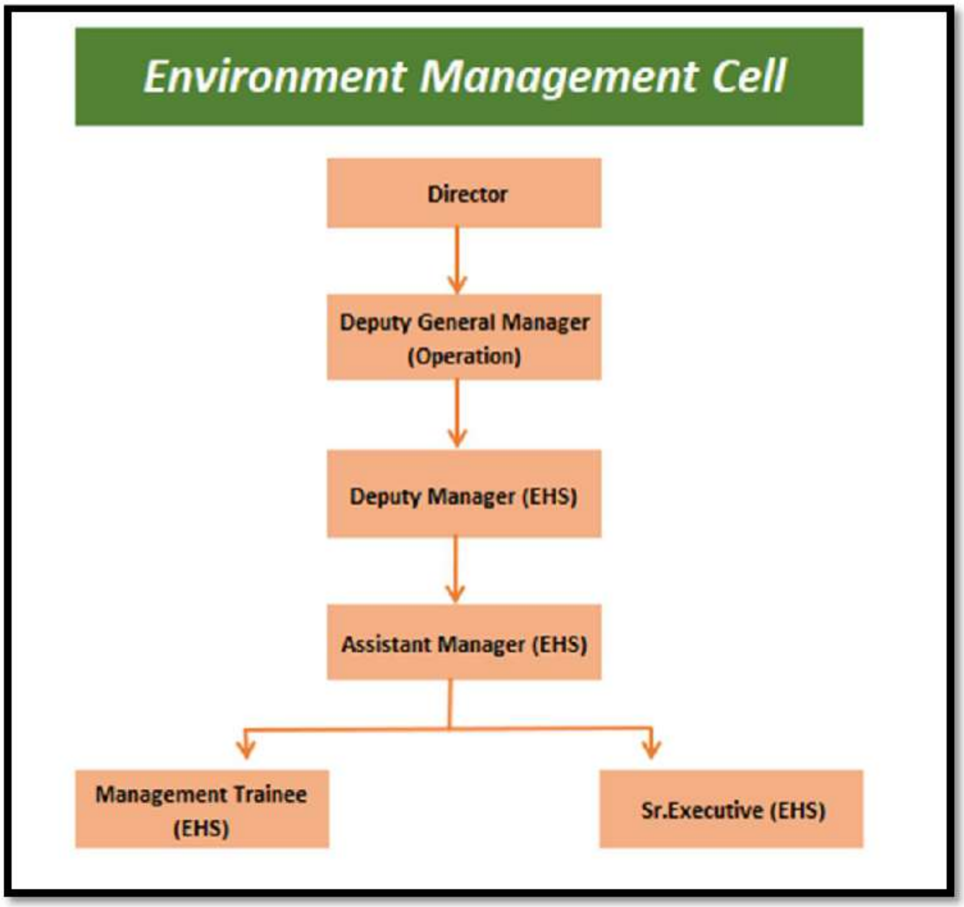

Fig No. 10.1: Institutional Arrangements

10.7 AWARENESS & TRAINING

Environmental awareness & training of human resource development is an important link to achieve sustainable operation of the facility and environmental management. For successful implementation of the EMP plan, relevant EMPs need to be communicated to the staff. Relevant personnel at site must be trained for the following:

- Functioning of the Environmental Management System including environmental monitoring, reporting and documentation needs.
- Applicable environmental, health and safety regulations and compliance requirements for the same.
- Techniques for waste minimization, water conservation and energy conservation.
- Operations and maintenance of various air and water pollution control system.
- Requirements of the Disaster/Emergency Management Plan in case of an emergency.

10.8 RECORD KEEPING & REPORTING

Record keeping and reporting of performance is an important management tool for ensuring sustainable environmental operation of the industry. Records will be maintained for regulatory, monitoring and operational issues. Typical record keeping particulars for the plant site are summarized in **Table-10.3.**

Table 10.3 RECORD KEEPING PARTICULARS

Parameter	Particulars
Solid Waste Handling and Disposal	Daily quantity of waste handling Weight & No of trucks
Regulatory Licenses (Environmental)	Environmental Permits / Consents from SPCB / MoEF&CC& concern authority.
Monitoring and Survey	Records of all monitoring carried out as per the finalized monitoring protocol.
Accident reporting	• As per SWM Rules 2016, Form -6, Date and time of the accident. • Sequence of events leading to accident. • Chemical datasheet, assessing effect of accident on health and environment Emergency measure taken Step to prevent recurrence of such events
Other	• Log book of complaints

Parameter	Particulars
	• Employee health and safety records • Equipment inspection and calibration records. • Vehicle maintenance & inspection records • Records of the plantation activities.

Any defect in the operation of pollution control equipment, deviation of environmental monitored data with respect to prescribed standards, accident or breach of safety aspect will be immediately brought to the notice of Head of the plant for required corrective measures**.**

10. 9 GREENBELT DEVELOPMENT PLAN

10.9.1 Introduction

The green belt development plan aims to improve the overall environmental conditions of the industrial complex. The plan addresses issues such as the prevention of land degradation due to activities during the construction phase, increasing the green cover of the area, enhancing the aesthetic value of the project area, and maintaining the ecological equilibrium of the area. Planting trees strategically can significantly improve air quality, reduce noise pollution, and enhance overall environmental health in urban and industrial areas.

Trees also help in removing carbon dioxide and other pollutants from the air and release oxygen into the air, thereby improving air quality. A green belt development helps in removing particulate matter from the air by trapping particulate matters. A green belt also reduces the intensity of sound and acts as a noise barrier. Thus, green belts in and around urban and industrial areas are important to the ecological health of any given region. It is recommended to raise plantations and develop green belts in the maximum available land around the project site.

In view of the above, an elaborate plantation plan has been chalked out for this project. It is proposed to raise greenbelt development in 40% of the total project area, equivalent to 6 acres (2.43 hectares) of land**.** The proposed area of the project where plantation will be undertaken, is shown in green color in the layout map (**Figure 10.2).** Plantation will be done in consultation with local Forest Department.

As per the Terms of Reference (ToR) approved by the Ministry of Environment, Forest and Climate Change (MoEF&CC), the plan includes planting 2000 trees per hectare within both the project site and its surroundings in 10km area. A total of 4860 trees will be planted across the project site.

In addition, an extensive plantation will also be undertaken within the 10km study area, focusing on areas near water reservoirs, schools, hospitals, and other institutional locations including Nallah/Streams during implementation of the project. A detailed survey of these areas will be carried out to identify the quantum of land available for plantation. Suitable tree species will be selected in consultation with the forest department for plantation in different identified locations. Accordingly, a detailed plan will be chalked out in consultation with concerned institutions for implementing the plantation program. Adequate funds will be allocated for implementing this additional plantation.

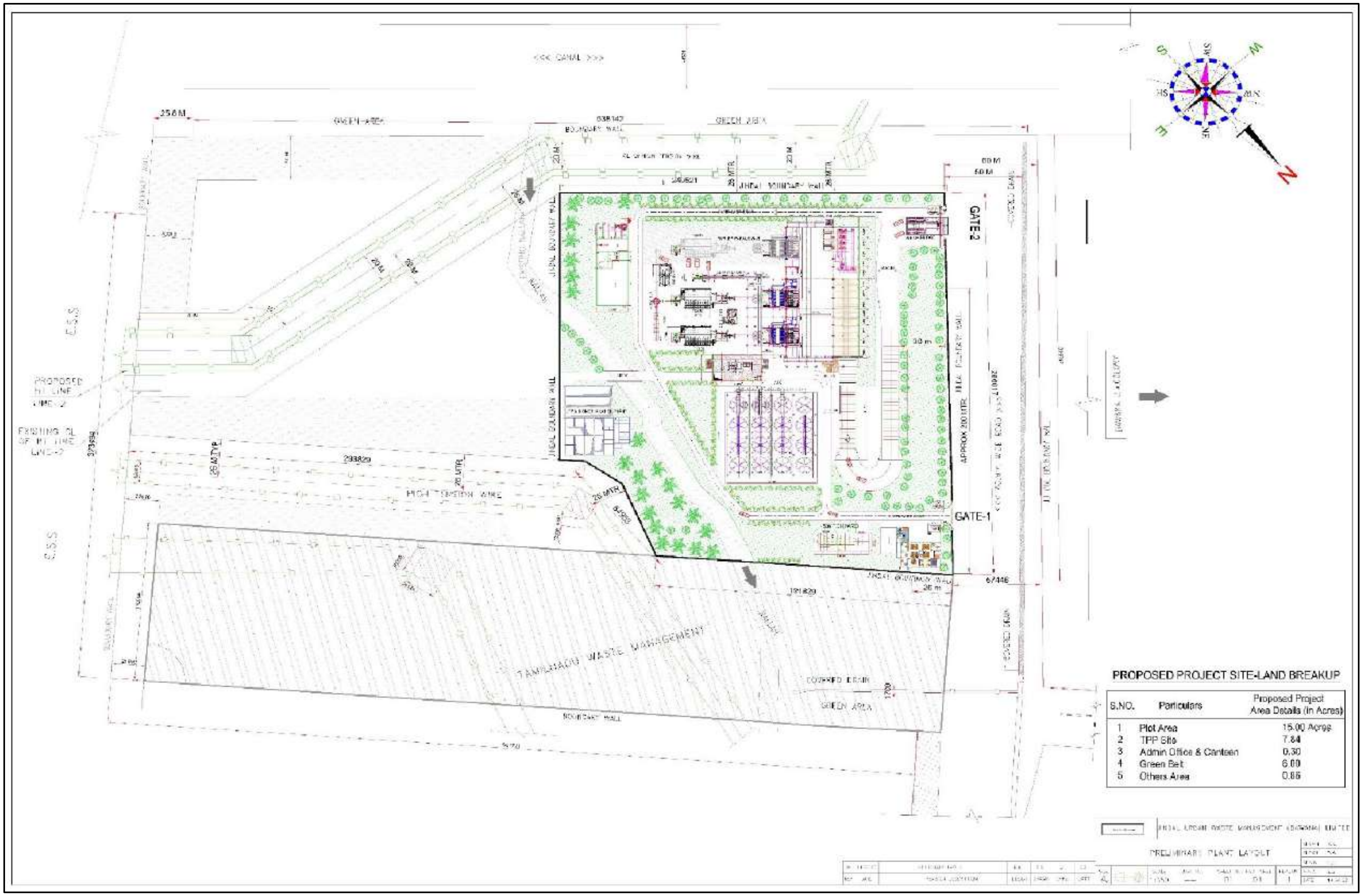

Figure 10.2: The proposed area of the project where plantation will be done, is shown in green color in the layout map

10.9.2 Plantation technique

Green Belt design and development have become highly significant and are now a crucial aspect of planning policy. The primary purpose of the green belt is to act as a buffer zone between pollution sources and surrounding areas. The green belt will be established using suitable plant species, as recommended by CPCB guidelines, to mitigate air pollution, improve aesthetics and improve the biodiversity of the study area.

1. **Preparation of Pits**
    a. Pits of dimension (0.3 m x 0.3 m) are typically dug in advance, preferably during the March to April months before the planting season begins. This allows sufficient time for soil conditioning and nutrient incorporation. Plantation will be carried out as per CPCB/MoEF&CC guidelines.
    b. The topsoil from the pits is set aside and exposed to sunlight, which helps in maintaining its nutrient content and microbial activity.
2. **Nutrient Placement:**
    a. Before refilling the pits, fertilizers or organic manures are applied to the bottom and sides of each pit.
    b. The type and quantity of nutrients applied depend on soil analysis and specific requirements. Commonly used fertilizers include nitrogen (N), phosphorus (P), and potassium (K), either in chemical forms or as organic compost.
3. **Mixing and Incorporation:**
    a. The dug-out soil is carefully mixed with the fertilizers or organic matter to ensure even distribution.
    b. This enriched soil mixture is then used to refill the pits, with the nutrient-rich topsoil placed at the bottom and the remaining soil layered on top.
4. **Root and Debris Removal:**
    a. Before refilling, all roots, stones, and debris are thoroughly removed from the soil to prevent hindrance to plant root growth and establishment.
5. **Plantation and further Maintenance**

a. Plantation will be carried out as per CPCB/MoEF&CC guidelines.
b. Provision for regular watering of planted trees will be made.
c. Dead species will be replaced immediately.
d. The plantation needs to be monitored regularly by watering, weeding, application of manure and impart proper protection.

6. Selection of Plant Species

The selection of plant species for the green belt development depends on various factors such as climate, elevation aspect and soil of plantation area. The plants would exhibit the following desirable characteristics in order to be selected for plantation:

- The species should be fast growing and providing optimum penetrability.
- The species should be wind-firm and deep rooted.
- The species should be indigenous and locally available.
- Species tolerance to air pollution like SO_2 and NO_2 should be preferred.
- The species should be permeable to help create air turbulence and mixing within the belt.
- Trees should be with high foliage density, dense canopy leaves with larger leaf area and hairy surfaces
- Ability to withstand conditions like inundation and drought.
- Attractive appearance with good flowering and fruit bearing trees.
- Bird and insect attracting tree species.
- Trees having sustainable green cover with minimal maintenance and soil improving properties (Nitrogen fixing, rapidly decomposable leaf litter) will be preferred for plantation.

Guidelines to be considered during plantation:

- Planting trees in each row will be in staggered orientation.
- In the front row, shrubs will be grown. Since the trunks of the tall trees are generally devoid of foliage, it will be useful to have shrubs in front of the trees to give coverage to this portion.

- The spacing between the trees will be maintained slightly less than the normal spaces, so that the trees may grow vertically and slightly increase the effective height of the green belt.
- Shrubs and trees will be planted in encircling rows around the project site.
- The short trees (<10 m height) will be planted in the first rows (towards the plant side) of the green belt. The tall trees (>10 m height) will be planted in the outer row.
- The names of various tree species recommended for plantation at the project site and other places in 10 km study area are given in **Table 10.4.**

Table 10.4: Name of Tree Species for plantation

S. No.	Scientific name	Common Name	Type	Reason
1	*Ailanthus excelsa*	Maharukh / Adu Neem	Tree	Pollution Sink, Noise Barrier
2	*Alstonia scholaris*	Saptaparni	Tree	Pollution Sink, Aesthetic Value, Medicinal Value
3	*Azadirachta indica*	Neem	Tree	Noise barrier, Pollution sink, Economic & Medicinal Value
4	*Bombax ceiba*	Semal	Tree	Aesthetic Value, Economic Value
5	*Butea monosperma*	Dhak	Tree	Aesthetic value, Pollution sink
6	*Calistemon viminalis*	Bottle Brush	Tree	Aesthetic value, Pollution Sink
7	*Cassia fistula*	Amaltas	Tree	Landscaping, Flowering plant, Pollution sink, Medicinal Value
8	*Dalbergia sissoo*	Sheesham	Tree	Economic Value, Pollution Sink
9	*Ficus bengalensis*	Bargad	Tree	Noise barrier, Pollution sink, Medicinal Value & Religious value
10	*Ficus religiosa*	Peepal	Tree	Noise barrier, Pollution sink, Religious values
11	*Melia azedarach*	Bakain	Tree	Noise Barrier, Pollution Sink, Economic and Medicinal Value
12	*Moringa oleifera*	Sahajana	Tree	Economic Value, Medicinal value
13	*Pongamia pinnata*	Karanj	Tree	Economic and Medicinal Value
14	*Syzygium cumini*	Jamun	Tree	Pollution sink, Economic Value
15	*Tamarindus indica*	Imli	Tree	Noise barrier, Pollution sink, Economic & Medicinal Value
16	*Tecomella undulata*	Rohira	Tree	Aesthetic Value, Economic and Medicinal Value

S. No.	Scientific name	Common Name	Type	Reason
17	*Terminalia arjuna*	Arjun	Tree	Noise barrier, Pollution sink, Medicinal Value
18	*Bougainvillea spectabilis*	Bougainvillea	Shrub	Landscaping, Flowering plant, Pollution sink
19	*Nerium oleander*	Oleander	Shrub	Landscaping, Flowering plant, Pollution sink
20	*Tecoma stans*	Tecoma stans	Shrub	Landscaping, Flowering plant, Pollution sink

10.9.3 Cost estimate for plantation

The average rate for planting a tree has been considered is INR 350/-. Thus, for a total of 4860 trees, INR 17, 01,000/- and recurring cost INR 51030/- is proposed for plantation details are given in **Table 10.5.**

Table 10.5: Year wise plantation plan along with cost

Year	Number of Saplings	Capital cost (INR)	Recurring cost (INR)
2024-2025	1000	350000	20500
2025-2026	1500	525000	25750
2026-2027	2360	826000	44780
Total	**4860**	**1701000**	**91030**

The project aims to enhance the environmental quality of the project site and its surrounding areas by planting trees and creating green spaces. This initiative not only contributes to environmental sustainability but also aligns with regulatory requirements and enhances the overall landscape around the WtE facility.

10.10 CORPORATE ENVIRONMENT RESPONSIBILITY (CER):

The CER activities including its cost of implementation will be finalized after Public Hearing. The details of CER will be included in the final EIA report.

10.11 ENVIRONMENT MANAGEMENT COST

The estimated cost of EMP is given in **Table 10.6.**

Table No. 10.6: Environment Management Cost

S. No.	Particulars	Equipment's/Measures Taken-other	Capital Cost (in Crores)	Recurring Cost per annum (in Crores)
1	Air Pollution Control	Flue Gas Cleaning System, Anti-Smog Gun	49.505	11.000
2	Water Pollution Control	WTP & LTP installation & operating cost.	31.400	2.200
3	Noise Pollution Control	Acoustic enclosures & Personal Protective Equipment.	No extra capital investment is required for NPCS to be purchased with noise compliance	0.500
4	Environment Monitoring and Management	• OCEMS/CAAQMS installation & Maintenance, Monitoring of Stack emissions.	3.000	0.170
		• Manual Environmental and Stack Monitoring	0.14	---
5	Occupational Health	Provision of OHC for working personnel.	0.200	0.150
6	Green Belt	Pursuant to Battery Limit intensifying the greeneries inside and outside of the project site.	0.170	0.091

S. No.	Particulars	Equipment's/Measures Taken-other	Capital Cost (in Crores)	Recurring Cost per annum (in Crores)
7	Wildlife Conservation Plan	Activities under biodiversity and habitat conservation	0.540	---
8	Others (Odour control management + Sanitization)	High Pressure Pump, Nozzle and its accessories for fogging unit/mist system & herbal solution spray.	0.050	0.084
Total			**85.005**	**14.195**

CHAPTER-11. SUMMARY AND CONCLUSION

11.1 INTRODUCTION

The advent of industrialization, urbanization, and population growth has led to an increase in the generation of municipal waste. The amount of waste generated through households, agriculture, and industries in our country is linked to population increase and rising GDP. The gigantic amounts of waste that are hauled to dumps and accumulate in heaps and open pits have become a major environmental issue. Sanitary Land filling is still the world's most widely used method for disposal of MSW. This practice has detrimental effects on the environment such as land degradation, greenhouse gas (GHG) emissions, groundwater pollution, odor, and aesthetics. The landfill site has collapsed sometimes due to over dumping of waste and exceeding the stipulated MSW mound height. In fact, land filling is inappropriate method for managing the municipal solid waste whereas Waste to Electricity is the most environment friendly method for managing municipal solid waste.

Waste collected in general contains a large amount of non-biodegradable material. Waste-to-Energy (WtE) encompasses methods to extract the valuable energy entrapped in waste to produce heat and electricity. It is a source of renewable energy. Therefore, energy-from-waste contributes to energy optimization and contributes to the growing demand for renewable energy in a carbon constrained world.

The objectives of this project are as follows:

1. Waste to Energy as a part of Green Energy Initiative.
2. To reduce the problem associated with disposal of unprocessed waste at landfill and to meet the objective and goal set for the country under the **Swachh Bharat Abhiyan (SBA).**
3. To minimize the MSW load going to landfill site through utilizing in electricity generation.
4. Utilization of reclaimed RDF from SLF.

North-West Delhi metropolitan city has witnessed rapid urbanization and industrialization in the past decade. JINDAL URBAN WASTE MANAGEMENT (BAWANA) LIMITED has proposed to set up a 30 MW WTE Project at Bawana, Delhi which will handle 3000 TPD of waste. The proposed project is an initiative of MCD.

The ToR for preparation of EIA report has been accorded by the MoEF&CC vide letter J-

13012/04/2023-IA.I (T) dated 10/01/2024. The EIA report has been prepared as per approved ToR and following the generic structure of EIA report mentioned in the EIA Notification, 2006.

The EIA study includes: -

- Compilation of baseline, environmental and social scenario of the study area within a radius of 10 km around the project site based on field studies and secondary data collected from the authorized source /Govt. agency.
- Identification, prediction and evaluation of potential environmental impacts expected during the construction and operation phase of the project.
- Preparation of mitigation measures, Environmental Management Plan (EMP) and Monitoring Program for implementation to be adopted during construction and operation phase.

The work of the preparation of EIA report has been awarded to M/s Mantec Consultant, Noida which is a QCI/ NABET accredited company for preparing EIA report.

11.2 PROJECT DESCRIPTION

Waste to Energy Project (30MW) at DSIIDC Industrial Area, Sector-5, Bawana, Delhi-110039. The vicinity map of the project site depicting 10Km radius study area is given as **Figure 11.1.** The project will be implemented by M/s Jindal Urban Waste Management (Bawana) Limited. The salient features of the project are given in **Table 11.1**.

Table 11.1: Salient Features of the Project

S. No.	Information	Details
1	Project name	Proposed Waste to Energy Project (30 MW) at DSIIDC Industrial Area, Sector-5, Bawana, Delhi.
2	Name of project Proponent	M/s Jindal Urban Waste Management (Bawana) Limited.
3	Capacity	30 MW
4	General Conditions	Delhi-Haryana State boundary is located at the distance of 4.48 Km in NNW direction.
5	**Site Location**	
	Village	Bawana
	District	North Delhi
	State	Delhi

S. No.	Information	Details
6	Land Requirement	15 Acres
7	Fuel (MSW)	3000 TPD of MSW
8	Water Requirement	• **During Construction phase**–40 KLD Industrial water will be met from Pragati Power Corporation Limited (PPCL)/Treated Sewage from Delhi Jal Board. • **During operation phase**- 625 KLD Industrial water will be met from Pragati Power Corporation Limited (PPCL)/Treated Sewage from Delhi Jal Board. • **Domestic water:** Domestic water of approx. 10 KLD during construction and approx. 7 KLD during operation phase will be required. This water will be supplied by DJB.
9	Construction Power Supply and its Source	The nearest construction power source is Tata Power Delhi Distribution Limited (TPDDL). No DG set will be used during construction phase. The 750 KVA DG set will be used during operation phase only in case of grid failure.
10	Employment Opportunity	**Employment potential:** • **During the construction phase:** Employment (Contract): 570 Nos On Roll:60 Nos **Total (On Roll + Contract): 630 Nos.** • **During the operational phase:** Contract: 156 Nos On Roll: 86 Nos **Total (On Roll + Contract): 242 Nos.**
11	Nearest Railway Station	Narela Railway Station~6.06 Km in NE direction
12	Nearest Airport	Indira Gandhi Airport, ~ 26.81 Km in South direction.
13	Project Cost	Estimated Cost of the Project Rs 660.00 Crore.

Proposed Fuel: Refused Derived Fuel (RDF) prepared from Municipal Solid Waste.

Technology: Reverse acting reciprocating forwarding grate type boiler and steam turbo-generator for power generation (Rankine cycle).

Design capacity of MSW fuel preparation plant: 3000 TPD.

11.3 Environmental Sensitivity

The brief of the site and its surrounding area including connectivity are given in the **Table 11.2.** The site has good connectivity with various transport facilities.

Table 11.2: Environmental Sensitivity around 10km Area

PARTICULARS	DETAILS
Inter-State Boundary of Haryana	Delhi-Haryana border approx. 4.48 km in NW direction.
Nearest State Highway/ National Highway	❖ NH-44~ 7.33 Km in East direction ❖ SH-18 ~ 4.64 Km in East direction ❖ UER-II~ 1.39 Km in SE direction
Seismic Zone	Zone-IV (As per IS 1893:2002)
Water Body	Western Yamuna Canal is located at approx. 32 meters from the project site in South West direction
Ecological Sensitive Areas (National Park, Wildlife Sanctuary, Biosphere Reserve, Reserve/ Protected Forest etc.) within 10 Km radius	❖ Ghoga RF: 3.12 Km in North direction ❖ Bawana RF: 1.70 km in North direction. ❖ Sultanpur RF: 4.29 km in SW direction ❖ Narela RF: 9.01km in NE direction. ❖ There is no National Park, Wildlife Sanctuary etc. within 10 km radius.
Areas occupied by sensitive manmade land uses (hospitals, schools, places of worship, community facilities	❖ Sandhyashi Hospital is located at a distance of 1.26 Km in the East direction. ❖ Jivan Hospital is located at a distance of 1.32 Km in NW direction. ❖ Bawana MCD Hospital is located at a distance of 2.46 Km in WNW direction. ❖ Siddhartha Hospital is located at a distance of 2.1 Km in the W direction. ❖ St. Omina Public School is located at a distance of 1.26 Km in East direction. ❖ Rana Public School is located at a distance of 7.35 Km in SE direction.

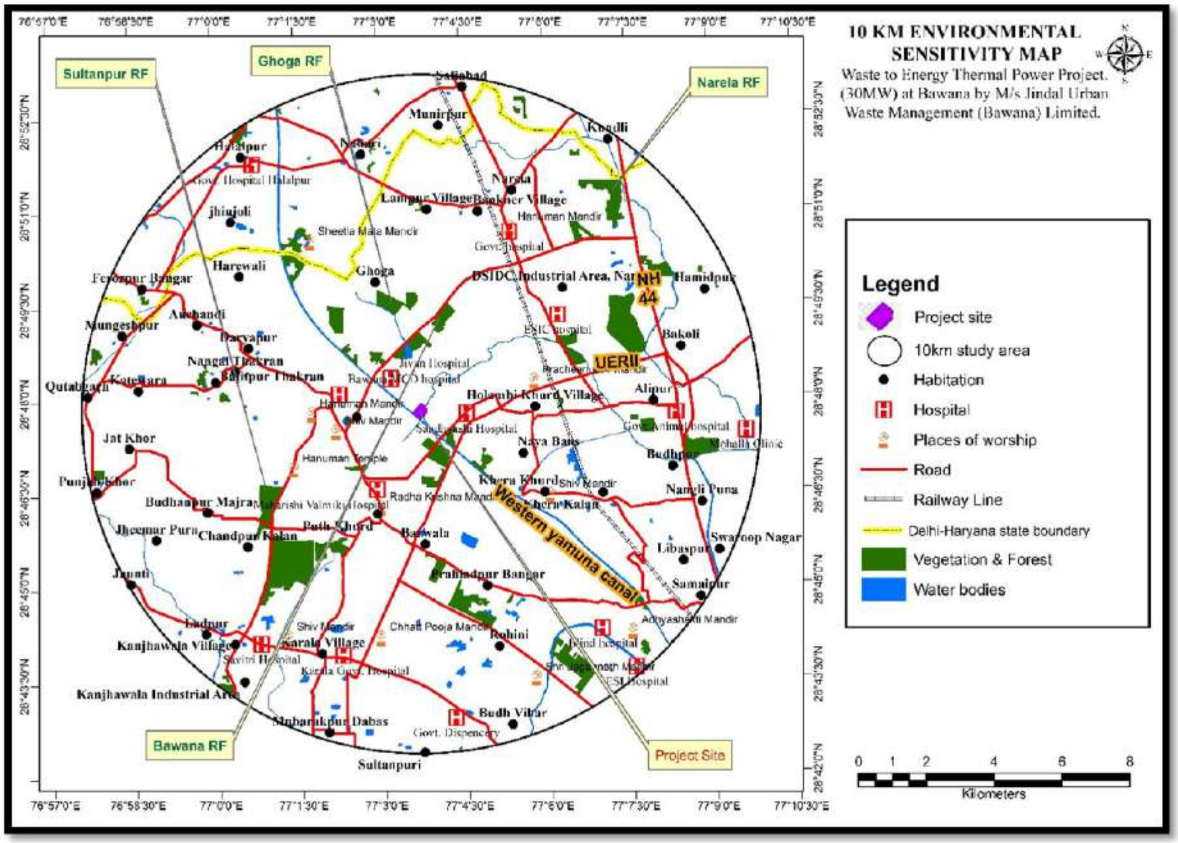

Figure 11.1: Sensitivity Map of 10km for Waste to Energy Plant, Bawana

11.4 Baseline environmental condition

The baseline environmental condition was monitored within the 10km study area with respect to meteorology, ambient air quality, noise levels, water quality, soil quality, biological environment and socioeconomic conditions.

11.4.1 Meteorology

The climate of NCT Delhi is mainly influenced by its land position and the prevalence of air of the continental type during major time of the year. Extreme dryness with the intensely hot summer and cold winter are the characteristics of the climate. The mean maximum annual temperature is 44.2°C and lowest mean temp is 3.5°C. The average annual mean humidity is 64 %. The mean maximum wind Speed is 25km/h and the mean minimum wind speed is 18km/h. The Maximum relative humidity is 66% and the minimum relative humidity is 18.5%.

11.4.2 Ambient Air Quality

The results of Ambient Air Quality Monitoring across 8 stations indicate varying concentrations of pollutants. The particulate matter, PM_{10} concentrations ranged from a minimum of 77.0 µg/m³ to a maximum of 380.0 µg/m³, while $PM_{2.5}$ levels varied between 46.0 µg/m³ and 228.0 µg/m³. Both the $PM_{2.5}$ (228.0 µg/ m³) and PM_{10} (380.0 µg/m³) were recorded highest at AAQ3 (Near Vaishno Devi Mandir Khera Kalan Delhi).

In terms of gaseous pollutants, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO), all remained within permissible limits set by the National Ambient Air Quality (NAAQ) Standards for residential and rural areas. The concentrations of NO_2 ranged from 14.0 µg/m³ to 32.0 µg/m³, SO_2 from 5.0 µg/m³ to 18.0 µg/m³, and CO from 0.52 mg/m³ to 0.84 mg/m³. Furthermore, the concentrations of mercury (Hg) were found to be below the detection limit (BDL). This is reassuring from a health perspective, as mercury contamination in ambient air can pose significant risks to human health and ecosystems.

11.4.3 Noise Environment

The noise levels were monitored at 8 locations. Day time noise levels ranged from 42.6 to 54.8 decibels (dB), while night time noise levels ranged from 36.2 to 42.6 dB. The higher daytime levels are attributed to construction, operations and vehicular movements, which are more active during the day. Conversely, nighttime noise is lower due to reduced activity during those hours.

11.4.4 Water Environment

11.4.4.1 Ground Water Quality

The ground water quality data was monitored at 8 locations. The pH ranges from 6.94 to 7.58 which is well within the specified standard of 6.5 to 8.5. TDS ranged from 232 to 698 mg/L. The chlorides ranged from 62 to 84 mg/L. The sulphate ranged from 44 to 58 mg/L and total hardness ranged from 134 to 250 mg/L. Iron is found less than 0.03 mg/L.

11.4.4.2 Surface Water Quality

The surface water quality was monitored at 8 locations. Monitored data of surface water pertaining to all the locations reveal that pH values ranged from 7.02 to 7.34, TDS ranged from 278 to 311 mg/L. Sulphate ranged from 26 to 46 mg/L, Total hardness ranged from 130 to 196 mg/L. COD ranged from 40 to 84 mg/L and BOD ranged from 10 to 20 mg/L.

11.4.5 Land Environment

The Land use pattern based on satellite imagery is given in **Table 11.3**.

Table No. 11.3: Land use pattern based upon the Satellite imagery within 10 km radius

S. No.	Class Name	Area in Hectares	Percentage
1	Agricultural Area	16977.593	53.208
2	Built-up	13375.821	41.92
3	Natural Vegetation	293.553	0.92
4	Water Body	220.803	0.692
5	Barren Land	1040.200	3.26
Total		**31907.97**	**100**

11.4.6 Soil Characteristics

The soil of the study area is characterized as Sandy Loam, which is known for its balanced mixture of sand, silt and clay particles, offering good drainage. pH value ranges from 6.22 to 7.66. Additionally, organic matter content was measured between 1.23% to 1.74%, indicating moderate levels that contribute to soil fertility and structure.

Nitrogen levels ranged from 311.58 kg/ha to 366.46 kg/ha, phosphorus concentrations varied between 13.89 kg/ha to 19.94 kg/ha and potassium content ranged from 191.74 kg/ha to 231.62 kg/ha. Copper ranged from 3.998 mg/kg to 28.98 mg/kg, Manganese levels ranged from 47.55 mg/kg to 292.224 mg/kg, Zinc levels ranged from 11.005 mg/kg to 63.025 mg/kg.

11.4.7 Biological Environment

The project area is located near Bawana industrial area, hence the natural vegetation is confined in some small patches of four RF in the study area. The Western Yamuna canal is flowing at a distance of 32m in SW direction from the plant boundary. There is no ecologically sensitive area within 10km study area. The area has some plantation near project site and Western Yamuna canal. The main tree species include *Cassia seamea, Melia azedarach, Azadirachta indica, Eucalyptus sp., Acacia nilotica, Acacia leucophloea, and Pongamia pinnata*. Shrubs include *Calotropis procera, Nerium oleander, Tecoma stans* and among herbs, *Ageratum houstonianum, Chenopodium album, Parthenium hysterophorus, Argemone mexicana, Achyranthes aspera, Digitaria sp., Cynodon dactylon, Saccrum sp.* are dominant.

Roadside plantations include Ac*acia leucophloea, Dalbergia sissoo, Azadirachta indica, Terminalia arjuna, Ficus benghalensis*.

Three Schedule-I species namely species *Pavo cristatus, Herpestes javanicus* and *Accipiter badius* have been reported in the study area.

11.5 IMPACT ASSESSMENT AND MITIGATION

The impact of the project on different component of environment has been assessed and mitigative measures have been suggested.

11.5.1 Land use Environment

The proposed site has been earmarked for solid waste management facility by DDA in **Zonal Development Plan of Zone "P1" Narela.** The land demarcated for the proposed project is for industrial purposes. Hence, there will be no impact on land use pattern.

To prevent soil pollution, it is imperative to establish a well-planned solid waste collection, storage, and segregation system on site as outlined for the proposed project. Only covered trucks will be allowed to enter the premises for unloading of materials. Good house-keeping helps to control contamination of soil.

11.5.2 Air Environment

The baseline condition of air with respect to particulate parameter is already worst in the city of Delhi. Emission modelling results show that increment value due to proposed project is insignificant. Installation of air pollution control devices for particulate matter and gaseous pollutants will limit the stack emission within standards prescribed in MSW Notification, 2016. For effective Odour control, bio inoculums comprising of consortium of microorganism called EM culture will be mixed with the raw MSW for odor control.

In addition, the MSW storage pit will be kept in enclosed negative pressure with the air flow routed to the boiler which prevents unpleasant odour from escaping into the atmosphere. Additionally, a special fragrance liquid will be sprayed through a foggy nozzle for reducing odour.

11.5.3 Water Environment

No groundwater will be extracted for operation of the plant. STP treated water from DJB/ blowdown PPCL will utilized for proposed project during both construction and operation phase. Hence, there will be no impact on surface and ground water resources.

All the drains will be properly cemented to avoid contamination of groundwater. The project will be designed based on the zero liquid discharge concept. The wastewater will be reutilized in the plant premises after adequate treatment and there will be no effluent discharge from the plant. All the effluents from various sections will be brought to common collection pit for treatment.

11.5.4 Noise Environment

All the noise generating equipment of the plant will be designed with noise level up to 85dBA. Proper acoustic enclosures will be provided to the equipment generating high noise level. Necessary PPE, earplug/earmuff will be provided to the workers in high noise area.

11.5.5 Biological Environment

Since the project site is demarcated for industrial use, there will be insignificant biological impact during construction phase. The layout has been planned in such a way that no tree cutting takes place. The proposed project will install efficient air and water pollution control equipment to minimize impact on terrestrial and aquatic biological environment.

A greenbelt will be developed in and around the proposed project to increase the green cover in the area. A total number of 4860 plants as per ToR points to meet 40% plantation criteria. Local species with aesthetic appeal will be planted that will attract local bird and insect species. All the open spaces in the plant premises will be landscaped and brought under green cover after construction of the plant. A wildlife conservation plan has been framed for three Schedule –I species which will be implemented in consultation with forest department.

11.5.6 Socio Economic

The land for the project is in physical possession of MCD, hence no R&R is involved. The proposed project would create additional employment opportunities during construction and operation.

Overall benefit and impact are summarized below:

1. Reduction in ever increasing volume of Municipal Waste at Sanitary Landfill Site.
2. Increase in employment opportunities for youth.
3. Improvement in the hygienic and sanitary condition of the area.
4. Increase in availability of power.

5. Increase in revenue for the DISCOMs as well as to the local body.

11.6 ENVIRONMENTAL MONITORING PROGRAM

Environmental monitoring is important in terms of evaluating the performance of pollution control equipment installed during operation. The sampling and analysis of the environmental attributes will be as per the guidelines of CPCB. Following attributes will be covered in the environmental monitoring as per stipulation of SPCB:

1. Stack Emission
2. Ambient Air quality
3. Water and wastewater quality
4. Noise levels
5. Occupational Health Survey

11.7 RISK ASSESSMENT AND DISASTER MANAGEMENT STUDIES

Risk in general is defined as a measure of potential economic loss or human injury. Risk comprises of two variables: magnitude of consequences and the probability of occurrence. Few hazards and mitigation measures are mentioned below: -

11.7.1 Vehicular movement hazard

The vehicles have the potential to meet with an accident during the transit due to various reasons.

Mitigation measure

All the vehicles used during project construction and operation shall be of good quality and maintained by the trained drivers under the supervision of designated supervisors.

11.7.2 Health Hazards of employees/workman engaged at the MSW site

Direct handling of MSW could lead health hazards.

Mitigation measure

- There is no direct human contact with the incoming municipal solid waste.
- All the employees shall be trained and provided with adequate PPE to protect from the health hazards.

11.7.3 Hazards during Storage of MSW at Site

11.7.3.1 Fire

An adequate firefighting system will be provided for proposed project as elaborated in Chapter 7 of the EIA report.

11.7.3.2 Electrical Hazards during power generation

Electrical shock may occur to workers and employees during construction and operation of the project.

Mitigation measure

The safe design and construction practices will be practiced and followed during the entire phase of construction and operation.

All the workmen shall be trained and provided with appropriate PPE while performing electric related jobs.

11.7.4 Disaster Management Plan

A Disaster Management Plan has been suggested for implementation during emergency.

11.8 Environmental Management Plan

An elaborate Environmental Plan will be implemented for mitigating the various impacts. The plan includes the air and water pollution control equipment, odour management, occupational health, green belt development and wildlife conservation. The total estimated budget for various EMP activities is **99.2 Cr.**

A well-defined Environmental Monitoring Program for construction and operation phase has been chalked out for the project. An Environment Management Cell (EMC) will be setup with trained and qualified staff for proposed project which will have the responsibility of implementing and monitoring all the environmental activities. The CER activities will be implemented and monitored by the EMC.

11.9 CORPORATE SOCIAL RESPONSIBILITY (CSR) POLICY

The Jindal Saw Limited is having a Corporate Social Responsibility (CSR) Policy **(Annexure XI)** and same will be adopted by M/s Jindal Urban Waste Management (Bawana) Limited. The company is committed to undertake activities such as free medical check-up camps for nearby local population, vocational training (Skill Development) to women, local villagers and rag pickers on Developing packaging and other products from recyclables/reusable, Books/Stationary distribution in nearby schools, undertaking plantation in nearby localities. The CSR activities will be dovetailed with government schemes. The CSR activities will be monitored by an independent cell comprising of higher officials after project completion.

11.10 CONCLUSION

- "WtE" is an important part of integrated solid waste management system.
- By means of adopting modern and efficient technology, effective implementation of EMP and by implementation of industrial best practices, the marginal impacts on Air, water, land, and noise will be reduced to negligible levels.
- The proposed Waste to Energy plant is likely to generate direct and indirect employment opportunities for both unskilled and semi-skilled local workers.
- This "WtE" project will reduce the problem associated with the disposal of unprocessed waste at landfill site and meet the objective and goal set for the country under the Swachh Bharat Abhiyaan (SBA).

CHAPTER 12. DISCLOSURE OF CONSULTANTS

12.1 INTRODUCTION OF ORGANIZATION

Mantec Consultants Pvt. Ltd., established in 1979, is a multi-disciplinary consulting firm offering infrastructural, environmental, management, technical and IT services.

Our team consists of technical and management experts coming from the top echelons of various professional services. The in-house capabilities are augmented and strengthened by our panel of associates who are well known experts in their respective fields.

We provide a complete range of environmental and social impact assessment services with an expert in-house team of professionals and associates. Mantec is an ISO 9001:2015 & OHSAS certified company, having a full-fledged Environmental Laboratory duly recognized by the Ministry of Environment Forest & Climate Change (MoEF&CC) and accredited by NABL (National Accreditation Board for Testing Calibration Laboratory). We are accredited by NABET/QCI for conducting the EIA studies.

Commitment to excellence has been the company's credo since the day of its inception and forms the central emphasis in all our operations.

12.2 SERVICES OFFERED

We at Mantec is providing various environmental services in more than 15 industries/sectors including infrastructure, mining, irrigation, river valley projects, power plants, refineries, ports, airports, highways, residential colonies, hazardous waste sites, forestry and rural development projects etc.

1. Environmental Impact Assessment Studies
2. Environment Management Plans
3. Social Impact Assessment Studies
4. Rehabilitation & Resettlement Studies and Resettlement Action Plans
5. Safety Audits & Environmental Audits
6. Risk Analysis and Disaster Management Plans
7. Environmental Monitoring of Air, Water, Noise, Soil, Solid and Wastes

8. Environmental Monitoring of Industrial emissions, industrial effluents, ambient air etc.
9. Wastewater Management Both domestic (sewage) and industrial
10. Ground & Surface Water Treatment and Supply
11. Design and implementation of Wastewater Treatment Plants as well as Common Effluent Treatment Plants
12. Studies on River, Lake, and Forest ecosystems
13. Watershed and Waste land management
14. Solid Waste Management including Hazardous and Biomedical Waste Management
15. Oil Spill Response
16. Rehabilitation of Mines
17. Remote sensing and GIS survey

12.3 LABORATORY FACILITY& EQUIPMENTS

Mantec Environmental Laboratory (Recognized by MoEF&CC and Accredited by NABL)

Monitoring & Analytical Capabilities for.

- Ambient Air
- Stack Gas emissions
- Process and work zone
- Indoor Air
- Volatile organic compounds (VOC's)
- PAH's in Ambient Air
- Hydrocarbon in Ambient Air and Stack
- Heavy metals in Ambient Air, water, Soil
- Air Modeling
- Drinking Water, Raw Water and Process Water Analysis
- ETP and STP Water Analysis
- Soil, Sludge and Hazardous Waste Analysis

Lab Equipments

- Dust Samplers and $PM_{2.5}$ Sampler
- Stack Monitoring Kit
- Organic Vapor Sampler
- Non-Dispersive Infrared Spectrophotometer (NDIR)
- Atomic Absorption Spectrophotometer
- Gas Chromatograph
- UV Spectrophotometer
- Flame Photometer
- Mercury Analyser
- COD Digester
- Micro meteorological Station
- ICP OES
- ORSAT
- CO Analyzer
- Bacteriological Chamber
- Digital Ultrasonic

12.4 ADDRESS & CONTACTS

Head Office
805, Vishal Bhawan, 95 Nehru Place, New Delhi-110019.
Phone: 91-11-26429293/4/5 Fax: 91-11-26842531
E-Mail: envmantec@yahoo.co.in

Environment Division,
D-36, Sector-6, Noida-201301
Email: mantec@vsnl.com,
Ph: 0120 – 4215804, 4215000
Fax: 0120 – 4215809

12.5 ESTEEMED CLIENTELE

1. BHARAT HEAVY ELECTRICALS LIMITED
2. BHARAT ELECTRONICS LIMITED
3. FCI ARAVALI GYPSUM AND MINERALS INDIA LIMITED
4. HINDUSTAN PETROLEUM CORPORATION LIMITED
5. INDIAN OIL CORPORATION LIMITED
6. NTPC LIMITED
7. NATIONAL HYDROELECTRIC POWER CORPORATION
8. INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION
9. ISHIKA FERTILIZER LIMITED
10. JAI PRAKASH ASSOCIATES
11. JUBILANT AGRI AND CONSUMERS PVT. LTD.
12. TATA CHEMICALS LIMITED
13. NATIONAL HIGHWAY AUTHORITY OF INDIA
14. NATIONAL FERTILIZERS LIMITED
15. PUNJAB ALKALIES AND CHEMICALS LTD.
16. RAJASTHAN STATE MINES AND MINERALS INDIA LIMITED
17. MYSORE MINERALS LIMITED
18. KANDLA PORT TRUST
19. KARNATAKA POWER CORPORATION LIMITED
20. KUMAON MANDAL VIKAS NIGAM LIMITED
21. SAURASHTRA CHEMICALS LIMITED, GUJARAT
22. UTTARAKHAND FOREST DEVELOPMENT CORPORATION
23. SUMAN ENTERPRISES
24. JAI YAMUNA JI DEVELOPERS
25. MARKANDESHWAR CONSTRUCTION COMPANY
26. M.P. STATE MINING CORPORATION LTD.
27. JINDAL MECTEC PVT. LTD.
28. HARYANA MINING CO.
29. ELDECO INFRASTRUCTURE
30. ANSAL PROPERTY & INFRASTRUCTURE
31. DELHI STATE INDUSTRIAL AND INFRASTRUCTURE DEVELOPMENT CORPORATION (DSIIDC)
32. EXOTICA HOUSING LTD.
33. LOUIS BERGER GROUP

34. AMBUJA CEMENT
35. WAPCOS LTD.
36. INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION
37. IL&FS TRANSPORTATION NETWORK LTD.
38. THDC INDIA LTD.
39. MADHYA PRADESH ROAD DEVELOPMENT CORPORATION
40. VEDANTA RESOURCES
41. RAVI TAWI IRRIGATION COMPLEX, GOVT. OF J&K
42. INSTITUTE OF CHEMICAL TECHNOLOGY
43. JHARKHAND ISPAT PVT LTD
44. KARNATAKA VETERINARY ANIMAL AND FISHERIES SCIENCES UNIVERSITY
45. ESSAR STEEL INDIA LTD.
46. WELCOME FOOTWEAR
47. COIM INDIA PVT. LTD.
48. HARYANA STATE ROADS AND BRIDGES DEVELOPMENT CORPORATION LIMITED
49. ULTRATECH CEMENT LTD.
50. AXISCADES ENGINEERING TECHNOLOGIES LTD.
51. INVESTIGATION DESIGN & RESEARCH BOARD (IDRB), KERALA
52. WATER RESOURCE DEPARTMENT, RAJASTHAN
53. BHARAT PETROLEUM CORPORATION LIMITED
54. ADOR FONTECH LTD.
55. PUBLIC WORKS DEPARTMENT DELHI
56. THE INDIAN EXPRESS
57. WATER RESOURCES DEPARTMENT, GOVT. OF JHARKHAND
58. SUN PETRO CHEMICALS PVT.LTD.
59. TANCEM
60. FCI ARAVALI
61. SATLUJ JAL VIDYUT NIGAM (SJVN)

12.6 OUR CREDENTIALS

QUALITY COUNCIL OF INDIA
Creating an Ecosystem for Quality

NABET

National Accreditation Board for Education and Training

Certificate of Accreditation

Mantec Consultants Pvt Ltd, Noida

D-36, Sector – 6, Noida, Uttar Pradesh-110019

*The organization is accredited as **Category-A** under the QCI-NABET Scheme for Accreditation of EIA Consultant Organization, Version 3: for preparing EIA-EMP reports in the following Sectors –*

S. No	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1	Mining of minerals- Open cast only	1	1 (a) (i)	A
2	River Valley projects	3	1 (c)	A
3	Thermal power plants	4	1 (d)	A
4	Petroleum refining industry	10	4 (a)	A
5	Chemical Fertilizers	16	5 (a)	A
6	Pesticides industry and pesticide specific intermediates	17	5 (b)	A
7	Isolated storage & handling of Hazardous chemicals	28	-	B
8	Ports, harbours, break waters and dredging	33	7 (e)	A
9	Highways	34	7 (f)	A
10	Building and construction projects	38	8 (a)	B
11	Townships and Area Development projects	39	8 (b)	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RAAC minutes dated September 15, 2023 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no QCI/NABET/ENV/ACO/23/2942 dated October 11, 2023. The accreditation needs to be renewed before the expiry date by Mantec Consultants Pvt Ltd, Noida following due process of assessment.

Sr. Director, NABET
Dated: October 11, 2023

Certificate No.
NABET/EIA/2326/RA 0305

Valid up to
April 20, 2026

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to the QCI-NABET website.

National Accreditation Board for Testing and Calibration Laboratories

NABL

CERTIFICATE OF ACCREDITATION

MANTEC ENVIRONMENTAL LABORATORY

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

D-36, SECTOR -06, NOIDA, GAUTAM BUDDHA NAGAR, UTTAR PRADESH, INDIA

in the field of

TESTING

Certificate Number: TC-6440

Issue Date: 11/06/2022 Valid Until: 10/06/2024

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.
(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Name of Legal Entity : MANTEC CONSULTANTS PVT. LTD.

Signed for and on behalf of NABL

N. Venkateswaran
Chief Executive Officer