ABC/EIA/2023-24/KSWMP/37/Rev 07

Draft

KERALA SOLID WASTE MANAGEMENT PROJECT

Environmental Impact Assessment Report for Proposed Scientific Landfill at Ambalamedu, Ernakulam District of Kerala



Category: B1 – 7(i)
Sector as per NABET Scheme: 37
Study Period: December 2023 to February 2024
ToR Identification No.: TO24B3401KL5888163N, dated: 08.08.2024

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QCI/NABET Accreditation vide NABET/EIA/2225/RA0290 dated 11.06.2023 with Validity till 16.11.2025

June 2025

PROJECT DETAILS			
Name of Project	Environmental Impact Assessment Report for the Proposed Scientific Landfill at Ambalamedu, Ernakulam District of Kerala.		
Project Number	**ABC/EIA/2023-24/KSWMP/37/R7**	**Released**	**June 2025**

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Name : G. Murugesh

Sign : 

Designation : Chairman & Managing Director

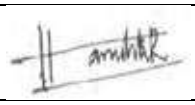
Date : 04/06/2025

DECLARATION OF EXPERTS

Name of the Project	Environmental Impact Assessment Report for the Proposed Scientific Landfill at Ambalamedu, Ernakulam District of Kerala.
Schedule as per EIA notification 2006	7 (i)
Category	B1
NABET Sector No.	37

DECLARATION

I, hereby, certify that I was a part of the EIA team in the following capacity that developed the above EIA.

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Functional Area Experts				
Sl.No.	**Functional Areas**	**Name of the Expert/s**	**Involvement**	**Signature**
1	WP	Vaishnavi Dhinakaran	**Period:** October 2023 – Till date **Task:** Selection of monitoring locations and parameters, Evaluation of water quality results, Verifying the water balance for the project, Impact identification and suggesting mitigation measures	
	SHW		**Period:** October 2023 – Till date **Task:** Identifying details regarding solid wastes generation, storage treatment & disposal, Impact identification and suggesting mitigation measures.	
2	AP	Haneesh KR	**Period:** October 2023 – Till date **Task:** Selection of monitoring locations and parameters,	

			Interpretation of parameters, Evaluation of ambient air quality results, Impact identification and suggesting mitigation measures, Post monitoring plan, EMP cost.	
3	EB	Abhik Saha	**Period:** October 2023 – Till date **Task:** Identifying and conducting sampling for terrestrial biodiversity on the basis of Land use and Land cover map, Identification of impacts and suggesting mitigation measures, Identification of flora and fauna within study area.	
4	AQ	Haneesh KR	**Period:** October 2023 – Till date **Task:** Running of informal AERMOD for selection of air sampling station to find out the maximum concentration to identify the air sampling locations, collection of meteorological data, run AERMOD to prepare site specific primary wind rose and GLC plots after verifying meterological data from secondary sources, Air quality impact prediction, calculation of output result, assessment of Result, Impact identification and suggesting mitigation measures.	
	NV		**Period:** October 2023 – Till date	

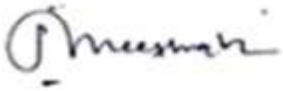
			Task: Selection of monitoring locations and parameters, Verification of analysis results based on secondary data, Identification of impacts and suggesting mitigation maeasures.	
5	HG	Dr. Veezhinathan Subramaniyam	**Period**: October 2023 – Till date **Task:** The Hydrogeological Study was conducted to examine the groundwater level scenario, groundwater movement direction at the study area. The groundwater samples around the study area were collected and tested for analytical values and presence of contamination in the sample.	
6	LU	Dr. N Rama Krishnan	**Period:** October 2023 – Till date **Task:** Preparation of toposheet and Land use/Land cover map from the satellite image. Identification of impacts and suggesting mitigation measures.	
	SE		**Period:** October 2023 – Till date **Task:** Identification of impact and suggesting mitigative measures of project on community, conducted FGD, preparation of CER plan in consultation with client	

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List of Abbreviations

AGL	:	Above Ground Level
AMSL	:	Above Mean Sea Level
ACF	:	Activated Carbon Filter
AAQ	:	Ambient Air Quality
ASTM	:	American Society for Testing and Material
BDL	:	Below Detectable Level
BOD	:	Biological Oxygen Demand
CGWB	:	Central Ground Water Board
CMS	:	Central Monitoring System
CPCB	:	Central Pollution Control Board
CPHEEO	:	Central Public Health and Environmental Engineering Organization
COD	:	Chemical Oxygen Demand
CFP	:	Carbon Footprint
CRZ	:	Coastal Regulation Zone
CCL	:	Compacted Clay Layer
UTC	:	Coordinated Universal Time
CER	:	Corporate Environmental Responsibility
DBU	:	Designated Best Use
DG	:	Diesel Generator
DCP	:	Dry Chemical Powder
EHT	:	Electrical High Tension
EMB	:	Embankment
EC	:	Environmental Clearance
EHS	:	Environmental Health & Safety
EIA	:	Environmental Impact Assessment
EMC	:	Environmental Monitoring Cell
EMF	:	Environmental Management Framework
EGL	:	Existing Ground Level
FCC	:	False Color Composite
FACT	:	Fertilizers and Chemical Travancore Limited
FGD	:	Focus Group Discussion
GAIL	:	Gas Authority of India Limited
GC-MS	:	Gas Chromatography – Mass Spectroscopy
GCL	:	Geo Clay Liner
GM	:	Geo Membrane
GTX	:	Geo Textiles
GSI	:	Geological Survey of India
GSM	:	Gram per Square Meter
GW	:	Ground Water
HDPE	:	High Density Poly Ethylene
HFL	:	High Flood Level
HPLC	:	High Pressure Liquid Chromatography
ICAR	:	Indian Council for Agricultural Research
IMD	:	Indian Meteorological Department
IRS	:	Indian Space Research Organization
IST	:	Indian Standard Time
IUCN	:	International Union for Conservation of Nature
KINFRA	:	Kerala Industrial Infrastructure Development Corporation
KSWMP	:	Kerala Solid Waste Management Project
KSEB	:	Kerala State Electricity Board
KSIDC	:	Kerala State Industrial Development Corporation
KSRTC	:	Kerala State Road Transport Corporation
KWA	:	Kerala Water Authority
KLD	:	Kilo Liter per Day
LTP	:	Leachate Treatment Plant

LOS	:	Level of Service
LISS	:	Linear Imaging Self Scanning Sensor
LNG	:	Liquefied Natural Gas
LSGD	:	Local Self Government Department
LEL	:	Lower Explosive Limit
MDR	:	Major District Road
MoEF&CC	:	Ministry of Environment, Forest & Climate Change
MCM	:	Mixing Cell Model
NAAQS	:	National Ambient Air Quality Standards
NH	:	National Highways
NGL	:	Natural Ground Level
NOC	:	No Objection Certificate
OSHA	:	Occupational Safety & Health Administration
OCP	:	Operation Control Procedure
ODR	:	Other District Road
PCU	:	Passenger Car Unit
PPE	:	Personal Protective Equipment
PVD	:	Prefabricated Vertical Drains
PDR	:	Preliminary Detailed Report
PSF	:	Pressure Sand Filter
PP	:	Project Proponent
RCV	:	Refuse Compactor Vehicle
RSLF	:	Regional Scientific Landfill
R&R	:	Rehabilitation and Resettlement
RE wall	:	Reinforced Earth Wall
RDS	:	Respirable Dust Sampler
SC	:	Scheduled Caste
ST	:	Scheduled Tribe
SLF	:	Scientific Landfill
SWM	:	Solid Waste Management
SPL	:	Sound Pressure Level
SOP	:	Standard Operating Procedure
SEIAA	:	State Environmental Impact Assessment Authority
SEAC	:	State Expert Appraisal Committee
SH	:	State Highways
SPCB	:	State Pollution Control Board
SW	:	Surface Water
TBM	:	Temporary Bench Mark
TERI	:	The Energy and Resources Institute
TPD	:	Tons Per Day
TPA	:	Tons Per Annum
UT	:	Union Territories
ULB	:	Urban Local Bodies

Terms of Reference (ToR) Compliance

Compliance to ToR issued by SEIAA – Kerala vide ToR Identification No. TO24B3401KL5888163N, dated: 08-08-2024

Standard Term of Reference		
I	**Project Details**	
1	Importance and benefits of the project	The SLF project is proposed as a regional facility for scientifically disposing the inert generated from various generators in the region.As a result of the proposed project there will be horizontal (geographically) and vertical benefits (standard of living) to society and environment respectively. ➢ Scientific disposal of inerts will result in compliance to the SWM rules by preventing contamination of ground & surface water, soil and improves the environmental quality of surroundings, waterways, low-lying areas and other areas where inerts are previously dumped.
2	The project should be designed based on the population projections as by Master Plan and in conformity to the Solid Waste Management Rules 2016 as amended from time to time.	The project is prepared based on the generation of rejects & inerts with the total capacity of 4 lakh cubic meter and cater to a projected life of 20 years @ 20000 tonnes per annum. It also conforms the Solid Waste Management Rules, 2016 and other applicable National rules and regulations. Details refer in Chapter 2, Table 2-11 of this EIA report.
3	Examine and submit details of alternative technologies viz. RDF shall also be evolved	The SLF site is a customized civil engineering work suitable to site. RDF is not planned for this project, the inert generated and segregated will be collected from transfer location sites and disposed at SLF.
4	Examine and submit details of storm water/leachate collection from the composted area including leachate treatment options proposed	Storm water drains of 1.1m depth x 1.2m width cross section is planned around the Scientific Landfill. Two Storm water drains from NE to SW flow direction are proposed on Northern and Southern side of SLF acting as garland drains. Garland Drains Length of about 700m is considered one on each South and North side for proposed SWD

Standard Term of Reference		
		planning. The surface run-off is estimated about 4694 cum/hr to the maximum of 9306 cum/hr during monsoons. The estimated leachate collection is 300 KLD and 400 KLD capacity leachate treatment plant is provided. For further details ref Section 2.20.10 of Chapter 2. The treated water will be used for Green Belt and Dust suppression, the excess water will be used by the nearby industries and the options are being explored.
5	Submit a copy of the layout plan of project site showing solid waste storage, green belt (width & length, 33% of the project area), all roads, prominent wind direction, processing plant & buildings etc. should be provided.	Layout copy is enclosed in the Chapter 2 as figure 2.5. The green belt of 2m is provided along the periphery amounting to 13,155 sq.m is provided. Further at the closure the proper SLF area of more than 70,000 sq.m will be covered under greenery/landscape. (Total Greenbelt proposed is around 15% of the total land area. However, the total greenbelt including landscaping of scientific capping shall be around 64% of the project area of KSWMP Phase)
6	Submit the details of sanitary land fill site, impermeability and whether it would be lined, if so details thereof.	The SLF is located at Ambalamedu at Ernakulam district. The SLF will have the liners as given in SWM rules 2016. The SLF subgrade preparation details refer section 2.20.5 of Chapter 2
7	The EIA would include a separate chapter on the conformity of the proposals to the Municipal Solid Waste Management Rules, 2016 and the Construction and Demolition Waste Management Rules, 2016 including the sitting criteria therein.	Complied, the EIA report is prepared inline with Solid Waste Management Rules, 2016 and the Construction and Demolition Waste Management Rules, 2016. The site selection criteria is covered in section 2.9 of Chapter 2 of EIA report. The proposed SLF site meets all the criteria as mentioned in the rules
8	Details of various waste management units with capacities for the proposed project. Details of utilities indicating size and capacity to be provided.	The SLF consists of disposal site of 73,615 m^2 with 400 KLD of leachate treatment plant with associated supporting facilities like weighing machine, security, admin block and along with firefighting system. The detailed land area break-up with proposed facilities are given in Table 2-12. Waste carrying is facilitated by

<table>
<tr><th colspan="3">Standard Term of Reference</th></tr>
<tr><td></td><td></td><td>Refuse Compact Vehicle (RCV), the details are covered in section 2.18.3</td></tr>
<tr><td>9</td><td>Details of storage and disposal of pre-processing and post-processing rejects/inert.</td><td>The SLF site is meant for disposal purpose. There will be no pre-processing involved in this project. It is planned to scientifically dispose the inerts of 4,00,000 MT in a span of 20 years</td></tr>
<tr><td>10</td><td>List of proposed end receivers for the rejects/inerts should be provided. MoUs to be submitted in this regard.</td><td>The Kerala Solid Waste Management Project which is a unit of Govt. Kerala is the project proponent. The inert are planned to be disposed at Ambalamedu SLF area.</td></tr>
<tr><td>11</td><td>The cost of the project (capital cost and recurring cost) as well as the cost towards implementation of EMP should be clearly spelt out.</td><td>About INR 274.79 Crore is the estimated cost as on 2025 first quarter. About 7.87 Crore is earmarked for EMP which includes including treatment plant. The details of EMP cost is given in Table 9.1.</td></tr>
<tr><td>12</td><td>NOC from local or nearest airport within 20 km and any flight funnel restrictions.</td><td>Applied for NoC for Cochin International Airport which is located at a distance of 18 km (NNE) and NOC is obtained for another airstrip which is Kochi Naval Airstrip at a distance of 10.10 km (WSW) from the SLF project site.</td></tr>
<tr><td>13</td><td>The project proponents should consult the Municipal solid waste Management manual of the Ministry of Housing and Urban Affairs, Government of India and draw up project plans accordingly.</td><td>The project proponent adhered to the solid waste management rules 2016, Government of India and project plans are drawn accordingly. For siting criteria, circulars issued by Kerala State Pollution Control Board are also considered.</td></tr>
<tr><td>14</td><td>Details of man-power requirement (regular and contract).</td><td>Construction phase – Approx. 200 persons, Operation Phase – Approx. 85 persons</td></tr>
<tr><td>15</td><td>Process description along with major equipment’s and machineries, process flow sheet (quantitative) from waste material to disposal to be provided.</td><td>The project description along with infrastructure are discussued in Chapter 2. The equipment likely to be deployed at SLF site are compactor, dozer, water tanker, tippers and front-end loader as per the table below.
<table>
<tr><th>Sl. No.</th><th>Description</th><th>Quantity in nos.</th></tr>
<tr><td>1</td><td>Landfill compactors</td><td>2</td></tr>
<tr><td>2</td><td>Dozer</td><td>2</td></tr>
<tr><td>3</td><td>Water tanker (5KL capacity)</td><td>2</td></tr>
</table>
</td></tr>
</table>

Standard Term of Reference		
		<table><tr><td>4</td><td>Tippers (10.5 cum capacity)</td><td>2</td></tr><tr><td>5</td><td>Front end loader with back - hoe</td><td>2</td></tr></table> In addition, one leachate treatment plant will be operating at site. The inert will be accepted based on the acceptance criteria and will be weighed on the weighing machine and disposed to SLF site of compaction. The inert at SLF will be spread into thin layers and compacted on daily basis. The exposed area is covered with 10cm of soil on daily basis as per the SWM rules, 2016.
II	**Land Environment**	
16	Submit a 10 km. radius map (on survey of India toposheet) showing co-ordinates of project site, national highway, state highway, district road/approach road, river, canal, natural drainage; protected areas, under Wild Life (Protection) Act, archaeological site, natural lake, flood area, human settlements (with population), industries, high tension electric line, prominent wind direction (summer and winter), effluent drain, if any and ponds etc. should be presented and impacts assessed on the same.	Complied, Refer Chapter 2 of EIA report for connectivity like SH, NH and approach road. The drainage map is shown in fig. 3.9 in EIA report. There is a bird sanctuary at 9.3 km away from the project site. The nearest Human settlements are located at a distance of about 1km. The SLF is located in KINFRA industrial area of Irumbanam. The high-tension line passes through the site and are planned to be diverted. The predominant wind direction is mainly from ESE and WNW.
17	Submit a copy of the land use certificate from the competent authority.	Present land use is an industrial estate area of KINFRA. The land is under procession of KINFRA and the industrial estate map same is enclosed as Annexure 6. As the land is unused covered by wild bushes and few trees.
18	Submit a copy of the topography of the area indicating whether the site requires any filling, if so, the details of filling, quantity of fill material required, its source and transportation, etc.	About 4m height is required to be raised with 7.0 lakh m^3 of borrowed soil plus 3 lakh m^3 for preloading and the details are shown in fig 2.10 of Chapter 2 of EIA report. For Topographical map, ref Figure 2.3
19	A sensitivity analysis of the site shall be carried out as per the CPCB site selection criteria and form part of the EIA report.	Complied, refer EIA report of site selection criteria of Chapter 2, section 2.10.
20	Post project reclamation management program with financial allocation.	Refer Chapter 2 Section 2.16.16 for capping of the SLF of the EIA report.
III	**Environmental Monitoring and Management**	

Standard Term of Reference		
21	Examine and submit details of monitoring of water quality around the landfill site. Water analysis shall also include for nitrate and phosphate.	About 4 piezometers will be installed and the water sampling will be analysed from the piezometers. The location of the piezometer is shown in the general layout Fig 2.7.
22	Examine and submit details of the odour control measures.	The background air quality along with methane is measured. It is expected the inert will be having lesser odour than the Municipal Solid Waste. The methane will be collected through vent pipes provided at every 2,500 sq.m as per FSR design of SLF area.
23	Submit a copy of the status of ambient air quality and surface and ground water quality, soil type, cropping pattern, land use pattern, population, socio-economic status, anticipated air and water pollution.	The present ambient air, surface, ground, soil, LU/LC are shown in table 3.13, 3.18 and 3.19, 3.21 and 3.22 respectively. The LU/LC is shown in Table 3.9. The Anticipated Air pollution is shown in Chapter 4 Table No 4.5.
24	Examine and submit the details of one complete season AAQ data (except monsoon) with the dates of monitoring, impact of the project on the AAQ of the area (including H2S, CH4).	Refer Chapter 3. The baseline data was generated during the month of December 2023 - February 2024 the date of monitoring is enclosed as Annexure 2.
25	Submit Environmental Management Plan and Environmental Monitoring Plan with costs and parameters.	The environmental monitoring programme is shown Chapter 6 and environmental management plan in Chapter 9. The expected environment cost is about 7.62 Crore which includes LTP. Monitoring parameters are shown in Table 6-3 under Chapter 6.
26	Examine and submit the details of impact on environmental sensitive areas.	The ESA of Mangalavanam Bird Sanctuary is located at 9.3 km and the SLF does not have impact on bird sanctuary.
27	A detailed draft EIA/EMP report should be prepared in accordance with the above additional TOR and should be submitted to the Ministry in accordance with the Notification.	Complied
28	Possible carbon footprint contribution from each activities and mitigation measures proposed shall be included as part of Environment Management Plan.	Complied and the details are covered in EIA/EMP report, Chapter 4 under section 4.14 and subsection 10.2.8 of this report.
IV	**Water Environment**	
29	Examine and submit details of impact on water bodies/rivers/ ponds and mitigative measures during rainy season.	The nearest water body is Chitrapuzha river which is 100m (N) & (W) away from the project location.

Standard Term of Reference		
		Storm Water Drain is provided all aound the SLF site.
30	Examine and submit the details of surface hydrology and water regime and impact on the same.	Complied and the details are given in EIA/EMP report, section 3.9 under chapter 3.
V	**Water Management**	
31	Requirement of water with source of supply, status of approval, water balance diagram.	The estimated water requirement is 4 KLD and source is KWA. The sewage water will be collected in septic tank connected to soak pit. The water balance is shown in Table 2.20.
32	Details of effluent treatment and reuse and recycling process.	Leachate treatment plant is envisaged with the capacity of 400 KLD with recycling facility. The excess water will be handed to nearest industry on identifying the needy.
33	Action plan for measures to be taken for excessive leachate generation during monsoon period.	It is planned to cover the SLF area and plan to work in 3 phases.
34	Pre-project monitoring of ground water quality is required.	Complied. A detailed hydrogeological study is covered under section 3.9 of chapter 3.
VI	**Waste Management**	
35	Submit the criteria for assessing waste generation. Any segregation of hazardous and bio-medical wastes. Submit a copy of detailed plan of waste management.	Following assumptions are considered for the waste generation: ➢ Per capita waste generation in Municipality area is 0.419 kg per day ➢ Per capita waste generation in Corporation area is 0.545 kg per day ➢ increase in per capita waste generation is 1.3% per year ➢ Percentage of waste rejects is 12% ➢ For design capacity, additional 20% of total reject is considered Hazardous and Bio Medical waste is not applicable. For detailed plan of waste management refer chapter 2 of EIA report.
VII	**Drainage**	
36	Details of Drainage of the project upto 5 km radius of study area. If the site is within 1 km radius of any major river, peak and lean season river discharge as well as flood occurrence frequency based on peak rainfall data of the past 30 years. Details of Flood Level of the	Drainage pattern is shown in fig 3.10 of EIA/EMP report. The Major river identified is Chitrapuzha River and the lean season details are collected and the details are covered in chapter 3. 30 years rainfall data and flood occurrence details are covered

Standard Term of Reference		
	project site and maximum Flood Level of the river shall also be provided.	in Chapter 3. The watershed and floodplain details are also covered in Chapter 3. For details refer subsection 3.3.4, section 3.7 & 3.8 EIA/EMP report.
37	Examine and submit the details of impact on the drainage and nearby habitats/settlements (surroundings).	Complied. Refer drainage map in section 3.7 & figure 3-13. The proposed SLF is located away from settlement there is no settlements in the proposed SLF area.
I	**Energy Requirement**	
i	A certificate of adequacy of available power from the agency supplying power to the project along with the load allowed for the project.	The power requirement is very meagre estimated as 88.52 KW and it is proposed to be sourced from KSEB.
ii	Details of the adequate power back up facility, to meet the energy requirement in case of power failure from the grid.	100 kVA DG set will be envisaged to be meet any power shut down.
VIII	**Disaster Management Plan**	
i	Submit details of a comprehensive Disaster Management Plan including emergency evacuation during natural and man-made disaster.	Refer Chapter 7 of Section 7.6 of EIA report
ii	Risk and hazard identification and details of proposed mitigation measures.	Methane Emission is calculated which is about: Average methane generation in terms m^3/s = 3.28 x 10-9 x 0.657 = 2.15 x 10^{-9}. Average H_2S generation is 30% of total methane = 2.15 x 10^{-9} x 0.30 = 0.645 x 10^{-9} m^3/s. As the generation is very meagre the SLF is safe and does not warrant for further analysis.
IX	**Socio-Economic Environment**	
38	Examine and submit the details of rehabilitation/compensation package for the project effected people, if any.	Not applicable.
39	Public hearing to be conducted for the project in accordance with provisions of Environmental Impact Assessment Notification, 2006 and the issues raised by the public should be addressed in the Environmental Management Plan. The Public Hearing should be conducted based on the ToR letter issued by the Ministry and not on the basis of Minutes of the Meeting available on the web-site.	will be complied after the public hearing

Standard Term of Reference		
40	Report on health and hygiene to be maintained for the sanitation workers at the work place.	Planned and complied
X	**Court Cases**	
41	Details of litigation pending against the project, if any, with direction /order passed by any Court of Law against the Project should be given.	Nil
XI	**Miscellaneous**	
42	Any further clarification on carrying out the above studies including anticipated impacts due to the project and mitigative measure, project proponent can refer to the model ToR available on Ministry website "http://moef.nic.in/Manual/Common Municipal Solid Wastes".	Complied. As per the SWM Rules, 2016, , the liners are provided. Capping are planned progressively. Carbon Footprint and Methane emission estimations are included.
Specific Terms of Reference		
1	Detailed hydrogeological study incorporating water table contour, water table fluctuations and water quality variations.	Complied and covered in section 3.9 of chapter 3.
2	Additional safeguards for sanitary landfill considering marshy or near marshy condition of the proposed site.	The existing ground level is proposed to be raised by 2.00 m above HFL in line with SWM Rules 2016, so total rise envisaged in existing ground level is around 3.95 m (i.e. 1.95 + 2.00) to account for the water barrier between high flood level and SLF base, plus filling of 1.3 m for settlement allowance.
3	Safeguard measures for sanitary landfill to prevent the emission of gases, considering the proximity to HPCL LPG plant, IOCL and BPCL plants and other industrial units and institutions.	Landfill gas management is proposed and the details are covered in section 2.32 of chapter 2. The estimated emission is meagre.
4	Post-Closure care of landfills with long term monitoring and maintenance strategies.	Closure profile and Post-Closure monitoring plan is given in subsection 2.14.1 of Chapter 2 & section 11.7 under chapter 11.

1 Introduction

1.1 General

Human activities generate waste materials that are often discarded because they are considered unusable. These wastes are normally solid, that the material is unwanted. However, many of these waste materials can be reused, and thus they can become a resource for industrial production or energy generation, if managed properly. Waste management has become one of the most significant problems of our time because our way of life produces enormous amounts of waste, and most people want to preserve their lifestyle, while also protecting the environment and public health. Industry, private citizens, and state legislatures are searching for means to reduce the growing amount of waste that every homes and industrial discard and to reuse it or dispose of it safely and economically. In recent years, Government of India has passed many rules and regulation for dealing with solid waste management than with any other topic on their legislative agendas.

Kerala Solid Waste Management Project (KSWMP) is planned to make Kerala's development journey in a sustainable way and to make Kerala's cities cleaner, healthier, and more liveable. The proposed project aims to improve Solid Waste Management (SWM) service in a scientific manner and will improve SWM service of all Urban Local Bodies (ULBs). Landfills are vital components of any well-designed Solid Waste Management (SWM) system.

In order to achieve the above goal, KSWMP proposed a cluster approach for the planning, design and development of Sanitary landfill,[1] which is the most critical regional facility required for the final disposal of non-biodegradable, non-hazardous, non-recyclable and non-reusable inerts/rejects. Kerala State Solid Waste Management Project (KSWMP), under Local Self Government Department (LSGD), is implementing the solid waste management project in 93 ULBs (87 municipalities and 6 corporations) vide G.O (Rt) No. 1420/2020/LSGD dated 29-07-2020. Initially, it is planned to establish a Scientific landfill (SLF) at Ambalamedu to cover the nearby Urban Local Bodies (ULBs), for which obtaining Environmental Clearance is mandatory. In total, five Clusters are planned to be covered under this SWM programme for which development of Regional Scientific Landfill (RSLF/SLF) is proposed. Out of five Clusters, the Cluster-4 (Ambalamedu) is identified, to manage inert rejects generated initially from five districts namely Ernakulam, Alappuzha, Kottayam, Idukki, and Thrissur and later stage the inert/rejects from other Urban Local Bodies (ULBs) shall also be assigned to the Ambalamedu SLF by Govt. of Kerala as on need basis.

1.2 Project Background

Kerala has 6 Municipal Corporations, 87 municipalities, 77 taluks, 14 District Panchayats, 152 Block Panchayats and 941 Gram Panchayats with a total population of 3.48 crores, as per 2011 census. As the census figures indicate, the state has been urbanizing more rapidly than the national average with an annual urban population growth of 9.75%.

Presently, in India it is general practice that the dry & wet waste are segregated at source and the dry waste is disposed in the earmarked Municipal solid waste area. The dry waste contains silt, textiles, leather, plastic, glass and metals which poses contamination hazards related to air (including odour), water, and soil. If Scientific Landfill is implemented the potential contamination impacts due to waste disposal may be mitigated to the greater extent.

[1] Landfill for Solid Waste Inerts and rejects are referred to as "Sanitary Landfill" in SWM Rules, 2016; and the terms scientific and sanitary landfill are seen interchangeably used in various Guidance.

The proposed project SLF falls under Item 7 (i) (Common Municipal Solid Waste Management facilities) as per Environmental Impact Assessment MoEF&CC notification dated September 14th, 2006 and its amendments. The project is categorised under 'B1' and will require Environmental Clearance from State Environmental Impact Assessment Authority (SEIAA) – Kerala as per the above notification. In order to obtain Environment Clearance M/s. ABC Techno Labs India Private Limited, Chennai which is a NABET accredited consultancy organization has been engaged by M/s. KSWMP to carry out an Environment Impact Assessment (EIA) study to obtain EC for the proposed scientific landfill at Ambalamedu, Ernakulam district.

1.3 Identification of Project and Project Proponent

The Proposed project is a development of new facility for disposal of Inert waste/ rejects ie. non-biodegradable and inert waste (by its nature or through pretreatment such as not bio-degradable, recyclable or combustible street sweeping or dust and silt removed from the surface drains[2]; generated from Solid Wastes segregated from various places. The project falls under **Category B1, schedule 7(i)** of the EIA notification, dated 14th September 2006 and as amended.

The project proponent details, and the correspondence details are as follows:

Name of the project proponent	:	Dr. Divya S Iyer, IAS,
Designation	:	Project Director, Kerala Solid Waste Management Project (KSWMP),
Address	:	Local Self Government Department Ground Floor, Trans Towers, Vazhuthacaud, Thiruvananthapuram – 695 014.
Contact details	:	pdkswmp@gmail.com

1.4 Brief Description of the Nature, Size, Location of the Project & Its Importance to the country, region

1.4.1 Site Overview

Based on the due diligence carried out under this ESIA, the proposed construction & development of Scientific Landfill Located within the Petrochemical Park of Kochi near Irumbanam and land is owned by KINFRA which is a government agency under the Government of Kerala. The project site is well isolated from settlements and environmentally sensitive areas. The site is mainly grassland and intermittently covered by patches of trees and bushes. The land is bounded by FACT Gypsum dump site in the east and in the south Kerala Enviro Infrastructure Limited (KEIL) which is operating hazardous land fill and biomedical treatment plant. The other two sides of the site are shielded by Chithrapuzha river after leaving sufficient offsets of more than 100m from the River as per the SLF site requirement criteria. The site selection criteria meets requirement of the Solid Waste Management Rules 2016.

1.4.2 Nature of the Project

The proposed development of a Scientific Landfill (SLF) under the Kerala Solid Waste Management Project (KSWMP) is to address inert waste management needs

[2] Refer Page 60: SWM Rules 2016: [Sanitary Landfills] allow only the non-usable, non-recyclable, non-biodegradable, non-combustible and non-reactive inert waste and pre-processing rejects and residues from waste processing facilities to go to sanitary landfill and the sanitary landfill sites shall meet the specifications as given in Schedule–I, however, every effort shall be made to recycle or reuse the rejects to achieve the desired objective of zero waste going to landfill
Available at: https://cpcb.nic.in/uploads/MSW/SWM_2016.pdf, Accessed on 28 April 2025

associated with solid waste management activities in the ULBs. The project site spreads over in an area of 25 acres within the Petrochemical Park of Kochi near Irumbanam and land is owned by KINFRA.

It is planned to dispose about 4.00 lakh tons of inert materials at an average of 20000 Tonnes per Annum (TPA) in an area of about 18.14 acres over a period of 20 years.

1.4.3 Location of the Project

The land parcel proposed by KSWMP for development of the regional scientific landfill is located at Ambalamedu, Kunnathnadu taluk, Ernakulam district of Kerala. The index map & topo map of the study area is shown in Figure 1-1 & 1-2 respectively. The details of the Ambalamedu site are given in Table 1-1.

Table 1-1 Site location of Ambalamedu

Sl.No.	Ambalamedu site location	
1	Village	Ambalamedu, Vadavucode - Puthencruz
2	Taluk	Kunnathunadu
3	District	Ernakulam
4	Survey numbers	23/4, 23/3, 23/5, 7/5, 7/4, 6/4, 23/2pt, 22/4pt, 22/3pt, 7/3pt, 5/3pt, 6/2pt, 6/3pt, 6/1pt, 6/7pt
5	GPS Coordinates	From 9°59'20.10"N, 76°21'58.51"E to 9°59'18.76"N, 76°21'56.41"E
6	Land allotted	KINFRA
7	Total land required for SLF	25 acres

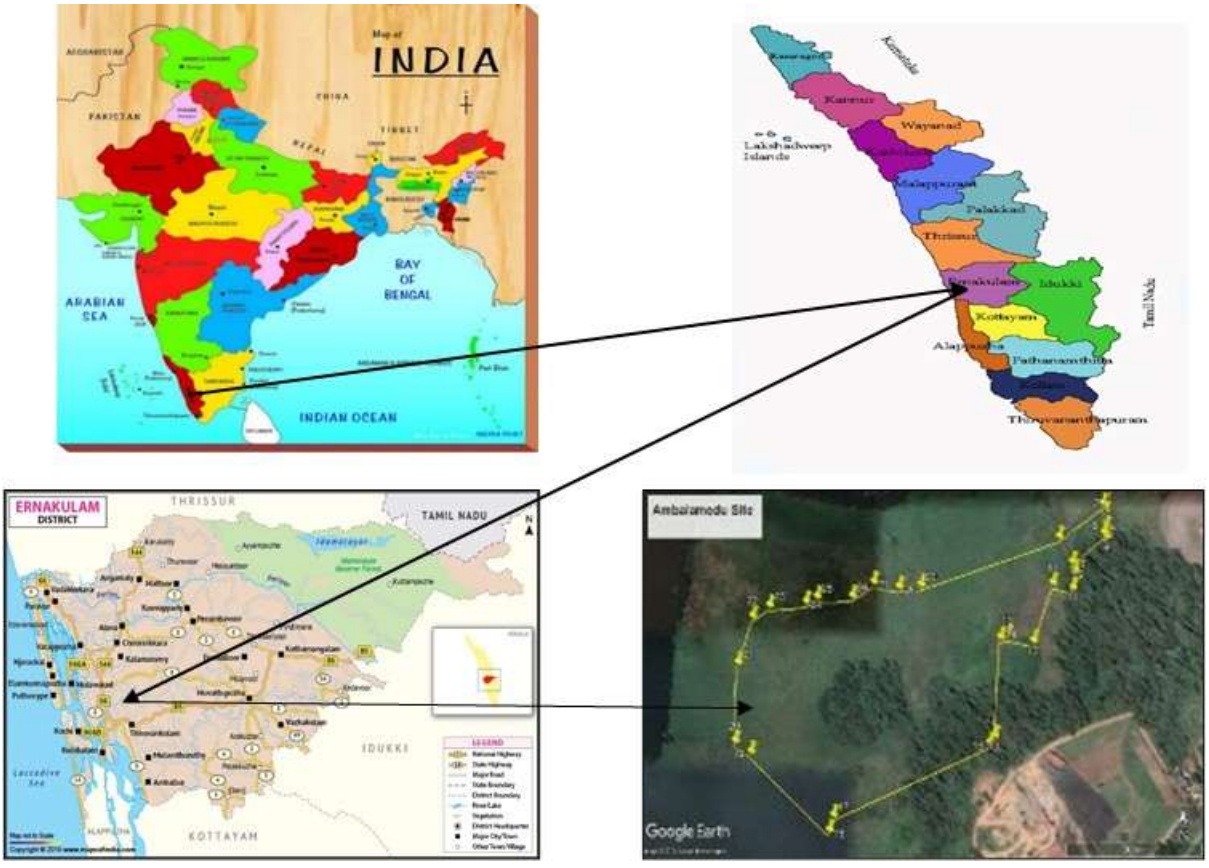


Figure 1-1 Index map of the project site

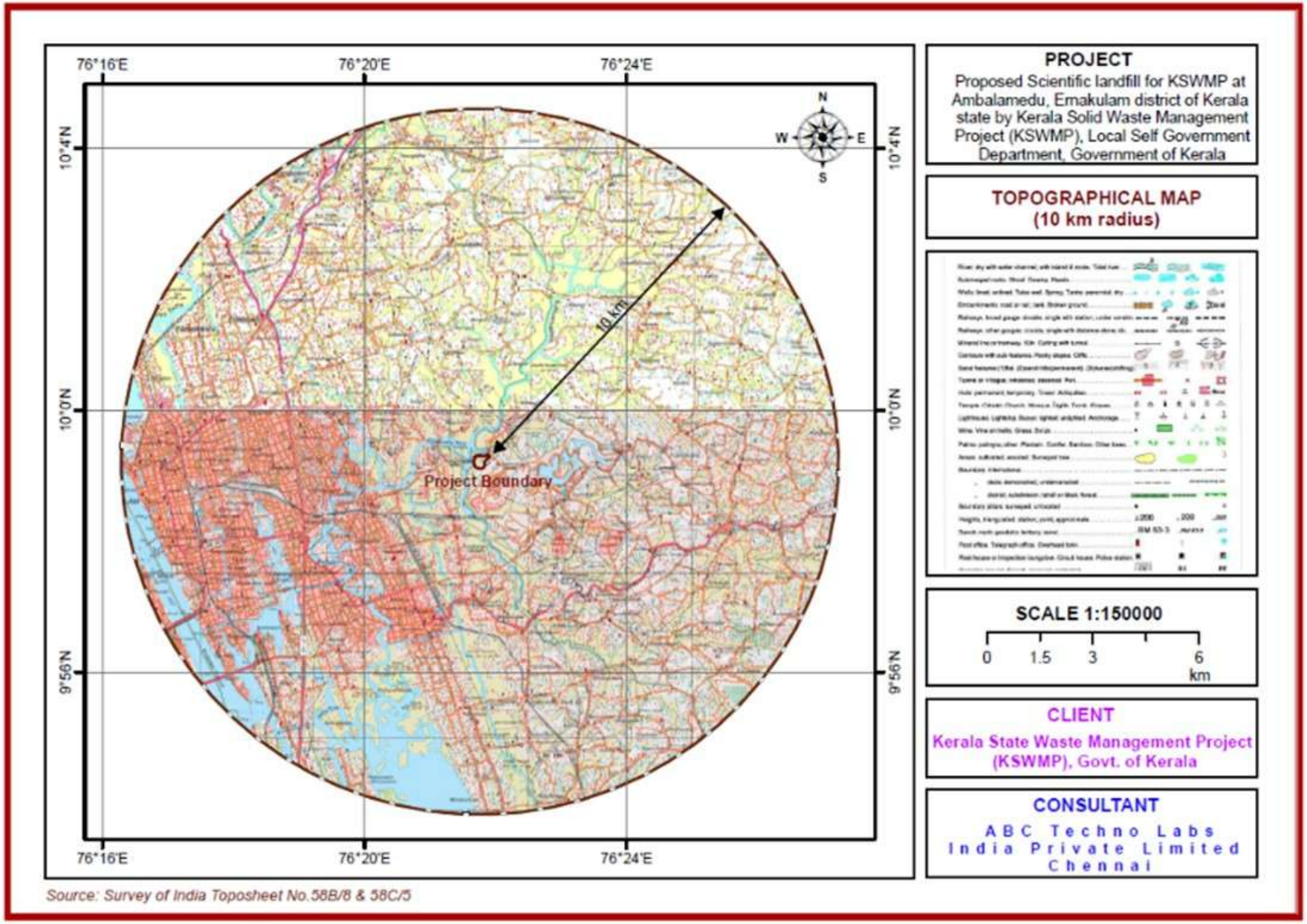


Figure 1-2 Topo map of the project site covering 10 km radius

1.5 Importance of the Project to the Country & Region

Due to rapid urbanization, economic growth and higher rates of urban consumption, India generated approximately 1.45 lakh metric tonnes of solid waste per day in 2021 (MoHUA, 2021[3]). Most of the waste generated remains untreated and even unaccounted. Inadequate waste collection, transport, treatment, and disposal have become major causes for illegal disposal thereby giving rise to environmental and public health concerns in the country. Waste that is not properly treated and disposed, and the inerts and process rejects often find way to rivers, canals and dumpsites.

After an analysis of the waste generated in various districts of Kerala, the FR proposes total five Clusters for development of regional sanitary landfills (RSLF). Out of five Clusters, FR & EIA are proposed for Cluster-4 considering the availability of land at Ambalamedu to manage inerts from four districts namely Ernakulam, Alappuzha, Kottayam, and Idukki. As per the secondary data on solid waste generated in Kerala, projected population in 2023 year is 19,07,433 while total solid waste generation is estimated approximately 920 MT/ day. Restricting the rejections through source segregation and enhanced processing will limit the waste rejects to less than 5 %.Hence, it is important to have scientific facilities to manage inerts and rejects in addition to developing facilities to manage various fractions of solid wastes. The proposed subproject addresses scientific management of inerts and rejects in a Sanitary Landfill in line with SWM Rules, 2016.

1.6 Scope of Study

Environment Impact Assessment (EIA) predicts the effects of a proposed activity/subproject on the environment. A decision making tool, EIA compares various alternatives for a project and seeks to identify the one which represents the best combination of economic and environmental costs and benefits. EIA systematically examines both beneficial and adverse consequences of the project and ensures that these effects are taken into account during project design. It helps to identify possible environmental effects of the proposed project, proposes measures to mitigate adverse effects and predicts whether there will be significant adverse environmental effects, even after the mitigation is implemented. By considering the environmental effects of the project and their mitigation early in the project planning cycle, environmental assessment has many benefits, such as protection of environment, optimum utilisation of resources and saving of time and cost of the project. Properly conducted EIA also lessens conflicts by promoting community participation, informing decision makers, and helping lay the base for environmentally sound projects. Benefits of integrating EIA have been observed in all stages of a project, from exploration and planning, through construction, operations, decommissioning, and beyond site closure.

The EIA for this SLF subproject is aimed at identifying and analysing the aspects that affect the environmental components (like air, noise, water, land and socio-economic) in the SLF site (Core -Zone) and 10 km radius around the SLF (Buffer-Zone).

This EIA is conducted in line with the EIA notification 2006 and its subsequent amendments with a view to assess the environmental impacts arising due to the proposed project and to present for Environmental Clearance. In addition, the report covers Impact assessment, mitigation management and monitoring measures to be ensured in line with KSWMP ESMF (https://kswmp.org/?p=1425) in line with the World Bank safeguard policies and the World Bank Environmental, Health and Safety (EHS) Guidelines applicable to KSWMP Project supported by the World Bank. Description of

[3] https://mohua.gov.in/pdf/627b8318adf18Circular-Economy-in-waste-management-FINAL.pdf

the safeguard policies as applicable to KSWMP and mitigation measures applicable to the proposed sanitary landfill and its associated facilities is presented in Annexure xVII

1.6.1 Terms of Reference of EIA Study prescribed by SEIAA KERALA

Online application for grant of ToR was submitted on behalf of KSWMP on 23.04.2024 under schedule 7 (i) of EIA Notification. The proposal was considered and the auto generated ToR was granted by SEIAA Kerala vide ToR Identification no. TO24B3401KL5888163N, dated 08-08-2024 (Copy of ToR enclosed as Annexure 1).

1.6.2 Applicability of Coastal Regulation Zone (CRZ)

The proposed site is not falling in CRZ zone as per the CRZ Notification 2019. Hence, CRZ clearance for the project site is not applicable.

1.6.3 Baseline data generation, field studies

The EIA report has been prepared on the basis of one season baseline environmental data collected during December 2023 to February 2024, by M/s. ABC Techno Labs India Private Limited.

The monitored baseline data includes micro meteorological parameters, ambient air quality, noise levels, and surface and ground water quality and soil characteristics. Site survey has been conducted for studying the flora and fauna, socio-economic conditions including public consultation, land use, hydrology and hydrogeology, ecology, and traffic density amongst others. Secondary information has been collected from several agencies and departments, both under State and Central Government.

The collected data have been analysed in detail for predicting and evaluating the environmental impacts by the proposed project. Potential impacts on environment have been assessed and suitable environmental management plan has been formulated.

1.6.4 Secondary data collection

Secondary baseline information on water resources, geology, hydrology, demography, ecology was collected from the following sources:

- India Meteorological Department (IMD)
- Geological Survey of India (GSI)
- Botanical Survey of India (BSI)
- Office of Divisional Forest Officer (DFO)
- Census of India
- Central Ground Water Board (CGWB)
- National Bureau of Soil Survey & Land use Planning
- State/Central Pollution Control Board

1.6.5 Report Coverage

This Environmental Impact Assessment Report (EIA) consists of twelve chapters (in addition to the Executive Summary). The report contains information on the existing environment and evaluates the predicted environmental and socio-economic impacts of the proposed project activities. A detailed coverage of project description, background environmental quality, pollution sources, anticipated environmental impacts (including socio-economic impacts) and mitigation measures, environmental monitoring programme, additional studies, project benefits, environmental monitoring plan and all related aspects have been covered in this report as per MoEF&CC guidelines.

1.6.6 National / State Acts/Rules Applicable to this project

The National and State Acts and Rules applicable to this project along with roles and responsibilities of the project proponent is given in the Table 1-2.

Table 1-2 Acts and Rules applicable to this project

Legal Channel	Responsible Ministries/Bodies	Objective of Legislation	Roles & Responsibilities
The Water (Prevention & Control of Pollution) Act 1974/ Rules 1975	CPCB, SPCB	The prevention and control of water pollution and also maintaining or restoring the wholesomeness of water	➢ Not to discharge any effluent, not confirming to standards, prescribed by CPCB/SPCB into any stream, well, sewers or land. ➢ Not to discharge air pollutant(s) in excess of standards, prescribed by the State PCB. ➢ Obtain 'Consent to Establish' prior to establish any process, operation or treatment system. ➢ Obtain 'Consent to Operate' prior to operation of system which is likely to discharge effluent. ➢ Apply for renewal of the 'Consent to Operate' before the expiry. ➢ Comply with conditions as prescribed under consents.
The Air (Prevention & Control of Pollution) Act 1981/ Rules 1982	CPCB, SPCB	The prevention, control and abatement of air pollution	
The Environment (Protection) Act 1986/ Rules 1986 The Environmental Impact Assessment (EIA) Notification, 2006	MoEF&CC, CPCB, SPCB	Protection and Improvement of the Environment	➢ Prevent discharge or emission of environment pollutants in excess of the prescribed standards. ➢ Submit 'Environmental Statement' every year. ➢ Obtain prior "Environmental Clearance' from MoEF&CC in case of new project or for Modernization / Expansion.
Hazardous and Other Wastes (Management and Trans boundary Movement) Rules, 2016	MoEF&CC, CPCB, SPCB	Management & Handling of hazardous wastes in line with the Basel convention	➢ It is the responsibility of the occupier to identify the hazardous wastes in their units and ensure proper handling and disposal. ➢ PP to take all steps to contain contamination, prevent accident and limit consequences on human being and environment. ➢ Obtain authorization from SPCB and comply with the conditions.

			➢ Maintain records of Hazardous Waste generated in Form-3 and submit yearly return for generation, treatment, recycling, disposal etc., to SPCB in Form-4 ➢ Used Oil to be send / sold to the registered recycler, re-processor, registered authorized facility ➢ Will be transported in accordance with the rule. ➢ Site storage is allowed for 90 days only
The Solid Waste Management Rules, 2016 Plastic Waste Management Rules, 2016 and its subsequent amendments	CPCB, SPCB	To manage/ utilize the generated solid waste & Plastic waste without damaging the environment and surroundings	➢ Segregate waste in to three streams, Wet (Biodegradable), Dry (Plastic, Paper, metal, wood, etc.) and domestic hazardous wastes (diapers, napkins, empty containers of cleaning agents, mosquito repellents, etc.) and handover segregated wastes to authorized rag-pickers or waste collectors or local bodies. Solid Waste Management rules, 2016 suggests sanitary landfill as the mechanism for scientific disposal of rejects and inerts
Noise Pollution (Regulation and Control) Rules, 2000 and its amendments	CPCB, SPCB, MoEF&CC	To maintain the noise levels with respect to the place/equipment/ industry	➢ Noise Quality Monitoring & submission of reports on weekly/monthly basis. ➢ Providing Ear plugs and Muffs to the workers working in noise prone areas. ➢ Dampening the source noise level or making the noise characteristics less annoying by providing suitable enclosures and barriers.
The Central Motor Vehicle Rules, 1989	Ministry of Road Transport and Highways	To consolidate and amend the law relating to motor vehicles including to regulate the	➢ Ensure compliance to safety provisions in the transport vehicle carrying dangerous and hazardous substances inside works

		transportation of dangerous goods with a view to prevent loss of life or damage to the environment	➢ Display of emergency information panels at front, back and both side of vehicle ➢ Every transporter to ensure safe transportation of dangerous/ hazardous goods. ➢ Earthing chain for grounding, any prevalent static charge. ➢ All motor vehicle entering the works will have properly maintained brakes, lights, signal system for brakes, blinkers and registration number displayed, and valid Pollution under Control Certificate.
Construction & Demolition Waste Management Rules, 2016.	CPCB, SPCB, MoEF&CC	To promote sustainable waste management by mandating segregation, recycling, and proper disposal of C&D waste and prevent obstruction to the traffic or the public or drains.	➢ To ensure environmentally sound management of C&D waste. While granting the authorization, the SPCB would assess and ensure the availability and adequacy of infrastructure with C&D facilities to meet the prescribed environmental norms. ➢ To provide technical support to local bodies, waste recyclers and other stakeholders. ➢ This is to ensure building materials made out of C&D Waste do not jeopardize the structural safety and life.

Only key Acts are mentioned here. In addition there are many other environmental, and Work safety related acts / rules including E-Waste Management Rules 2022, Plastic Wastes management Rules, 2018, the Building and other Construction Workers act 2016 and others that may be applicable to various wastes, and activities associated with this subproject.

2 Project Description

2.1 General

This chapter provides a detailed overview of the present proposal of Scientific Landfill which is covering various engineering techniques in line with SWM Rules, 2016.

There are three Electrical High-Tension Lines (EHT) of KSEB passing through the footprint area of the proposed land parcel. The KSWMP (through KSEB) is in process of shifting all the three lines beyond the landfill boundary. However, the feasibility study and approvals are granted for shifting of EHT line A only and the EHT lines B & C may be shifted in future based on the technical feasibility.

KSWMP Phase: This phase is of 18.14 acres land after realignment of EHT line A. This will accommodate inert waste disposal for about 20 years.The detailed design and construction for this phase is expected to be completed by November 2028.

The project description also highlights the technology adopted for landfilling, Leachate collection & treatment facilities, storm water management and other allied facilities with respect to the environmental protection in order to provide the efficient management system of wastes in the state of Kerala. Some of the associated facilities like construction of approach road, shifting of KSEB HT line, proposed mechanism of collection of inerts & rejects from various districts that are part of this subproject, utilities and post closure details are also described in this chapter.

2.2 Type of the Project

The proposed project SLF falls under Item 7(i) (Common Municipal Solid Waste Management facilities) as per Environmental Impact Assessment notification dated September 14th, 2006 and its amendments. The project is categorised under ‘B1’ and will require Environmental Clearance from State Environmental Impact Assessment Authority (SEIAA) Kerala as per the above notification.

Scientific landfilling is the method of disposing of inert solid waste in an engineering designed land area for spreading inert waste into thin layers, compacting to the smallest volume and covering with soil on daily basis. Landfill gas such as methane generated from the anaerobic conditions prevailing in the landfill due to the presence meagre amount of organic material can be evacuated through vent pipes.

2.3 Need of the Project

Kerala Solid Waste Management Project (KSWMP), is a project of the Kerala Local Self Government Department, to establish a SLF. This decision meets the “SWM Rules, 2016, wherein it is stated that all ULBs have to establish a SLF by 2019. Alternately they can participate in a regional SLF. As ULBs in Kerala face shortage of land, it was proposed to develop a Regional SLF catering to cluster of ULBs. The proposed Ambalamedu SLF caters to ULBs from four districts that do not have access to dedicated SLF. In total, five Clusters are planned to be covered under this SWM programme for which development of Scientific Landfill is proposed. Out of five Clusters, the Cluster-4 (Ambalamedu) was identified to manage inert rejects generated from four surrounding districts as shown in the Figure 2-1.At a later stage, inert/rejects from other Urban Local Bodies (ULBs) shall also be assigned to the Ambalamedu SLF by Govt. of Kerala if site is able to accommodate more quantity than the estimated one, owing to the technology improvement. Cluster 4 covers municipalities under the Ernakulam, Idukki, Alappuzha, Thrissur and Kottayam districts.

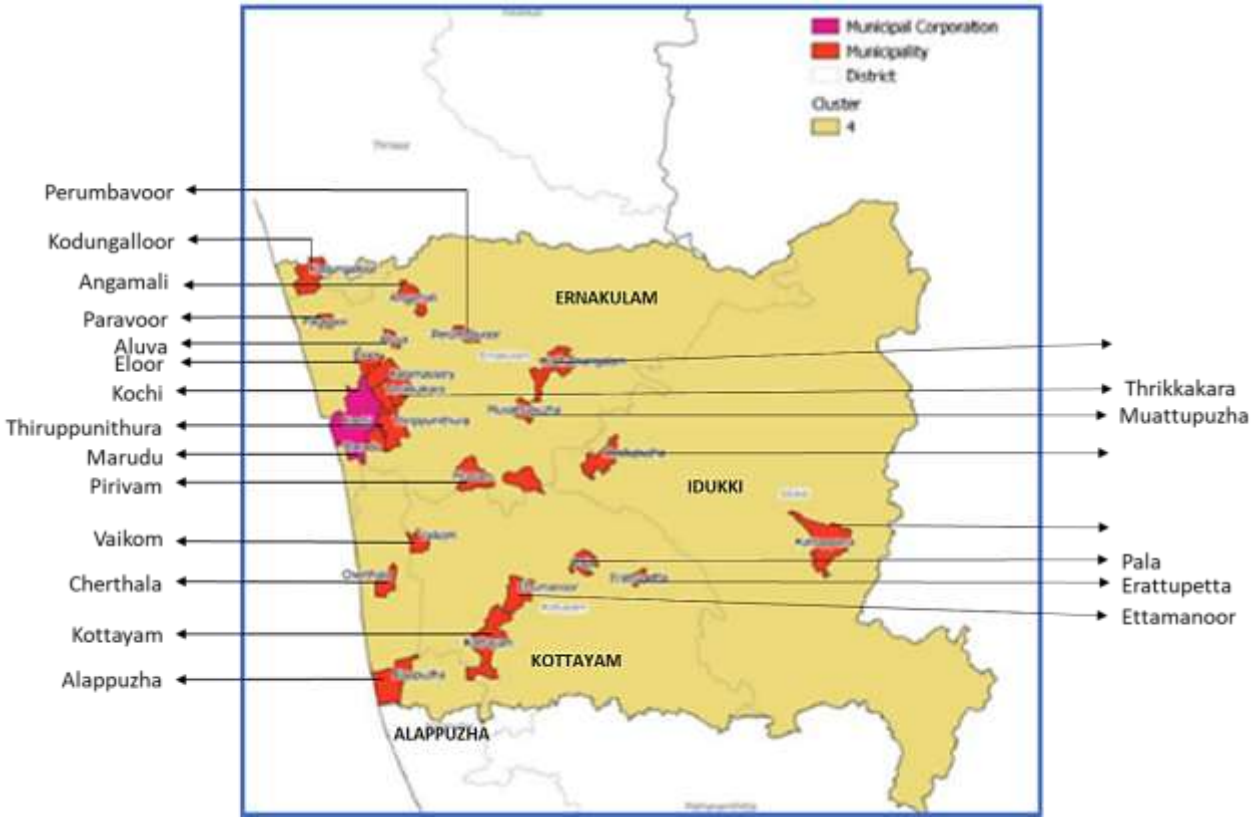


Figure 2-1 Image showing Cluster 4 of KSWMP

2.4 Salient features of the project

The brief note on proposed project site covering engineering facilities, life of SLF, various utilities with project cost is given in Table 2-1.

Table 2-1 Salient Features of the project

Description	Details
Project activity in brief	➢ The implementation of SLF will have four major steps such as 1. Ground improvement and Land development 2. SLF Construction 3. Leachate management 4. Allied Infrastructure 5. Shifting of HT line and development of approach road. ➢ Inert/rejects will be collected and transported to the SLF site by Refuse Compactor Vehicles (RCV);specialized large capacity trucks designed to collect and compact waste materials and transfer over long distances. ➢ The expected average annual disposal of inert 20000 TPA
Project life span	20 years of operation and maintenance, and 15 years post closure maintenance.
Manpower requirement	Construction phase – Approx. 200 persons Operation Phase – Approx. 85 persons
Water requirement & source	During Construction Phase – 35 KLD through contractor by engaging with KWA During Operation & Maintenance Phase for drinking – 3 KLD by Kerala Water Authority (KWA)
Power requirement & source	Power requirement at SLF would be about 88.52 kW

Estimated cost of the project	~ INR 274.79 Crore.

2.5 Size/Magnitude of the operation

The overall SLF is planned in an area of 18.14 acres of land to accommodate 4,00,000 MT of inert waste for a period of 20 years. The project will have associated leachate collection & treatment plant with designed capacity of 400 KLD against the generation of about 300 KLD, also considering precipitation and rainfall days based on CPHEEO SWM Manual, India Meteorological Department's Data on rainfall and rainy days and adding 28% more capacity to take care of unforeseen events.

2.6 Location of the Project

The land for proposed SLF for Cluster-4 is located at Ambalamedu, Kunnathnadu Taluk, Ernakulam District, Kerala. The site is under the ownership of Kerala Industrial Infrastructure Development Corporation (KINFRA) and the extent of land is about 25 acres earmarked for KSWMP SLF. The site boundary map is shown in Figure 2-2. The boundary co-ordinates of the proposed SLF site are given in Table 2-2. The SLF boundary superimposed on the KINFRA layout along with surrounding environment is shown in Figure 2-3.

Table 2-2 Site boundary co-ordinates

Points	Latitude	Longitude	Points	Latitude	Longitude
1	9°59'20.10"N	76°21'58.51"E	16	9°59'10.46"N	76°21'53.06"E
2	9°59'19.78"N	76°21'58.61"E	17	9°59'7.54"N	76°21'45.56"E
3	9°59'19.17"N	76°21'58.65"E	18	9°59'6.93"N	76°21'45.36"E
4	9°59'18.77"N	76°21'58.72"E	19	9°59'10.10"N	76°21'41.60"E
5	9°59'18.77"N	76°21'58.64"E	20	9°59'10.53"N	76°21'40.84"E
6	9°59'18.92"N	76°21'58.56"E	21	9°59'13.69"N	76°21'40.98"E
7	9°59'17.74"N	76°21'57.04"E	22	9°59'15.56"N	76°21'41.68"E
8	9°59'17.40"N	76°21'57.19"E	23	9°59'15.99"N	76°21'42.49"E
9	9°59'17.32"N	76°21'57.11"E	24	9°59'16.14"N	76°21'44.24"E
10	9°59'16.70"N	76°21'57.07"E	25	9°59'16.34"N	76°21'44.77"E
11	9°59'16.90"N	76°21'56.10"E	26	9°59'16.37"N	76°21'46.47"E
12	9°59'14.56"N	76°21'55.17"E	27	9°59'16.93"N	76°21'47.49"E
13	9°59'14.79"N	76°21'53.94"E	28	9°59'16.74"N	76°21'48.71"E
14	9°59'14.70"N	76°21'53.58"E	29	9°59'16.82"N	76°21'49.76"E
15	9°59'10.74"N	76°21'53.31"E	30	9°59'18.76"N	76°21'56.41"E

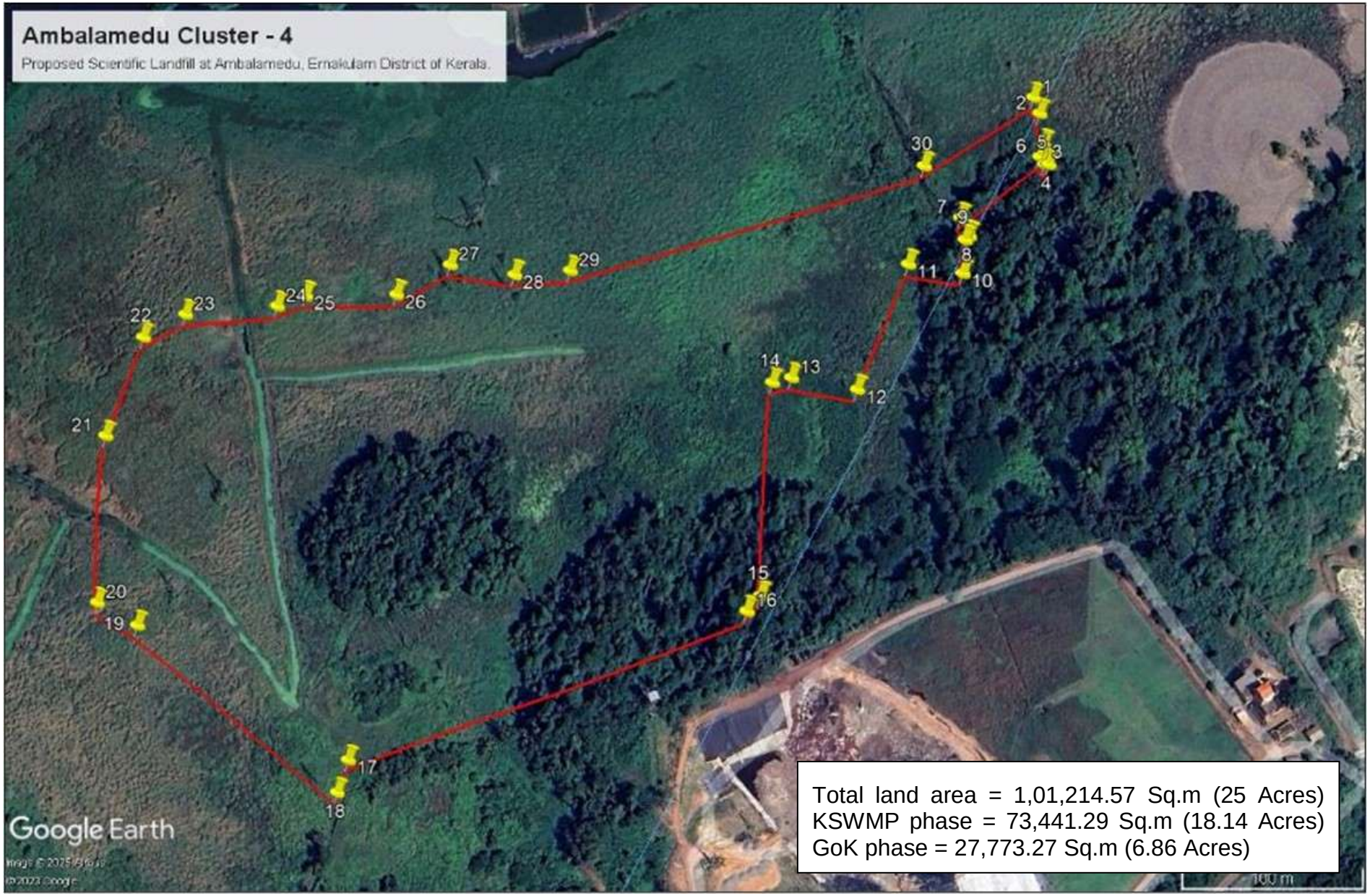


Figure 2-2 Google imagery of project site boundary

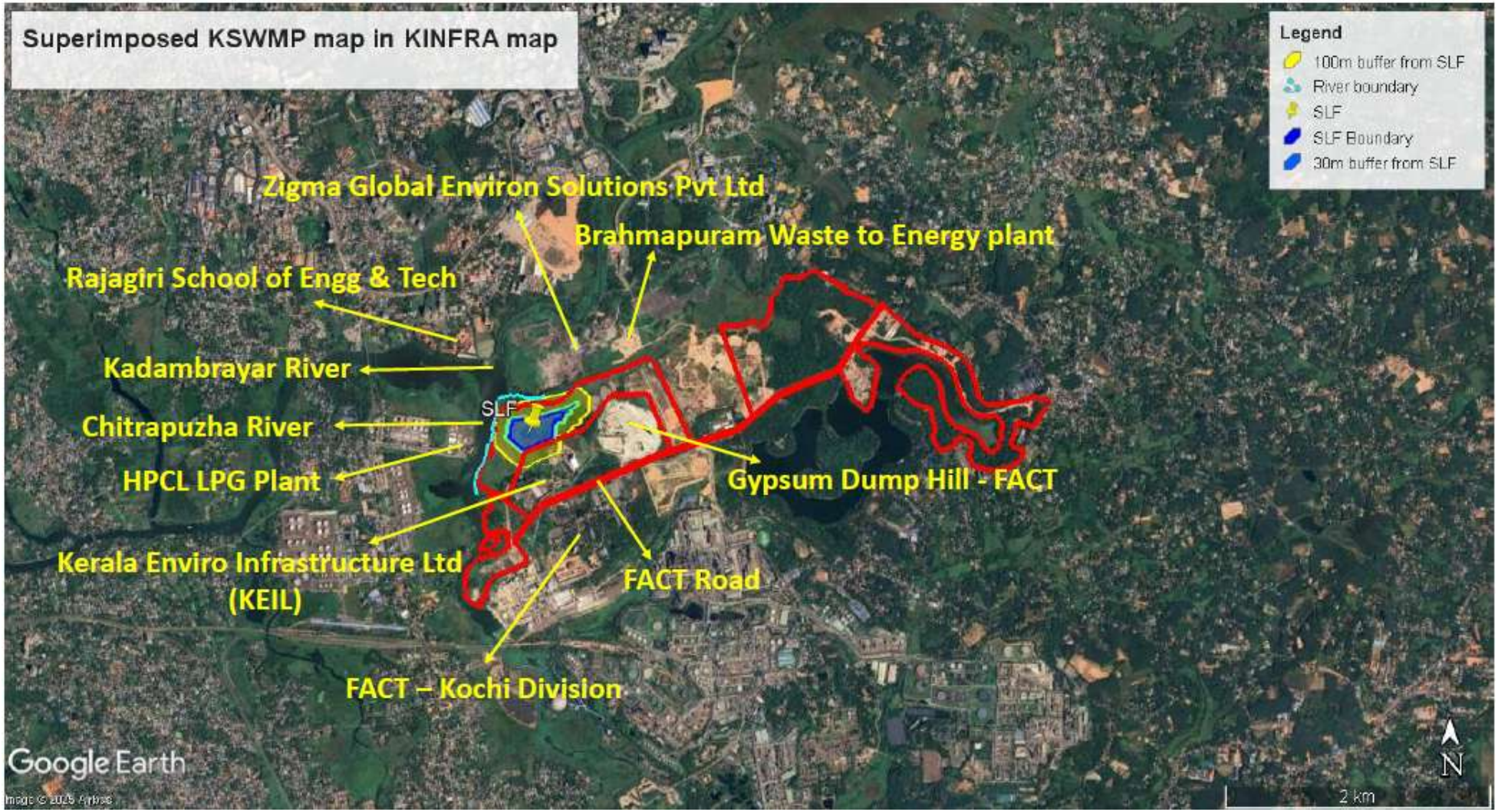


Figure 2-3 Proposed Landfill & KINFRA Layout Super imposed on Google Earth Map

2.7 Connectivity

The project site is well connected with road, rail & airways. The project site has enough setbacks with the water body to satisfy the SLF requirement of 100 meters distance buffer and is situated along the Chitrapuzha River's bank. The site can be accessed by SH 41 (3.5 km – N) & NH 85 (3 km – SSW) which is connecting the Cochin port and Cochin International Airport. The nearest railway station is Tripunithura located in the SSW direction at a distance of about 4 km. The Cochin International Airport in the NNE direction at a distance of 18 km and Naval airstrip at a distance of 10 km in WSW direction from the project site. The nearest city is Ernakulam at a distance of 4 km to the west. The connectivity map of the project site covering 10 km radius is shown in Figure 2-4.

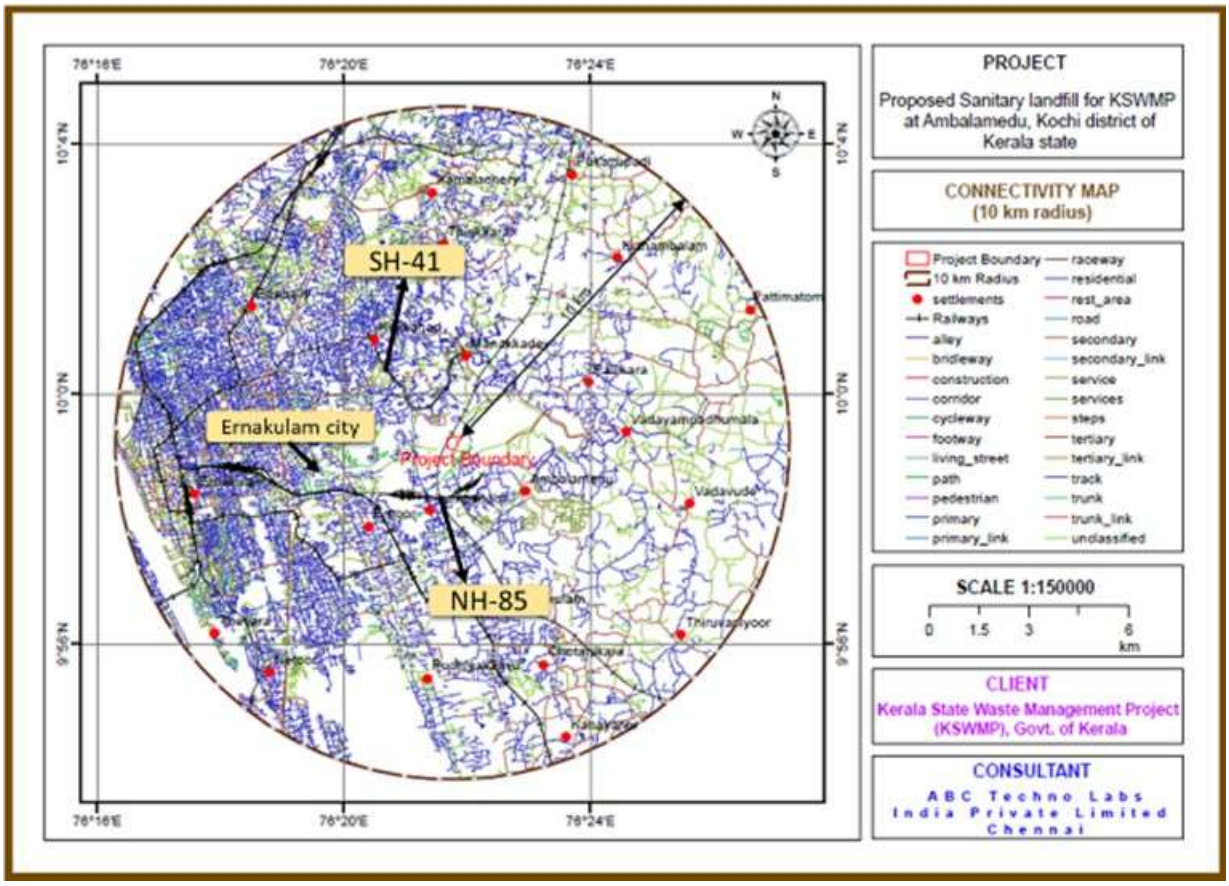


Figure 2-4 Connectivity map of the site covering 10 km radius

2.8 Proposed Schedule for Approval & Implementation

The project is planned to be completed in 28 months on obtaining all statutory clearances.

2.9 Site selection criteria

A detailed reconnaissance survey was carried to identify any location which is having facility to dispose inert waste. It was observed that Kerala Environ Infrastructure Limited (KEIL) is operating Secured Landfill for Common Hazardous Waste Treatment, Storage and Disposal Facility (CHWTSDF) located at a crow fly distance of 250m in S direction from the proposed SLF. The KEIL's Transfer Storage, Disposal Facility (TSDF) and activities here are for Hazardous waste management whereas the proposed Ambalamedu SLF is planned for scientific disposal of of inerts from solid waste.

A detailed comparison of site selection criteria with its conformity for the proposed activity on confirmation of the coordinates of the site. The below criteria are prima facie fit for Ambalamedu site

Table 2-3 Conformity with the Site selection criteria

Sl. No.	Criteria for landfill as per SWM Rules, 2016	Conformity with criteria
1	No landfill is permitted 500m from a notified habitant area	Complied
2	Landfill site is not allowed within 100m from the river bank (diversion, culverting or channelling is economically and environmentally feasible to protect the stream from SLF area will be provided)	Complied
3	Landfill site is not permitted within 200m of a lake or pond	Complied
4	Flood prone areas are to be avoided	With reference to the local temporary benchmark at the proposed site given in the topographic contour map, the lowest natural ground level (NGL) is 20.60 m MSL, the highest natural ground level (NGL) is 21.332 m MSL. The average ground level at the site is 21 meters MSL. The given High Flood Level (HFL) is 22.95 m MSL. The original/ existing average ground level of 21 MSL as per DGPS survey which is around 1.95 m below HFL (i.e. HFL = 22.95 meter MSL). The existing ground level is proposed to be raised by 2.00 m above HFL in line with SWM Rules 2016, so total rise envisaged in existing ground level is around 3.95 m (i.e. 1.95 + 2.00) to account for the water barrier between high flood level and SLF base, plus filling of 1.3 m for settlement allowance.
5	200m of right of way of any State or National Highways is to be provided	Complied
6	No landfill within 200 m of public park	Complied
7	Wetlands are not to be used for landfills	The proposed site is not a designated wetland
8	No landfill within 20km of an airport or airbase	Cochin International Airport is located at a distance of 18 km in NNE direction. An Airport NOC will be obtained from the competent authority. NOC from Naval airstrip has already been obtained.
9	No landfill in a coastal regulation zone	The proposed site is not a CRZ area.
10	No landfill in potentially unstable zones	The site not an unstable zone
11	Landfill should have a buffer zone around it up	30m buffer zone from the SLF footprint area boundary is provided as per KSPCB order vide letter no.

Sl. No.	Criteria for landfill as per SWM Rules, 2016	Conformity with criteria
	to a distance prescribed by the regulatory agencies	PCB/SO/SEE2/Modelcity/kozhikoducorporation/2019 dated 09.09.2021 and circular vide KSPCB/1249/2024-SEE-1 dated 25.01.2025
12	Exclude the areas with unstable geological features such as weak soils (organic soils or soft clay or clay-sand mixtures or soils that lose strength with compaction or with wetting, etc.)	Complied
13	Exclude the areas with high population, unique archaeological, historical, paleontological and religious interests	Complied
	Exclude areas of ground water recharge and extremely high water table zone	Complied
14	Exclude areas prone to natural hazards (such as volcanic activity, seismic disturbance and landslides)	Complied
15	Exclude areas with subsidence (such as owing to subsurface mines; water, oil or gas withdrawal; or solution – prone subsurface)	Not Applicable
16	Exclude agricultural/forest areas	No agricultural/forest areas included
17	Alternate Site Consideration	Before identifying the location of landfill for Cluster 4, alternative sites have been considered for the project activity. The availability of land, location of the waste collection area and other regulatory criteria as required to meet the site selection have been considered, and after analysing the permutation and combination the present site for Cluster 4 has been finalized.

2.9.1 Waste acceptance criteria

A waste acceptance criteria must be formulated for this site and shall be detailed in the Operating Manual for the Proposed Sanitary Landfill. The following waste acceptance criteria are suggested:

a. Inert waste will be routinely accepted if the truck/tipper has authorized documents indicating the source, quantity and composition of waste. Waste composition

shall be assessed by the Engineer in-charge at the respective ULB's before sending the vehicles.

b. Inert waste laden in authorized trucks from all authorized waste collection stations within Kerala will be visually inspected at sanitary landfill and inerts/rejects as defined in SWM Rules, 2016 only will be allowed for disposal. A waste screening and weighing platform is provided for this purpose. A Standard Operating Procedure / Operations Manual for the Proposed Sanitary Landfill shall describe the process to be used to 'reject' wastes from being deposited.
c. There shall be third party audit, (both quantity & composition using appropriate scientific mechanism) of the material sent to the landfill both at the collection points and landfill once in a quarter in line with applicable regulations and international good practices.

2.10 Forecasting of inert waste generation

Projected District wise **ULB Population** for the periods 2021-2037, and from 2038 to 2055 are presented in Tables 2-4 and 2-5 below. Based on total population, **ULB wise total solid waste generation** of each ULB is projected and presented in Tables 2-6, and 2-7. Computing 12 percent of the total waste as rejects/inerts, **ULB wise rejects/inert generation** is projected for the above periods and presented in Tables 2-8, and 2-9. Finally, ULB wise inerts/rejects for the subproject period is **summarised** and presented in Table 2-10.

Following assumptions are considered to project the waste generation:

- Per capita per day waste generation in Municipality area is 0.419 kg
- Per capita per day waste generation in Corporation area is 0.545 kg
- Per year increase in per capita waste generation is 1.3%
- Percentage of waste inerts/rejects is 12%

Table 2-4 Population Projection (2021 – 2037)

S.No.	Name of ULB (Municipality)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Alappuzha																		
1	Cherthala	46549	46592	46630	46663	46690	46712	46729	46740	46746	46747	46743	46733	46718	46697	46672	46641	46605
2	Alappuzha	171323	170894	170439	169959	169452	168919	168359	167774	167163	166525	165862	165172	164457	163715	162947	162154	161334
Kottayam																		
1	Kottayam	145730	145632	145373	144951	144368	143623	142717	141648	140418	139026	137473	135757	133880	131841	129640	12728	124754
2	Pala	21472	21377	21275	21167	21052	20930	20801	20666	20525	20376	20221	20059	19891	19716	19534	19345	19150
3	Vaikom	23827	23879	23929	23979	24026	24073	24118	24162	24204	24245	24285	24323	24360	24396	24430	24463	24495
4	Erattupetta	34307	34787	35271	35758	36249	36799	37242	37744	38250	38759	39272	39788	40308	40832	41359	41890	42424
5	Ettumanoor	75835	78306	80776	83247	85717	88188	90659	93129	95600	98070	100541	103012	105482	107953	110423	112894	115365
Idukki																		
1	Thodupuzha	57844	58430	59016	59604	60193	60783	61374	61965	62558	63152	63748	64344	64941	65539	66138	66738	67340
2	Kattappana	45684	45923	46150	46366	46569	46761	46941	47110	47266	47411	47544	47665	47775	47872	47958	48032	48095
Ernakulam																		
1	Koothattukulam	16824	16746	16661	16570	16473	16369	16259	16142	16019	15889	15754	15611	15462	15307	15146	14978	14803
2	Muvattupuzha	31548	31649	31748	31845	31939	32030	32119	32205	32289	32371	32450	32526	32600	32671	32740	32807	32871
3	Aluva	20746	20627	20518	20417	20326	20243	20170	20105	20050	20003	19966	19938	19918	19908	19907	19914	19931
4	Eloor	32842	32862	32861	32838	32795	32729	32643	32535	32405	32255	32084	31890	31676	31440	31183	30905	30605
5	Maradu	48396	48701	48995	49277	49547	49806	50053	50289	50513	50725	50926	51115	51292	51458	51612	51754	51885
6	Thrikkakara	88654	89692	90712	91715	92700	93668	94619	95552	96468	97367	98248	99111	99957	100786	101597	102391	103168
7	Angamali	33521	33445	33354	33249	33129	32994	32844	32679	32499	32305	32096	31872	31633	31380	31111	30828	30530
8	Trippunithura	108878	110511	112143	113776	115409	117041	118674	120307	121939	123572	125204	126837	128470	130102	131735	133367	135000
9	Kalamassery	78960	79729	80493	81254	82010	82761	83509	84252	84991	85726	86456	87182	87904	88622	89335	90044	90749
10	Perumbavoor	29673	29821	29967	30111	30254	30395	30535	30673	30809	30944	31078	31209	31339	31468	31595	31720	31844
11	N. Paravoor	32947	33072	33193	33311	33425	33536	33643	33747	33847	33944	34037	34126	34212	34294	34373	34448	34520
12	Kothamangalam	40501	40668	40835	41003	41170	41338	41506	41674	41842	42010	42178	42346	42515	42684	42852	43021	43190
13	Piravam	32032	32513	32993	33473	33953	34434	34914	35394	35875	36355	36835	37316	37796	38276	38757	39237	39717
14	Kochi Corporation	671531	675521	679546	683606	687701	691831	695996	700196	704431	708700	713005	717345	721719	726129	730573	735053	739567
Thrissur																		
1	Kodungalloor	73221	73318	73401	73468	73521	73560	73583	73592	73586	73566	73531	73481	73416	73336	73242	73133	73010
Total Population		1962845	1974695	1986281	1997606	2008668	2019468	2030005	2040280	2050293	2060044	2069532	2078758	2087721	2096422	2104861	2113038	2120952
In Lakhs		19.63	19.75	19.86	19.98	20.09	20.19	20.30	20.40	20.50	20.60	20.70	20.79	20.88	20.96	21.05	21.13	21.21

Table 2-5 Population Projection (2038 – 2055)

Sl. No	Name of ULB (Municipality)	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055
Alappuzha																			
1	Cherthala	46563	46517	46465	46408	46345	46277	46204	46126	46042	45953	45859	45759	45654	45544	45429	45308	45182	45051
2	Alappuzha	160488	159615	158717	157793	156843	155866	154864	153835	152781	151700	150593	149460	148301	147116	145905	144668	143404	142115
Kottayam																			
1	Kottayam	122068	119220	116211	113040	109707	106212	102555	98737	94757	90615	86312	81847	77220	72431	67480	62368	57094	51658
2	Pala	18948	18740	18525	18303	18075	17839	17598	17349	17094	16832	16564	16288	16007	15718	15423	15121	14812	14497
3	Vaikom	24525	24554	24582	24608	24633	24656	24679	24699	24719	24737	24754	24769	24783	24796	24807	24817	24826	24833
4	Erattupetta	42982	43504	44049	44599	45151	45707	46267	46831	47398	47969	48543	49121	49703	50288	50877	51469	52066	52665
5	Ettumanoor	117835	120306	122776	125247	127718	130188	132659	135129	137600	140071	142541	145012	147482	149953	152424	154894	157365	159835
Idukki																			
1	Thodupuzha	67942	68546	69150	69756	70362	70970	71578	72188	72799	73410	74023	74637	75252	75868	76485	77103	77722	78342
2	Kattappana	48145	48184	48211	48226	48229	48221	48201	48169	48125	48070	48002	47923	47833	47730	47616	47489	47351	47202
Ernakulam																			
1	Koothattukulam	14622	14435	14242	14042	13835	13622	13403	13177	12945	12706	12461	12210	11952	11688	11417	11140	10857	10567
2	Muvattupuzha	32932	32991	33048	33102	33153	33202	33248	33292	33334	33373	33409	33443	33475	33504	33531	33555	33576	33595
3	Aluva	19957	19991	20035	20088	20150	20221	20300	20389	20487	20594	20710	20835	20969	21112	21264	21425	21595	21774
4	Eloor	30284	29941	29578	29193	28786	28358	27909	27439	26947	26434	25900	25344	24767	24169	23549	22908	22246	21562
5	Maradu	52004	52112	52208	52293	52365	52426	52476	52514	52540	52555	52558	52549	52529	52497	52454	52398	52332	52253
6	Thrikkakara	103927	104668	105393	106100	106789	107461	108116	108753	109372	109975	110560	111127	111677	112210	112725	113223	113704	114167
7	Angamali	30217	29890	29547	29190	28818	28431	28029	27613	27182	26736	26275	25799	25308	24803	24283	23748	23198	22634
8	Trippunithura	136633	138265	139898	141531	143163	144796	146428	148061	149694	151326	152959	154591	156224	157857	159489	161122	162755	164387
9	Kalamassery	91450	92146	92838	93526	94210	94889	95564	96235	96901	97564	98222	98875	99525	100170	100811	101448	102080	102708
10	Perumbavoor	31966	32087	32206	32324	32439	32554	32666	32778	32887	32995	33101	33206	33309	33411	33511	33609	33706	33802
11	N. Paravoor	34588	34653	34714	34772	34826	34876	34923	34966	35006	35042	35075	35104	35130	35152	35171	35186	35197	35205
12	Kothamangalam	43380	43529	43698	43868	44038	44208	44378	44548	44718	44888	45059	45229	45400	45571	45742	45913	46084	46256
13	Piravam	40198	40678	41158	41639	42119	42599	43080	43560	44040	44521	45001	45481	45961	46442	46922	47402	87883	48363
14	Kochi Corporation	744117	748701	753321	757975	762664	767389	772148	776942	781771	786635	791534	796468	901437	806441	811480	816554	821663	826806
Thrissur																			
1	Kodungalloor	72872	72719	72551	72369	72171	71960	71733	71492	71236	70965	70680	70379	70065	69735	69391	69032	68658	68270
Total Population		2128604	2135993	2143120	2149985	2156588	2162928	2169006	2174821	2180374	2185665	2190694	2195460	2199964	2204205	2208185	2211902	2215356	2218548
In Lakhs		21.29	21.36	21.43	21.50	21.57	21.63	21.69	21.75	21.86	21.86	21.91	21.95	22.0	22.04	22.08	22.12	22.15	22.19

Table 2-6 Waste generation from ULBs (2021 – 2037)

Sr. No	Name of ULB	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Alappuzha																		
1	Cherthala	19.50	19.78	20.05	20.32	20.60	20.88	21.16	21.44	21.72	22.00	22.29	22.57	22.86	23.14	23.43	23.72	24.01
2	Alappuzha	71.78	72.54	73.28	74.03	74.76	75.50	76.23	76.95	77.67	78.38	79.08	79.77	80.46	81.14	81.81	82.47	83.12
Kottayam																		
1	Kottayam Municipality	61.06	61.81	62.51	63.13	63.70	64.19	64.62	64.97	65.24	65.43	65.54	65.57	65.50	65.34	65.09	64.73	64.27
2	Pala Municipality	9.00	9.07	9.15	9.22	9.29	9.35	9.42	9.48	9.54	9.59	9.64	9.69	9.73	9.77	9.81	9.84	9.87
3	Vaikom Municipality	9.98	10.14	10.29	10.44	10.60	10.76	10.92	11.08	11.25	11.41	11.58	11.75	11.92	12.09	12.27	12.44	12.62
4	Erattupetta Municipality	14.37	14.77	15.17	15.57	15.99	16.42	16.86	17.31	17.77	18.24	18.72	19.22	19.72	20.24	20.76	21.30	21.86
5	Ettumanoor Municipality	31.77	33.24	34.73	36.26	37.82	39.42	41.05	42.71	44.42	46.16	47.93	49.75	51.61	53.50	55.44	57.42	59.43
Idukki																		
1	Thodupuzha Municipality	24.24	24.80	25.37	25.96	26.56	27.17	27.79	28.42	29.07	29.72	30.39	31.08	31.77	32.48	33.20	33.94	34.69
2	Kattappana Municipality	19.14	19.49	19.84	20.19	20.55	20.90	21.25	21.61	21.96	22.31	22.67	23.02	23.37	23.73	24.08	24.43	24.78
Ernakulam																		
1	Koothattukulam Municipality	7.05	7.11	7.16	7.22	7.27	7.32	7.36	7.40	7.44	7.48	7.51	7.54	7.56	7.59	7.60	7.62	7.63
2	Muvattupuzha Municipality	13.22	13.43	13.65	13.87	14.09	14.32	14.54	14.77	15.00	15.24	15.47	15.71	15.95	16.19	16.44	16.68	16.93
3	Aluva Municipality	8.69	8.76	8.82	8.89	8.97	9.05	9.13	9.22	9.32	9.41	9.52	9.63	9.74	9.87	9.99	10.13	10.27
4	Eloor Municipality	13.76	13.95	14.13	14.30	14.47	14.63	14.78	14.92	15.06	15.18	15.30	15.40	15.50	15.58	15.66	15.72	15.77
5	Maradu Municipality	20.28	20.67	21.07	21.46	21.85	22.26	22.66	23.06	23.47	23.87	24.28	24.69	25.09	25.50	25.91	26.32	26.73
6	Thrikkakara Municipality	37.15	38.07	39.00	39.95	40.90	41.87	42.84	43.82	44.82	45.83	45.84	47.87	48.90	49.95	51.01	52.07	53.15
7	Angamali Municipality	14.05	14.20	14.34	14.48	14.62	14.75	14.87	14.99	15.10	15.20	15.30	15.39	15.48	15.55	15.62	15.68	15.73
8	Trippunithura Municipality	45.62	46.91	48.22	49.56	50.92	52.31	53.73	55.18	56.65	58.16	59.69	61.26	62.85	64.48	66.14	67.83	69.55
3	Kalamassery Municipality	33.08	33.84	34.61	35.39	36.18	36.99	37.81	38.64	39.49	40.35	41.22	42.11	43.01	43.92	44.85	45.79	46.75
10	Perumbavoor Municipality	12.43	12.66	12.88	13.11	13.35	13.59	13.82	14.07	14.31	14.56	14.82	15.07	15.33	15.60	15.86	16.13	16.41
11	N. Paravoor Municipality	13.80	14.04	14.27	14.51	14.75	14.99	15.23	15.48	15.73	15.98	16.23	16.48	16.74	17.00	17.26	17.52	17.78
12	Kothamangalam Municipality	16.97	17.25	17.56	17.86	18.16	18.48	18.79	19.11	19.44	19.77	20.11	20.45	20.80	21.15	21.51	21.88	22.25
13	Piravam Municipality	13.42	13.80	14.19	14.58	14.98	15.39	15.81	16.23	16.67	17.11	17.56	18.02	18.49	18.97	19.46	19.95	20.46
14	Kochi Corporation	365.98	372.95	380.04	387.29	394.67	402.20	409.88	417.72	425.71	433.85	442.16	450.64	459.28	468.09	477.08	486.25	495.59
Thrissur																		
1	Kodungalloor Municipality	30.68	31.12	31.56	32.00	32.44	32.88	33.32	33.75	34.19	34.62	35.06	35.49	35.92	36.35	36.77	37.19	37.61
	Total Waste	907.05	924.38	941.89	959.60	977.50	995.59	1013.87	1032.34	1051.01	1069.87	1088.91	1108.16	1127.59	1147.22	1167.04	1187.06	1207.26

Table 2-7 Waste generation from ULBs (2038 – 2055)

Sl. No	Name of ULB (Municipality)	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055
Alappuzha																			
1	Cherthala	24.30	24.59	24.88	25.18	25.47	25.76	26.06	26.35	26.64	26.94	27.23	27.53	27.82	28.11	28.41	28.70	28.99	29.28
2	Alappuzha	83.76	84.38	85	85.60	86.19	86.77	87.33	87.88	88.41	88.93	89.43	89.91	90.37	90.81	91.24	91.64	92.02	92.38
Kottayam																			
1	Kottayam	63.71	63.03	62.24	61.32	60.29	59.13	57.83	56.41	54.84	53.12	51.26	49.24	47.05	44.71	42.20	39.51	36.64	33.58
2	Pala	9.89	9.91	9.92	9.93	9.93	9.93	9.92	9.91	9.89	9.87	9.84	9.80	9075	9.70	9.64	9.58	9.51	9.42
3	Vaikom	12.80	12.96	13.16	13.35	13.54	13.73	13.92	14.11	14.30	14.50	14.70	14.90	15.10	15.31	15.51	15.72	15.93	16.14
4	Erattupetta	22.42	23	23.59	24.19	24.81	25.45	26.09	26.75	27.43	28.12	28.83	29.55	30.29	31.04	31.81	32.60	33.41	32.23
5	Ettumanoor	61.50	63.60	65.75	67.95	70.19	72.48	74.81	77.20	79.63	82.11	84.65	87.23	89.87	92.57	95.31	98.12	100.98	103.90
Idukki																			
1	Thodupuzha	35.46	36.24	37.03	37.84	38.67	39.51	40.37	41.24	42.13	43.03	43.96	44.90	45.86	46.83	47.83	48.84	49.87	50.93
2	Kattappana	25.13	25.47	25.82	26.16	26.50	26.84	27.18	27.52	27.85	28.18	28.51	28.83	29.15	29.46	29.78	30.08	30.39	30.68
Ernakulam																			
1	Koothattukulam	7.63	7.63	7.63	7.62	7.60	7.58	7.56	7.53	7.49	7.45	7.40	7.35	7.28	7.22	7.14	7.06	6.97	6.87
2	Muvattupuzha	17.19	17.44	17.70	17.96	18.22	18.48	18.75	19.02	19.29	19.56	19.84	20.12	20.40	20.68	20.97	21.26	21.55	21.84
3	Aluva	10.42	10.57	10.73	10.90	110.7	11.26	11.45	11.65	11.85	12.07	12.30	12.53	12.78	13.03	13.30	13.57	13.85	14.15
4	Eloor	15.80	15.83	15.84	15.84	15.82	15.79	15.74	15.68	15.59	15.50	15.38	15.25	15.09	14.92	14.73	14.51	14.28	14.02
5	Maradu Municipality	27.14	27.55	27.96	28.37	27.78	29.19	29.59	30.00	30.40	30.81	31.21	31.61	32.01	32.41	32.80	33.19	33.58	33.97
6	Thrikkakara Municipality	54.24	55.33	56.44	57.56	58.69	59.82	60.97	62.13	63.29	64.47	65.65	66.85	68.05	69.27	70.49	71.72	72.96	74.21
7	Angamali Municipality	15.77	15.80	15.82	15.84	15.84	15.83	15.81	15.77	15.73	15.67	15.60	15.52	15.42	15.31	15.18	15.04	14.89	14.71
8	Trippunithura Municipality	71.31	73.10	74.92	76.78	78.68	80.61	82.58	84.58	86.63	88.71	90.83	93.00	95.20	97.45	99.73	102.06	104.44	106.86
9	Kalamassery	47.73	48.71	49.72	50.74	51.77	52.82	53.89	54.98	56.08	57.19	58.33	59.48	60.65	61.87	63.04	64.26	65.50	66.76
10	Perumbavoor	16.68	16.96	17.25	17.54	17.83	18.12	18.42	18.72	19.03	19.34	19.66	19.98	20.30	20.62	20.96	21.29	21.63	21.97
11	N. Paravoor	18.05	18.32	18.59	18.86	17.14	19.42	19.69	19.98	20.26	20.54	20.83	21.12	21.41	21.70	21.99	22.29	22.59	22.88
12	Kothamangalam Municipality	22.63	23.01	23.40	23.80	24.20	24.61	25.03	25.45	25.88	26.31	26.76	27.21	27.67	28.13	28.60	29.08	29.57	30.07
13	Piravam	20.98	21.51	22.04	22.59	23.15	23.72	24.29	24.88	25.49	26.10	26.72	27.36	28.01	28.67	29.34	30.03	30.73	31.44
14	Kochi Corporation	505.12	514.84	524.75	534.86	545.17	555.67	566.39	577.31	588.45	599.81	611.39	623.20	635.24	647.52	660.04	672.80	685.81	699.07
Thrissur																			
1	Kodungalloor Municipality	38.03	38.44	38.85	39.26	39.66	40.06	40.45	40.84	41.22	41.60	41.97	42.34	42.70	43.05	43.39	43.73	44.06	44.38
Total waste		**1227.67**	**1248.26**	**1269.05**	**1290.03**	**1311.21**	**1332.57**	**1354.13**	**1375.88**	**1397.82**	**1419.95**	**1442.27**	**1464.78**	**1487.48**	**1510.36**	**1533.43**	**1556.69**	**1580.13**	**1603.75**

Table 2-8 Projection of Waste Rejects (2021 – 2037)

Sr. No	Name of ULB	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Alappuzha																		
1	Cherthala Municipality	2.34	2.37	2.41	2.44	2.47	2.51	2.54	2.57	2.61	2.64	2.67	2.71	2.74	2.78	2.81	2.85	2.88
2	Alappuzha Municipality	8.61	8.70	8.79	8.88	8.97	9.06	9.15	9.23	9.32	9.41	9.49	9.57	9.66	9.74	9.82	9.90	9.97
Kottayam																		
1	Kottayam Municipality	7.33	7.42	7.50	7.58	7.64	7.70	7.75	7.80	7.83	7.85	7.87	7.87	7.86	7.84	7.81	7.77	7.71
2	Pala Municipality	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.14	1.15	1.16	1.16	1.17	1.17	1.18	1.18	1.18
3	Vaikom Municipality	1.20	1.22	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.49	1.51
4	Erattupetta Municipality	1.72	1.77	1.82	1.87	1.92	1.97	2.02	2.08	2.13	2.19	2.25	2.31	2.37	2.43	2.49	2.56	2.62
5	Ettumanoor Municipality	3.81	3.99	4.17	4.35	4.54	4.73	4.93	5.13	5.33	5.54	5.75	5.97	6.19	6.42	6.65	6.89	7.13
Idukki																		
1	Thodupuzha Municipality	2.91	2.98	3.04	3.12	3.19	3.26	3.33	3.41	3.49	3.57	3.65	3.73	3.81	3.90	3.98	4.07	4.16
2	Kattappana Municipality	2.30	2.34	2.38	2.42	2.47	2.51	2.55	2.59	2.64	2.68	2.72	2.76	2.80	2.85	2.89	2.93	2.97
Ernakulam																		
1	Koothattukulam Municipality	0.85	0.85	0.86	0.87	0.87	0.88	0.88	0.89	0.89	0.90	0.90	0.90	0.91	0.91	0.91	0.91	0.92
2	Muvattupuzha Municipality	1.59	1.61	1.64	1.66	1.69	1.72	1.75	1.77	1.80	1.83	1.86	1.89	1.91	1.94	1.97	2.00	2.03
3	Aluva Municipality	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.16	1.17	1.18	1.20	1.22	1.23
4	Eloor Municipality	1.65	1.67	1.70	1.72	1.74	1.76	1.77	1.79	1.81	1.82	1.84	1.85	1.86	1.87	1.88	1.89	1.89
5	Maradu Municipality	2.43	2.48	2.53	2.58	2.62	2.67	2.72	2.77	2.82	2.86	2.91	2.96	3.01	3.06	3.11	3.16	3.21
6	Thrikkakara Municipality	4.46	4.57	4.68	4.79	4.91	5.02	5.14	5.26	5.38	5.50	5.62	5.74	5.87	5.99	6.12	6.25	6.38
7	Angamali Municipality	1.69	1.70	1.72	1.74	1.75	1.77	1.78	1.80	1.81	1.82	1.84	1.85	1.86	1.87	1.87	1.88	1.89
8	Trippunithura Municipality	5.47	5.63	5.79	5.95	6.11	6.28	6.45	6.62	6.80	6.98	7.16	7.35	7.54	7.74	7.94	8.14	8.35
9	Kalamassery Municipality	3.97	4.06	4.15	4.25	4.34	4.44	4.54	4.64	4.74	4.84	4.95	5.05	5.16	5.27	5.38	5.50	5.61
10	Perumbavoor Municipality	1.49	1.52	1.55	1.57	1.60	1.63	1.66	1.69	1.72	1.75	1.78	1.81	1.84	1.87	1.90	1.94	1.97
11	N. Paravoor Municipality	1.66	1.68	1.71	1.74	1.77	1.80	1.83	1.86	1.89	1.92	1.95	1.98	2.01	2.04	2.07	2.10	2.13
12	Kothamangalam Municipality	2.04	2.07	2.11	2.14	2.18	2.22	2.26	2.29	2.33	2.37	2.41	2.45	2.50	2.54	2.58	2.63	2.67
13	Piravam Municipality	1.61	1.66	1.70	1.75	1.80	1.85	1.90	1.95	2.00	2.05	2.11	2.16	2.22	2.28	2.33	2.39	2.46
14	Kochi Corporation	43.92	44.75	45.61	46.47	47.36	48.26	49.19	50.13	51.08	52.06	53.06	54.08	55.11	56.17	57.25	58.35	59.47
Thrissur																		
1	Kodungalloor Municipality	3.68	3.73	3.79	3.84	3.89	3.95	4.00	4.05	4.10	4.15	4.21	4.26	4.31	4.36	4.41	4.46	4.51
Total Rejects		**108.85**	**110.93**	**113.03**	**115.15**	**117.30**	**119.47**	**121.66**	**123.88**	**126.12**	**128.38**	**130.67**	**132.98**	**135.31**	**137.67**	**140.04**	**142.45**	**144.87**

Table 2-9 Projection of Waste Rejects (2037 – 2055)

Sl. No	Name of ULB (Municipality)	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055
Alappuzha																			
1	Cherthala Municipality	2.92	2.95	2.99	3.02	3.06	3.09	3.13	3.16	3.20	3.23	3.27	3.30	3.34	3.37	3.41	3.44	3.48	3.51
2	Alappuzha Municipality	10.05	10.13	10.20	10.27	10.34	10.41	10.48	10.55	10.61	10.67	10.73	10.79	10.84	10.90	10.95	11.00	11.04	11.09
Kottayam																			
1	Kottayam Municipality	7.64	7.56	7.47	7.36	7.23	7.10	6.94	6.77	6.58	6.37	6.15	5.91	5.65	5.37	5.06	4.74	4.40	4.03
2	Pala Municipality	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.18	1.18	1.18	1.17	1.16	1.16	1.15	1.14	1.13
3	Vaikom	1.54	1.56	1.58	1.60	1.62	1.65	1.67	1.69	1.72	1.74	1.76	1.79	1.81	1.84	1.86	1.89	1.91	1.94
4	Erattupetta	2.69	2.76	2.83	2.90	2.98	3.05	3.13	3.21	3.29	3.37	3.46	3.55	3.63	3.73	3.82	3.91	4.01	4.11
5	Ettumanoor	7.38	7.63	7.89	8.15	8.42	8.70	8.98	9.26	9.56	9.85	10.16	10.47	10.78	11.11	11.44	11.77	12.12	12.47
Idukki																			
1	Thodupuzha Municipality	4.25	4.35	4.44	4.54	4.64	4.74	4.84	4.95	5.06	5.16	5.27	5.39	5.50	5.62	5.74	5.86	5.98	6.11
2	Kattappana Municipality	3.02	3.06	3.10	3.14	3.18	3.22	3.26	3.30	3.34	3.38	3.42	3.46	3.50	3.54	3.57	3.61	3.65	3.68
Ernakulam																			
1	Koothattukulam Municipality	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.90	0.90	0.89	0.89	0.88	0.87	0.87	0.86	0.85	0.84	0.82
2	Muvattupuzha Municipality	2.06	2.09	2.12	2.15	2.19	2.22	2.25	2.28	2.31	2.35	2.38	2.41	2.45	2.48	2.52	2.55	2.59	2.62
3	Aluva Municipality	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.40	1.42	1.45	1.48	1.50	1.53	1.56	1.60	1.63	1.66	1.70
4	Eloor Municipality	1.90	1.90	1.90	1.90	1.90	1.89	1.89	1.88	1.87	1.86	1.85	1.83	1.81	1.79	1.77	1.74	1.71	1.68
5	Maradu Municipality	3.26	3.31	3.36	3.40	3.45	3.50	3.55	3.60	3.65	3.70	3.75	3.79	3.84	3.89	3.94	3.98	4.03	4.08
6	Thrikkakara Municipality	6.51	6.64	6.77	6.91	7.04	7.18	7.32	7.46	7.60	7.74	7.88	8.02	8.17	8.31	8.46	8.61	8.76	8.91
7	Angamali Municipality	1.89	1.90	1.90	1.90	1.90	1.90	1.90	1.89	1.89	1.88	1.87	1.86	1.85	1.84	1.82	1.81	1.79	1.77
8	Trippunithura Municipality	8.56	8.77	8.99	9.21	9.44	9.67	9.91	10.15	10.40	10.65	10.90	11.16	11.42	11.69	11.97	12.25	12.53	12.82
9	Kalamassery Municipality	5.73	5.85	5.97	6.09	6.21	6.34	6.47	6.60	6.73	6.86	7.00	7.14	7.28	7.42	7.56	7.71	7.86	8.01
10	Perumbavoor Municipality	2.00	2.04	2.07	2.10	2.14	2.17	2.21	2.25	2.28	2.32	2.36	2.40	2.44	2.47	2.51	2.55	2.60	2.64
11	N. Paravoor Municipality	2.17	2.20	2.23	2.26	2.30	2.33	2.36	2.40	2.43	2.47	2.50	2.53	2.57	2.60	2.64	2.67	2.71	2.75
12	Kothamangalam Municipality	2.72	2.76	2.81	2.86	2.90	2.95	3.00	3.05	3.11	3.16	3.21	326	3.32	3.38	3.43	3.49	3.55	3.61
13	Piravam Municipality	2.52	2.58	2.65	2.71	2.78	2.85	2.92	2.99	3.06	3.13	3.21	328	3.36	3.44	3.52	3.60	3.69	3.77
14	Kochi Corporation	60.61	61.78	62.97	64.18	65.42	66.68	67.97	69.28	70.61	71.98	73.37	74.78	76.23	77.70	79.20	80.74	82.30	83.89
Thrissur																			
1	Kodungalloor Municipality	4.56	4.61	4.66	4.71	4.76	4.81	4.85	4.90	4.95	4.99	5.04	5.08	5.12	5.17	5.21	5.25	5.29	5.33
Total Rejects		147.32	149.79	152.29	154.80	157.34	159.91	162.50	165.11	167.74	170.39	173.07	175.77	178.5	181.24	184.01	186.80	189.62	192.45

Table 2-10 Summary of Waste Rejects (2024 – 2055) from 12 TS

Sl. No	TS Name	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055
1	Kalamassery	14	15	15	15	15	15	16	16	16	16	17	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20	20	21	21	21	21
2	Kappolachira	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
3	Vadavathoor	12	12	12	13	13	13	13	14	14	14	14	14	15	15	15	15	15	16	16	16	16	16	16	16	16	16	16	16	17	17	17	16
4	Sarvodayapuram	9	9	9	9	9	9	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10	11	11	11	11	11	11	11	11	11	11	11
5	Vallakuzhi	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	Thodapuzha	10	11	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	16	16	16	16	17	17	17	18	18	18	19
7	Puliyanmala	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4
8	Kochi 1 (60%)	46	47	48	49	50	51	52	53	54	55	56	57	58	59	61	62	63	64	65	67	68	69	71	72	73	75	76	78	79	81	82	84
9	Maradu	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4
10	Trippunithura	6	6	6	6	7	7	7	7	7	8	8	8	8	8	9	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13
11	Thrikkakara	5	5	5	5	5	5	5	6	6	6	6	6	6	6	7	7	7	7	7	7	7	7	8	8	8	8	8	8	8	9	9	9
12	Perumbavoor	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
Total		**117**	**119**	**121**	**123**	**126**	**128**	**130**	**132**	**135**	**137**	**140**	**142**	**144**	**147**	**149**	**152**	**154**	**157**	**160**	**162**	**165**	**167**	**170**	**173**	**175**	**178**	**181**	**183**	**186**	**189**	**191**	**194**

The graphical representation of total population in numbers, total waste generation in tons per day and total waste rejects (12% from waste generation) in tons per day for the period of 2021 to 2055 is given below

Figure 2-5 Forecasting of inert waste generation against population from each ULBs (2021 – 2055)

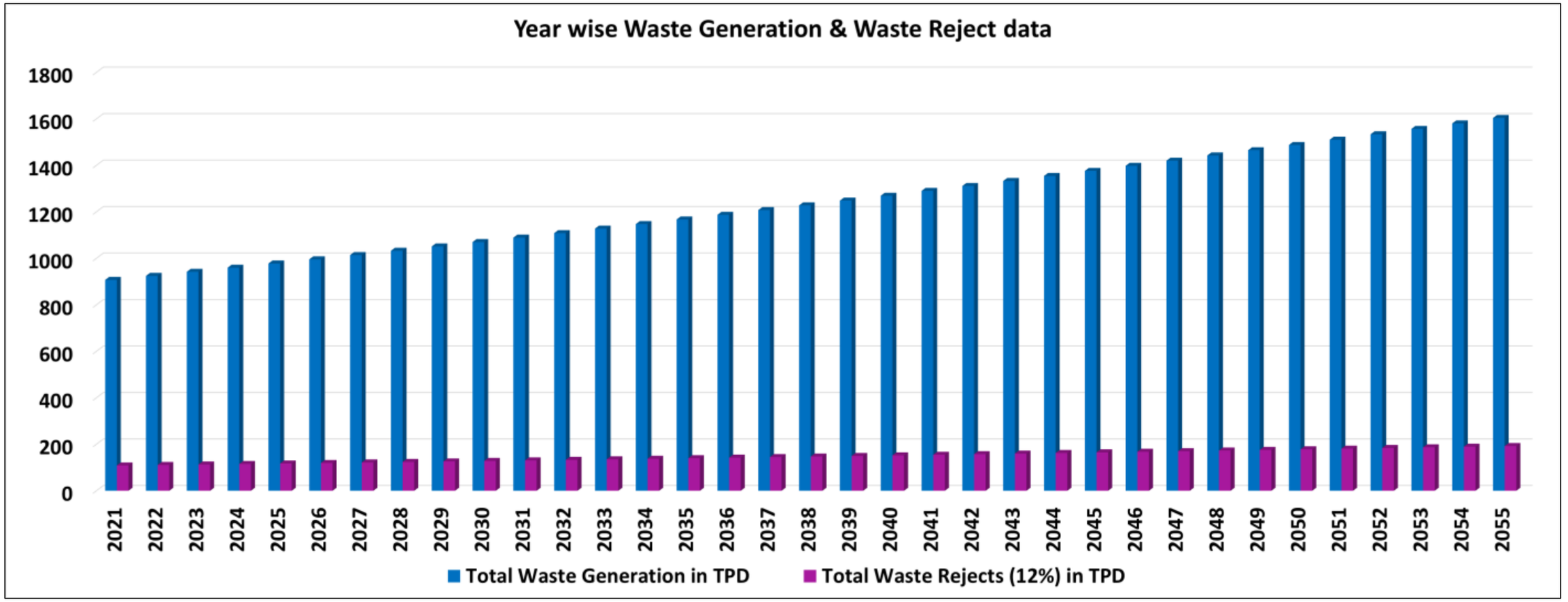


Figure 2-6 Total Waste Generation & waste rejects from each ULBs (2021 – 2055)

2.11 Required SLF Volumetric Capacity of SLF

As per the secondary data received, projected population in 2024 year is 19,97,606 while total solid waste generation is estimated approximately 978.8 MT/ day. 12% rejects of total waste generation are considered as a landfillable waste, hence average quantity of reject is estimated around 117 MT/ day during year 2024. The annual and cumulative generation of the reject/ inert quantities are presented in the below Table 2-11.

Table 2-11 Volume Calculation

Sl. No	Year	Waste (TPD)	Waste/ year (cum)	Volume of			Tot. req. volume (cum)	Cumulative volume (cum)
				inert waste (m^3)	daily soil cover (m^3)	liner (m^3)		
				Volume: 1	10%	5%		
1	2024	117	42610	42610	4261	2130	49001	49001
2	2025	119	43405	43405	4340	2170	49915	98916
3	2026	121	44208	44208	4421	2210	50839	149756
4	2027	123	45020	45020	4502	2251	51773	201529
8	2028	126	45841	45841	4584	2292	53671	254246
6	2029	128	46671	46671	4667	2334	53671	307918
7	2030	130	47509	47509	4750	2375	54635	362553
8	2031	132	48356	48356	4835	2418	55609	418162
9	2032	135	49211	49211	4921	2461	56593	474754
10	2033	137	50075	50075	5008	2504	57587	532341
11	2034	140	50948	50948	5095	2547	58590	590932
12	2035	142	51830	51830	5183	2591	59604	650536
13	2036	144	52720	52720	5272	2636	60628	711164
14	2037	147	53619	53619	5362	2681	61662	772827
15	2038	149	54527	54527	5453	2726	62706	835533
16	2039	152	55444	55444	5544	2772	63761	899294
17	2040	154	56369	56369	5637	2818	64825	964118
18	2041	157	57304	57304	5730	2865	65899	1030018
19	2042	160	58246	58246	5825	2912	66983	1097001
20	2043	162	59198	59198	5920	2960	68078	1165079
21	2044	165	60158	60158	6016	3008	69182	1234261
22	2045	167	61127	61127	6113	3056	70297	1304558
23	2046	170	62070	62070	6207	3103	71380	1357938
24	2047	173	63020	63020	6302	3151	72473	1448411
25	2048	175	63978	63978	6398	3199	73575	1521985
26	2049	178	64944	64944	6494	3247	7486	1596671
27	2050	181	68918	65918	6592	3296	75806	1672477
28	2051	183	66900	66900	6690	3345	76935	1749413
29	2052	186	67890	67890	6789	3395	78074	1827486
30	2053	189	68888	68888	6889	3444	79221	1906707
31	2054	191	69893	69893	6989	3495	80377	1987084
32	2055	194	70906	70906	7091	3545	81542	2068626

2.12 Land Requirement

The land parcel proposed by KSWMP for development of regional Scientific landfill for Cluster-4 located at Ambalamedu, has an area of approximately 25 acres. The general layout is shown in Figure 2.7 with existing HT line. The overall project will be carried out two phases, one is KSWMP Phase which covers 18.14 acres land after realignment of EHT line A (Under WB fund) and other is GoK phase covers 6.86 acres shall be developed after realignment of EHT B & C (under GoK fund). The layout of the available land parcel of 25 acres covering the proposed KSWMP & GoK phases is shown in Figure 2-7. The land area break-up of total land parcel and the facilities planned for SLF is given in Table 2-12.

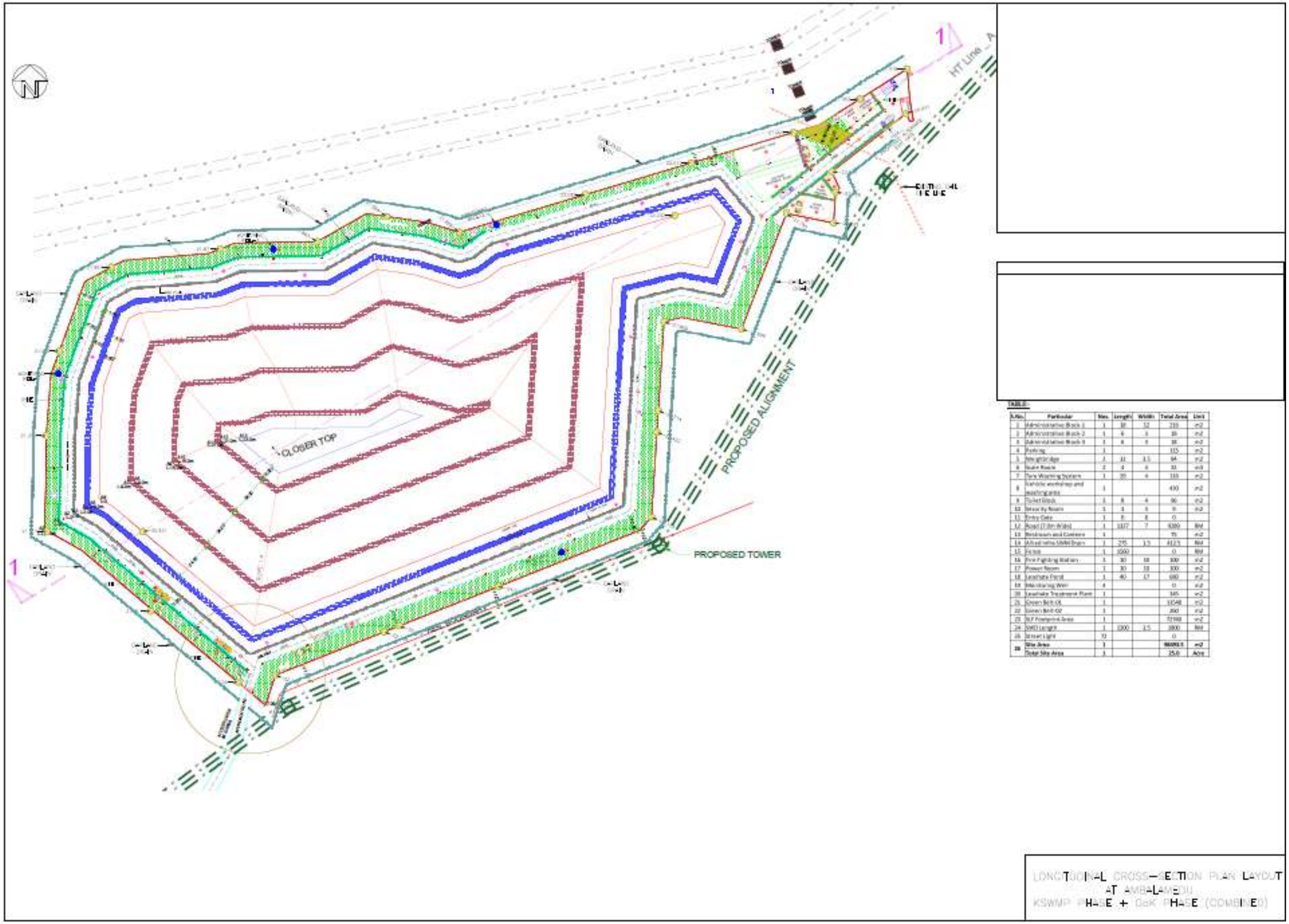


Figure 2-7 SLF general layout plan (showing EHT lines)

Table 2-12 Detailed land area break-up with proposed facilities

S.No	Particular	Nos.	Length	Width	Total Area	Unit
1	Administrative Block-1	1	18	12	216	m^2
2	Administrative Block-2	1	6	3	18	m^2
3	Administrative Block-3	1	6	3	18	m^2
4	Parking	1			115	m^2
5	Weighbridge	2	12	3.5	84	m^2
6	Scale Room	2	4	4	32	M^2
7	Tyre Washing System	1	29	4	116	m^2
8	Vehicle workshop and washing area	1			420	m^2
9	Toilet Block	3	8	4	96	m^2
10	Security Room	1	3	3	9	m^2
11	Entry Gate	1	0	8	0	No
12	Road (7.0m Wide)	1	1190	7	8330	RM
13	Restroom and Canteen	1	15	5	75	m^2
14	Allied Infra SWM Drain	1	375	1.5	412.5	m^2
15	Fence	1	1303		0	RM
16	Fire Fighting Station	1	10	10	100	m^2
17	Power Room	1	10	10	100	m^2
18	Leachate Pond	1	40	17	680	m^2
19	Piezometer monitoring well	4			0	Nos.
20	Leachate Treatment Plant	1			345	m^2
21	Green Belt-01	1			10,194	m^2
22	Green Belt-02 (94+461)	1			534	m^2
23	SLF Footprint Area	1			49300	m^2
24	SWD Length	1	1065	1.5	1597.5	RM
25	Street Light	60				
Total Site Area		**1**			**72792**	**m^2**
		1			**18.14**	**Acre**

***Note**: Total Greenbelt proposed is around 15% of the total land area. However, the total greenbelt including landscaping of scientific capping shall be around 64% of the project area of KSWMP Phase.*

2.13 Geotechnical Investigation

During preparation of FSR, a total 11 boreholes were drilled at SLF site to understand the soil strata to analyse the bearing capacity of the soil. Soil and rock samples were collected and relevant laboratory tests were carried on it. The details of the geotechnical investigation details with thickness of soil, N values, rock level occurrence are extracted and included here. The borehole locations are earmarked in the general layout is shown in the Figure: 2-8.



Figure 2-8 Bore logs points (Red dots)

Table 2-13 Bore Hole (BH) details

Rock occurrence level between 10 to 12m BGL					
BH No.	**Thickness of soil overburden (m)**	**SPT N values in overburden**	**Rock level occurrence BGL (m)**	**Depth of BH termination BGL (m)**	**Location / Remarks**
1	11.80	3,2,15	11.80 to 14.80	14.80	Within footprint
9	11.50	1,1,10,9	11.50 to 16.50	16.50	Edge of footprint
Rock occurrence level >12m BGL (beyond footprint)					
BH No.	**Thickness of soil overburden (m)Gr**	**SPT N values in overburden**	**Rock level occurrence BGL (m)**	**Depth of BH termination BGL (m)**	**Location / Remarks**
3	14.90	0,1,22,11,>100	14.90 to 21.50	21.50	Beyond footprint & close to river Chitrapuzha & waterlogged
10	14.00	0,16,9,3,14	14.00 to 19.00	19.00	Beyond Footprint and along the footprint of Proposed Tower shifting and waterlogged

Rock occurrence level between 3 to 6m BGL					
BH No.	**Thickness of soil overburden (m)**	**SPT N values in overburden**	**Rock level occurrence BGL (m)**	**Depth of BH termination BGL (m)**	**Location / Remarks**
2	3.80	0	3.80 to 6.80	6.80	Within footprint & waterlogged
4	4.35	0,7	4.35 to 8.85	8.85	Within footprint
5	4.00	1	4.00 to 9.15	9.15	Within footprint
Rock occurrence between 6 to 10m BGL					
BH No.	**Thickness of soil overburden (m)**	**SPT N values in overburden**	**Rock level occurrence BGL (m)**	**Depth of BH termination BGL (m)**	**Location / Remarks**
6	8.10	0,3	8.50 to 15.60	15.60	Within footprint & waterlogged
7	6.50	9,20,24	6.50 to 11.60	11.60	Within footprint
8	7.50	15,3,13	7.50 to 15.00	15.00	Beyond Footprint and close to marshy /waterlogged area
11	8.40	0,0,22,40,>50	8.40 to 17.40	17.40	Within footprint & waterlogged

Based on the soil investigations it is understood that the subsoil is very weak and rock levels vary. Without any ground improvement the subsoil will not be capable of transferring the bearing pressures of the order of 250 to 300 kPa on account of its very high compressibility characteristics. Therefore, ground improvement is necessary to improve the weak/very weak sub-soil noticed at the project site. Considering the clayey soil, it will be necessary to adopt Preloading with PVD (Prefabricated Vertical Drains). The good earth used for preloading surcharge for accelerating consolidation works such as SLF embankment, subgrade, bed slopes, daily soil cover, and intermediate cover.

2.14 Volumetric capacity of SLF (KSWMP Phase & GoK Phase)

With the shifting of EHT line A, B & C the dimensions and volumetric capacity with capping slope of 1:3:5 ratio in the SLF area is presented in the below Table 2-14 and the interim arrangement of SLF plan is shown in Figure: 2-9. Table 2-15 gives the summary of SLF project phases.

Table 2-14 Volumetric capacity of SLF

Capping 1:4 slope						
Sl. No.	**Volumes**	**Base area (m^2)**	**Top area (m^2)**	**Average area (m^2)**	**Height (m)**	**Total volume (cum)**
1	V – 1	34,288	40,091	37,190	3	1,11,569
2	V – 2	40,091	21,073	30,582	6	1,83,492
3	V – 3	19,053	6,959	13,006	6	78,036
4	V - 4	5,590	1,138	3,364	4	13,456
Total volume & Height of Landfill					**19**	**3,86,553**

Based on the above plan for SLF KSWMP Phase,

- Footprint area – 49,300 sq.m.
- Lifespan – about 20 years
- Capping surface area – around 40,062 sq.m have been arrived.

The capacity of SLF can be increased by achieving higher density of the inert waste.

2.14.1 Closure profile & section of SLF

The closure profile of SLF KSWMP phase plus GoK Phase (Combined) is planned and proposed based on the available footprint area and required capacity with capping slope of 1:3:5 and required berm of 3m width at required intervals of height to ensure slope stability, smooth movement of landfill vehicles and post closure maintenance. The figure 2-10 shows the closure profile of KSWMP phases and the cross section of SLF is Figure 2-11. After closure, no construction activities of any sort will be permitted without scientific evidence for utilizing the site for any other purposes. The remaining plant area of 27,559 sq.m will be used for next 15 years as a maintenance period.

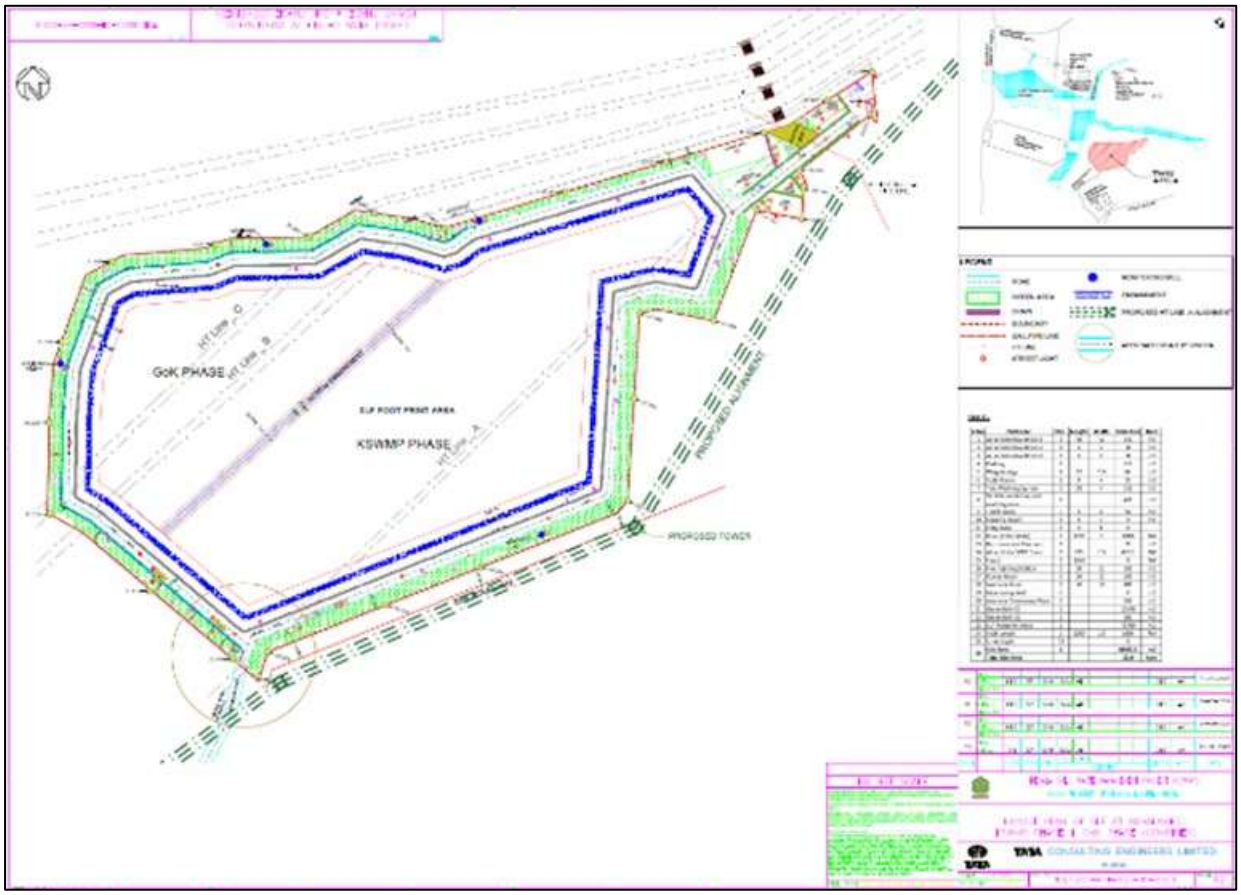
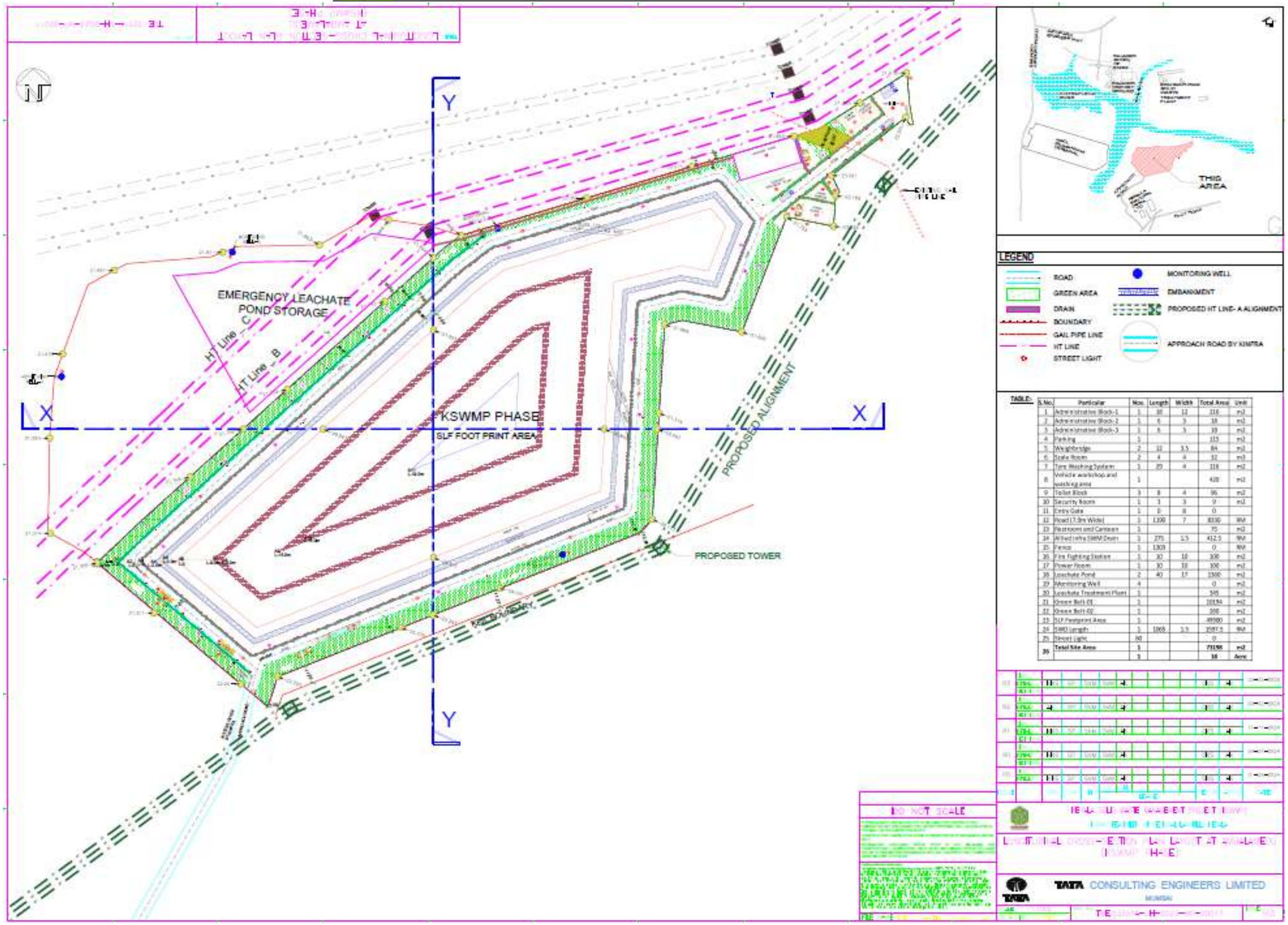


Figure 2-9 Interim Arrangement – SLF Plan



S.No.	Particular	Nos.	Length	Width	Total Area	Unit
1	Administrative Block-1	1	10	12	116	m2
2	Administrative Block-2	1	6	5	30	m2
3	Administrative Block-3	1	6	5	30	m2
4	Parking	1			115	m2
5	Weighbridge	2	12	3.5	84	m2
6	Scale Room	2	4	4	32	m2
7	Tyre Washing System	1	29	4	116	m2
8	Vehicle workshop and washing area	1			420	m2
9	Toilet Block	3	8	4	96	m2
10	Security Room	1	3	3	9	m2
11	Entry Gate	1	0	0	0	
12	Road (7.0m Wide)	1	1200	7	8330	RM
13	Restroom and Canteen	1			75	m2
14	Wheel Infra SWM Drain	1	275	1.5	412.5	RM
15	Fence	1	1300		0	RM
16	Fire Fighting Station	1	30	10	300	m2
17	Power Room	1	30	10	300	m2
18	Leachate Pond	2	40	17	1360	m2
19	Monitoring Well	4			0	m2
20	Leachate Treatment Plant	1			345	m2
21	Green Belt 01	1			10494	m2
22	Green Belt 02	1			300	m2
23	SLF Footprint Area	1			49500	m2
24	SWD Length	1	1065	1.5	3597.5	RM
25	Street Light	Nil			0	
26	**Total Site Area**	1			**75595**	m2
		1			**18**	Acre

Figure 2-10 SLF Closure profile (SLF KSWMP phase)

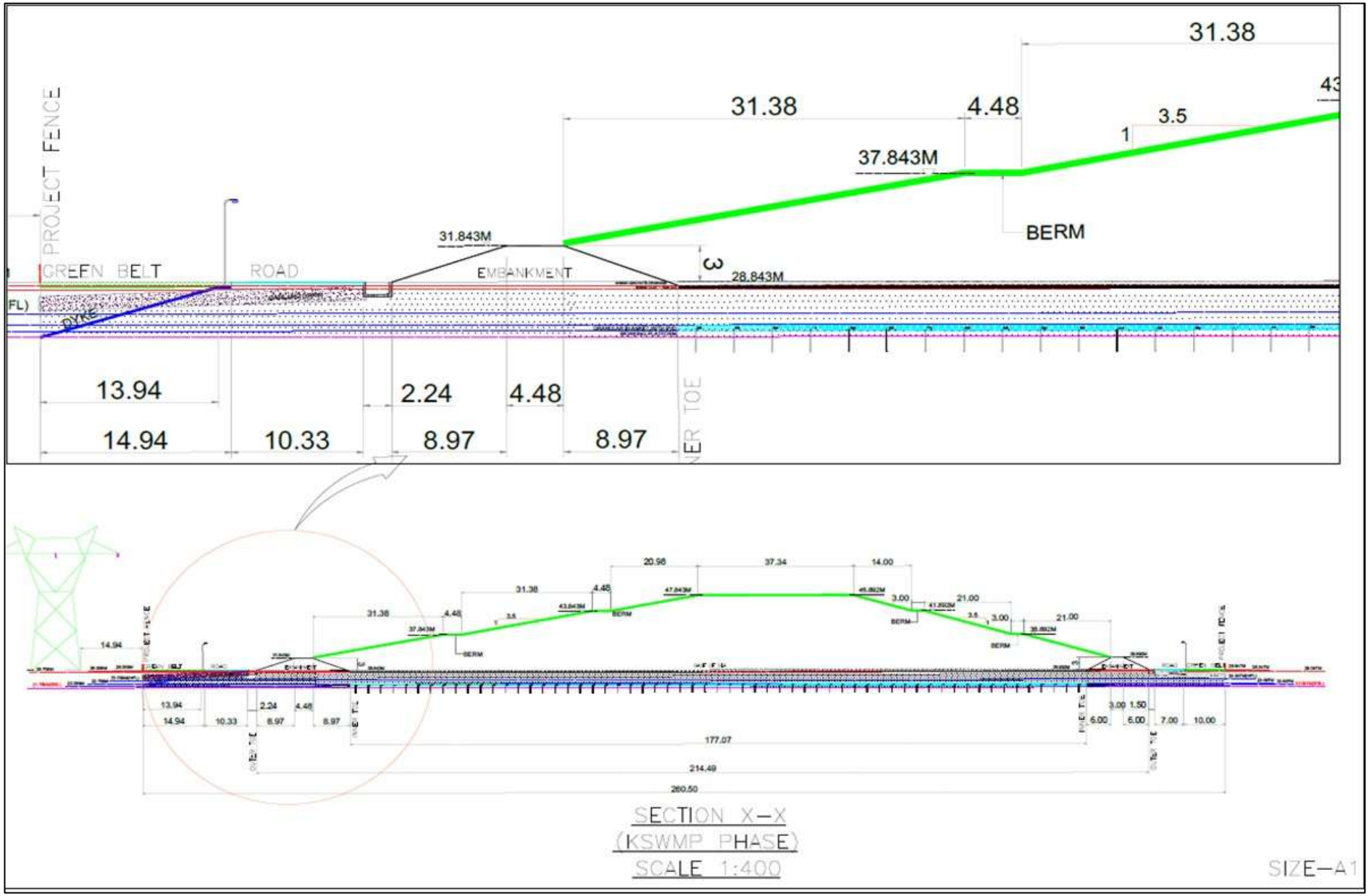


Figure 2-11 Cross Section (SLF KSWMP phase)

Table 2-15 Summary of SLF Project phases

Sl. No.	Parameters	KSWMP phase (funded by WB)
1	Total project area	18.14 acres
2	SLF footprint area	12.2 acres
3	EHT line shifting	A
4	SLF Height	23 m (Approx:)
5	Volumetric capacity	4.00 lakhs cum(Approx:)
6	Life span	20 years
7	Expected time for completion of construction	January 2029

Note: The project boundary for development of SLF KSWMP Phase has been finalised considering all the parameters such as realignment of EHT line A, ancillary developments, and KSWMP Project Period etc. KSWMP Phase project comprising of ground improvement (PVD, Granular Blanket, Soil filling, surcharge, and loading/unloading), construction of SLF and all ancillary civil works will be developed and completed by January 2029.

2.15 SLF site infrastructure requirement

As per SWM Rules, 2016 following infrastructures are required at the SLF site.

1. Entrance gate
2. Compound wall
3. Security chain
4. Approach road
5. Weigh bridge with cabin
6. Site office
7. Site storm water drainage facilities
8. Plantation for buffer zone
9. Leachate collection system
10. Leachate solar evaporation pond
11. Leachate treatment plant
12. Fire extinguisher system'
13. Tyre washing system
14. Gas collection system
15. Laboratory

2.16 Steps involved for Landfill Development for KSWMP Phase

As proposed SLF site at Ambalamedu comprises of weak sub-soil, it requires Ground Improvement measures which can be one of the below,

- Prefabricated Vertical drains (PVD) with /without vacuum consolidation and Preloading
- Deep Soil Mixing (DSM)
- Stone columns (SC) with Preloading
- Constrained Modulus Columns (CMC)

As proposed SLF site at Ambalamedu required few interventions for site improvement such as Prefabricated Vertical Drains (PVDs), Ground raising besides SLF components, the envisaged implementation sequence of the same is mentioned here below,

1. Ground Improvement & Land development
    - Shifting of EHT Line - A
    - Ground Clearing
    - Ground Improvement (PVDs / Drainage Layer)
    - Ground Raising (Through filling of suitable material)
    - Preloading and surcharging to accelerate the consolidation process
    - Unloading the preloading /surcharge embankment to SLF Subgrade
2. SLF Construction
    - SLF Subgrade Preparation
    - SLF Embankment Construction
    - SLF Base Sealing /Liner System
    - SLF Top Cover System
    - Leachate Drainage Layer
    - Leachate Drainage Pipeline System
    - Erosion Control System (Stone Pitching on Embankment)
3. Leachate Management
    - Leachate storage system
    - Leachate treatment plant
4. Allied infrastructure
    - Storm water drain
    - Internal roads
    - Greenbelt
    - Office building/Admin blocks
    - Weighbridge
    - Sanitary blocks
    - Laboratory
    - Canteen
    - Workshop
    - Tyre washing facility
    - Flood protection dyke
    - Retaining Wall

2.17 Project Description

2.17.1 Scientific landfill

All Preliminary design & engineering has been discussed in this section for the proposed of Sanitary Landfill for disposing the inert waste to be generated from various ULB's. The construction of landfill planned to be taken up into phase wise manner. After filling of each phase, it will be covered with top cover progressively and subsequently the landfill space will be utilized as per SWM Rules. The inert is dispose in thin layers, well compacted to maximise the density. The waste is covered with soil on daily basis. Any Landfill gas such as methane from the anaerobic degradation of organic material will be collected through horizontal and vertical vent pipes. The facilities at the scientific landfill include leachate collection & treatment system, and storm water management system to avoid ground and surface water pollution & erosion respectively. The general layout of proposed landfill is shown in Figure 2-7. The general layout covers about 73,615 m^2 of SLF footprints out of total 1,01,123 m^2. The SLF facilities covers groundwater monitoring well, firefighting system, tyre washing system, greenbelt and other associated facilities. The proposed land area breakup is shown in Table 2-12. The

maximum height envisaged for SLF is 23m from the AGL. The slope will be maintained at 1:4 horizontal - vertical ratio. The requisite setbacks distance is shown in the general layout. The SLF will also have greenbelt width of 2m along the periphery. The filling of inert waste will be carried out in three phases. The typical cross section of SLF with leachate collection system is shown in the Figure 2-9 that includes both KSWMP phase & GoK phase.

2.18 Mechanism or Collection & Transportation

Inerts gets collected at various transfer points as given in the Table 2-16. either directly into tertiary transport vehicles (direct unloading) or into a storage area. Following technologies were studied for the project and only RCV Technology found suitable for the Ambalamedu project

1. **Direct Unloading (Elevated Ramp and Storage)** – not proposed due to non-suitability
2. **Unloading to Storage (Static Compactor)** – proposed only at Kochi TS due to higher quantity of waste
3. **Unloading to Storage (Portable Compactor)** - proposed at location where the space for the TS and vehicle movement is limited
   Refuse Compact Vehicle (RCV) – specialised trucks designed to collect & compact waste materials.

2.18.1 Refuse Compactor Vehicle (RCV)

Refuse Compactor Vehicles (RCV's) are specialized trucks designed to collect and compact waste materials. The Figure 2-14 shows the typical structure of RCV. The key features of a refuse compactor vehicle include:

Compaction Mechanism: The truck is equipped with a compactor mechanism that compresses the collected waste materials. This compaction reduces the volume of the waste, allowing more waste to be transported before needing to unload.

Storage Capacity: RCV's have large storage compartments hold the compacted waste. The size of these compartments varies depending on the capacity of the vehicle.

Hydraulic Systems: These vehicles are powered by hydraulic systems that operate the compaction and loading mechanisms.

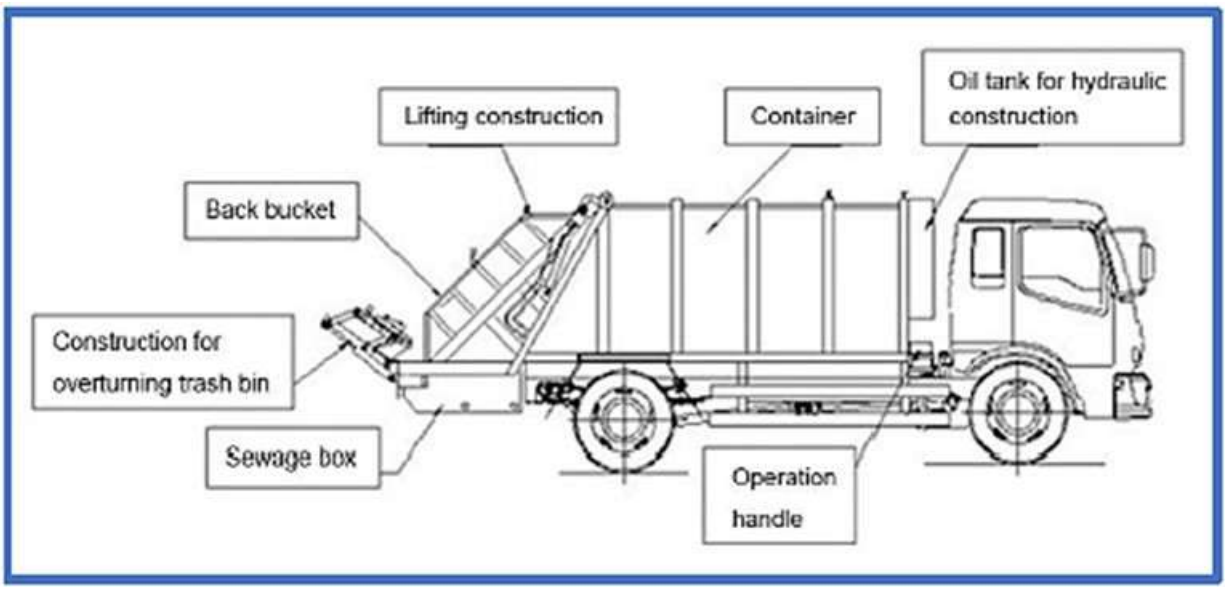




Figure 2-12 Refuse Compactor Vehicle (RCV)

Among the three options RCV (Option-3) is selected as the mechanism is more suitable for existing practice of collection and transportation of inert.

Inert Transfer Location (ITL)

In case of Ambalamedu SLF, Eleven (11) nos. of Inert Transfer Location are identified for the transportation of the process rejects and inert from the nearby five districts. These Inert Transfer Location shall receive process rejects and inert from various MSW processing facilities of Kerala. The following 11 locations/site are initially proposed by KSWMP for site suitability assessment for the Inert Transfer Locations and these augmented whenever the need arise. The proposed ITL are given in Table 2-16.

Table 2-16 Proposed Inert Transfer Locations

Sr. No.	Sr. No as per RFP	Location	Village
1	ITL 1 a	Vedimara Dumpsite	Paravoor
2	ITL 1 b	Kalamassery	Trikkakara North
3	ITL 2 a	Kumbalathumury	Kothamangalam
4	ITL 2 b	Vallakuzhi	Vellorkunnam
5	ITL 3 a	Kappolachira	Naduvuile Village
6	ITL 3 b	Vaikom	Vadakkemuri
7	ITL 4	Sarvodayapuram Solid Waste Management Plant	Pathirapalli
8	ITL 5	Vadavathoor	Vijayapura
9	ITL 6 a	Pala	Lalam
10	ITL 6 b	Parakkadavu	Thodupuzha
11	ITL 7	Puliyanmala	Kattappana

2.19 Steps for Landfill Development

2.19.1 Ground Clearing

The site is presently occupied with patchy vegetation, which need to be removed in order to develop the proposed landfill. The site is unapproachable due to growth of wild bushes and trees. However, an attempt has been made to count the number of trees which are likely to be affected due to the proposed SLF. In this attempt, Coconut, Areca, Acacia, Eucalyptus trees are not accounted for transplantation. Species like Mango, Neem, Charu, Anjili have been planned for transplantation. The girth which are greater than 40 cm are expected to be about 10 – 15 in numbers which is also not planned for transplantation. Whereas, the girth less than 30 cm is expected to be about 100 in numbers are planned to be used in the greenbelt. It is also planned to remove about 30

numbers of trees having girth of 40 cm a suitable greenbelt will be developed as mitigation measures.

2.19.2 Ground Level Raising

The local temporary benchmark at the proposed site given in the topographic contour map, the lowest natural ground level (NGL) is 20.60 m MSL, the highest natural ground level (NGL) is 21.332m MSL. The average ground level at the site is 21 meters AMSL. The given High Flood Level (HFL) is 22.95m MSL.

The maximum water level expected at site is HFL 22.95m MSL with respect to the local TBM as per Topographic survey map provided.

Further, due to Climate change maximum of 3.3 mm per year water level rise is expected. Accordingly, the estimated maximum water level rise due to climate change is 132 mm (i.e., 13.2 cm) in next 40 years from HFL 22.95m MSL to level 23.082m MSL.

However, the proposed design will raise the ground by minimum of 2m above HFL 22.95m MSL to level 24.95m MSL. Hence, there would be minimum buffer of 1.868m is maintained to meet the maximum HFL after 40 years.

The maximum water level expected at site is HFL 22.95m (MSL) with respect to the local TBM as per topographic survey map provided. Further due to Climate change maximum 3.3 mm per year water level rise is envisaged based on Government of India document (Source: Rising Sea Level Impact on Coastal Areas,Answer dated 10th August 2023 on starred Question Number 228 by Rajya Sabha ,Govt:Of India). So accordingly, maximum 132 mm (i.e., 13.2 cm) rise is expected in next 40 years from HFL 22.95m MSL to level 23.082m MSL.

However, it is planned to raise the ground by minimum 2m above HFL 22.95m MSL to level 24.95m MSL. Hence, there would be minimum buffer of 1.868m (24.95m MSL - 23.082m MSL = 1.868) even after 40 years from now based on above assumptions. The Schematic Plan for SLF Base Levels are shown in Figure 2-15.

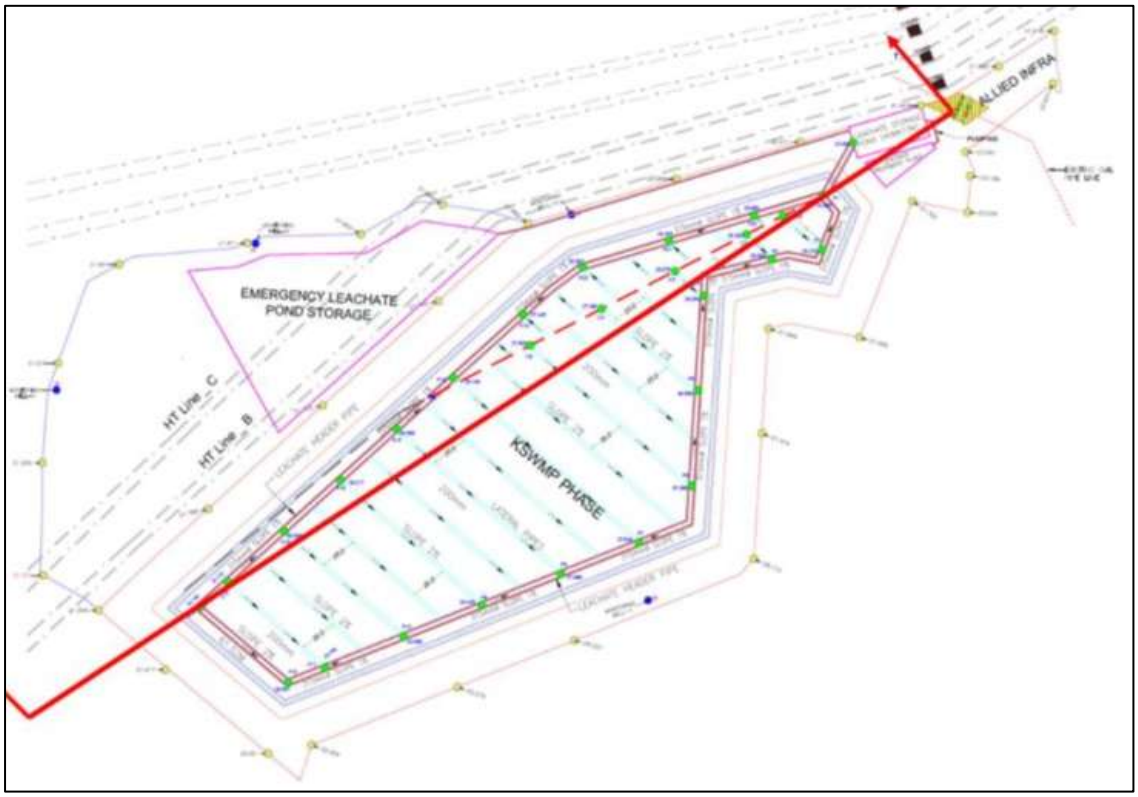
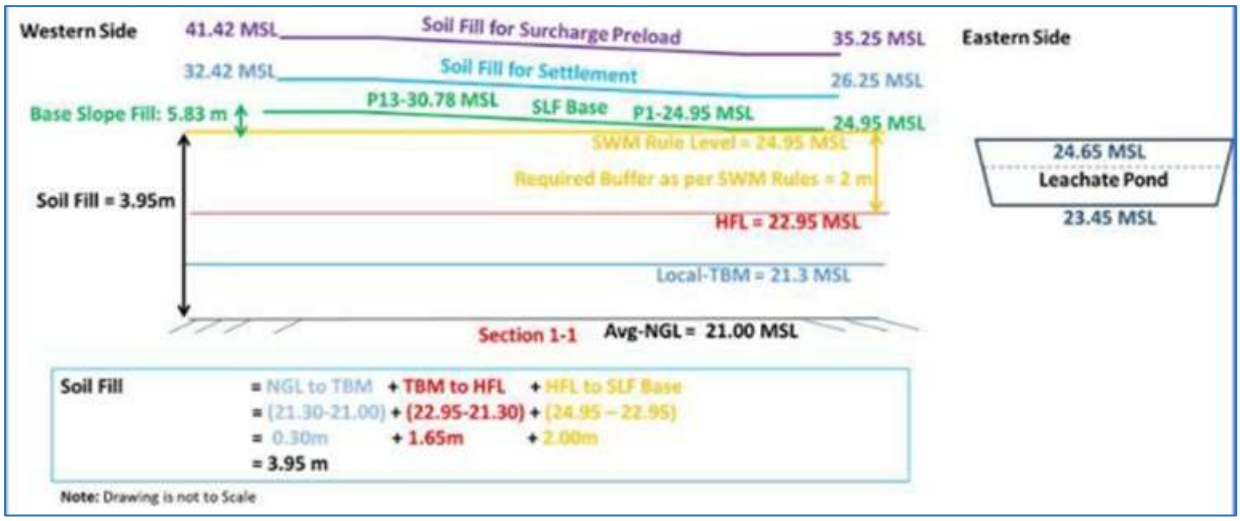


Figure 2-13 Schematic Plan for SLF Base Levels

The sections of the SLF Base Levels are presented in Figure 2-16, 17 & 18 at three different stages such as preloading, SLF commissioned, and SLF Closure stage respectively.



Source: DPR, TCE

Figure 2-14 Schematic Diagram for SLF Base Levels at Site during Preload Surcharge Stage

As per FSR, The estimated corrected consolidation settlement of the native soil due to expected Construction of SLF and a load of 300kPa is expected to be 1.3m and provision is made in ground filling calculations. Allowance of two meters between water table and liner base is also considered as per SWM rules 2016. The original/ existing average ground level of 21 MSL as per DGPS survey which is around 1.95 m below HFL (i.e. HFL = 22.95 meter (MSL). The existing ground level is proposed to be raised by 2.00 m above HFL in line with SWM Rules 2016, so total rise envisaged in existing ground level is around 3.95 m (i.e. 1.95 + 2.00) to account for the water barrier between high flood level and SLF base, plus filling of 1.3 m for settlement allowance on eastern side and 1.64 m on the western side.

Once the SLF is ready with after all preload removal, subgrade preparation and liner installation, it will be ready for the acceptance of Inert as presented in the Figure 2-17.

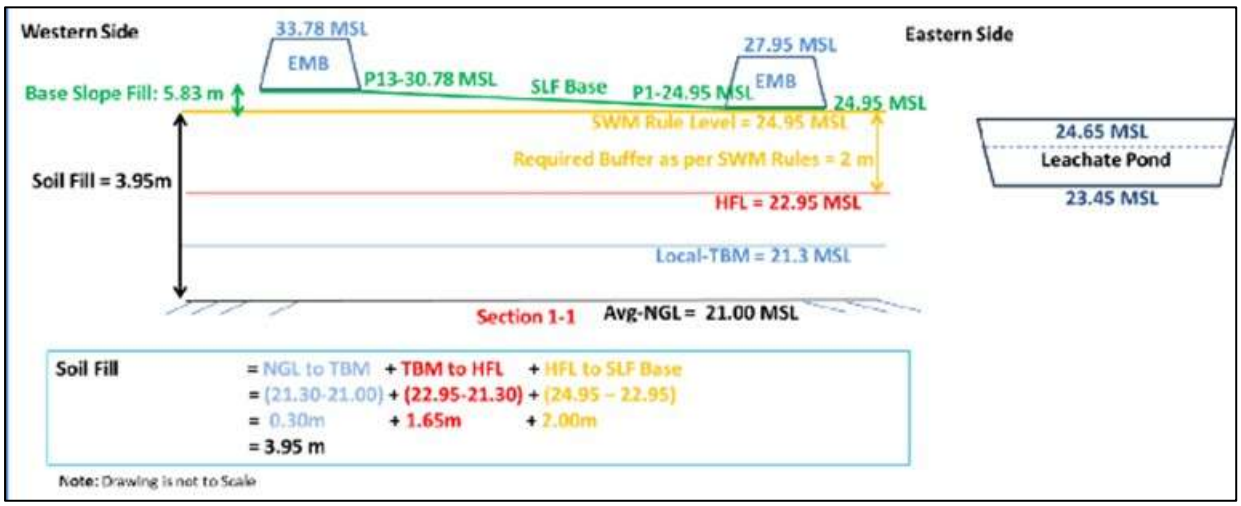


Figure 2-15 Schematic Diagram for Final SLF Base Levels at Commissioned Stage

Once the SLF is filled with Inert to its full capacity after that scientific closure shall be done as presented in the Figure 2-18.

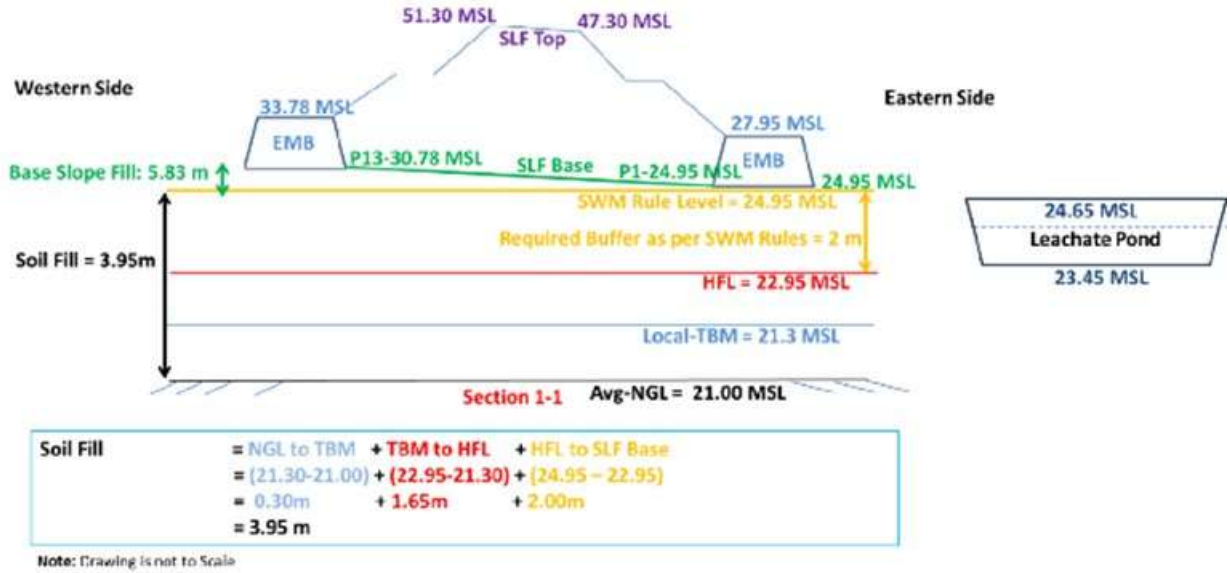


Figure 2-16 Schematic Diagram for SLF Base Levels at SLF Closure Stage

2.19.3 Ground Improvement

The ground improvement will be completed in single stage manner to ensure proper & maximum compaction, consolidation, and drainage of the original ground/ native soil in early stage. The conceptual details of the ground improvement are provided in subsequent sections. The proposed land parcel is grassland with wild shrubs and above mentioned plant species.

From the Geotechnical investigation results shown in previous section 2.13, It indicates that ground improvement depths can vary between 3.8m to 11.8m. Analysis shows that due to load of 300kPa (target SBC), consolidation settlement will be of order of 1300mm (after applying all corrections) considering the compressible thickness layer as 6m (BH-1, which is weakest borehole among all the borehole drilling). Therefore, Ground Improvement becomes necessary to ensure 90% of this settlement is completed before the actual construction of SLF commences. The ground improvement should be completed in such a manner that 1170 mm (90%) of the expected consolidation settlement will be completed during land development process itself which is expected to be completed in a time frame of around 18 months. Balance residual settlement of 130 mm (10%) is proposed to be adjusted in detailed design by providing extra (SLF base slope) material. The ground improvement is proposed to be done up to 15m beyond KSWMP phase battery limit to take care of any base failure (natural ground) of soil filling on the road, green belt area.

There are various methods of improving the weak sub-soils as encountered in SLF Ambalamedu as stated below. Any one of the methods can be adopted. It is imperative that this ground improvement work shall be implemented by a Contractor

- Prefabricated vertical drains (PVD)
- Stone Columns (SC)
- Deep Soil Mixing (DSM)
- Constrained Modulus Columns (SMC)

The previous paragraph provided a technical comparison of the methods.

Stage 1- Site grading is 3.5m above GL + 3m confining embankment (If RS/RE walls not adopted)

Stage-1- Site Grading

Layer lift (m)	Description	Pressure (kPa) considering unit weight as 17.5kN/m^3	Estimated theoretical consolidation Settlement in centre (Stagewise) below the Pre-loaded area, Uncorrected (mm)
1m	First lift after GI	17.50	190
1+1=2m	Second lift after GI	17.5+17.5=35.00	190+190=380
2+1.5=3.5m	Third Lift after GI	35.00+26.25=61.25	380+205=585
3.5+3.0=6.5m	Preloading /Edge confinement	61.25+52.5= 113.75	585+163=748
Total 6.50m		6.50m	748mm

Stage 2-Preloading in stages simulating the MSW landfill load (23 m height means 230kPa) hold in place and unload

SLF Height (m)	SLF Volume	Pressure (kPa) considering unit weight of good murrum soil as 10kN/m^3	Estimated theoretical consolidation Settlement in centre (Stagewise) below the Pre-loaded area, Uncorrected (mm)
19	3.86 lakhs cum	190	730.00
23	7.3 lakhs cum	190+40=230	730+153= **883mm**
>23 not feasible as per Geometry.	N.A.	N.A.	N.A.

Therefore, total long term primary consolidation settlement = 883mm+748= 1631mm (Stage wise) and ignores the improvement in shear strength parameters as filling proceeds. With a conservative correction factor of l 0.8 (Code range of 0.7 to 1), it works out as 1300mm as we are doing stage wise Filling and thus the soil properties is expected to improve. Please note that settlement monitoring is done after achieving the final grade level (i.e.) 3.5m, 6.5m etc and thereafter stage wise pre-loads at heights which simulate the actual MSW construction and considers the weakest borehole. Once 90% of this consolidation settlement is completed, unloading up to Grade level, conduct confirmatory Geotechnical Investigations and check whether design parameters are achieved and after which MSW SLF construction can be started.

The brief stepwise methodology of ground improvement is provided here below,

Step-1: Prefabricated vertical drains (PVDs) will be installed to facilitate water drainage, allowing the soil to consolidate more quickly under the influence of added load.

Step-2: The natural ground will be filled up through soil material, along with layer wise controlled filling and compaction.

Step-3: The embankment will be built using layer wise controlled filling and compaction in layers to ensure stability and load-bearing capacity.

Step-4: Mass filling of surcharge material will be applied to increase the load on the soil, helping to speed up the pre-consolidation process.

Step-5: The surcharge material will be removed from the KSWMP phase (project area) and transported to the buffer area, where it can later be used for landfilling or other applications.

The quantity of PVD for the KSWMP Phase are worked out for SLF area of 78581 sqm. plus, for additional 15m peripheral area of 21450 sqm. So, total area of around 100031 sqm. is considered for the PVD application, with average depth of 5.5m PVD-TRIANGULAR PATTERN at 1.0m C/C SPACING.

2.19.4 Additional Technical Measures to Enhance SLF Volumetric Capacity

It is to be noted that the land parcel identified for the Scientific Landfill is the only land available and there are no alternate sites. Without any ground improvement the subsoil will not be capable of transferring the bearing pressures of the order of 250 to 300 kPa on account of its very high compressibility characteristics.

Therefore, ground improvement is necessary to improve the weak/very weak sub-soil noticed at the Project site. Considering the clayey soil, it will be necessary to adopt ground improvement methods which can be applied to improve the sub-soil is stated in previous paragraph. An important aspect is such slopes require sufficient footprint at the base thus impacting the volumetric capacity of landfill. To overcome this constraint, in many Scientific landfills, the approach these days is provide a confinement on the periphery like Retaining walls /Reinforced Soil walls. The same shall be examined during detailed engineering study by contractor before implementation and approval taken from the client. The good earth used for preloading surcharge for accelerating consolidation will be used for Earth works such as SLF embankment, subgrade, bed slopes, daily soil cover, intermediate cover.

2.19.5 Landfill Base Slope

Based on the detailed geotechnical investigation, sub soil formation and expected settlement of the soil, it is further concluded to propose the Landfill base slope as presented below for ensuring efficient gravity flow of leachate through the drainage media at the bottom of the landfill towards leachate storage pond located in the North-East of the site. The leachate shall flow from central ridge line through lateral pipes towards norther and southern side header pipes. The design and size of the header and lateral pipe are mentioned in the leachate generation and management section of this report.

The leachate conveying system for SLF is presented below Figure 2-19, however the contractor shall further plan and design it in consultation with PMC/ client and as per the ground conditions and detailed investigation.

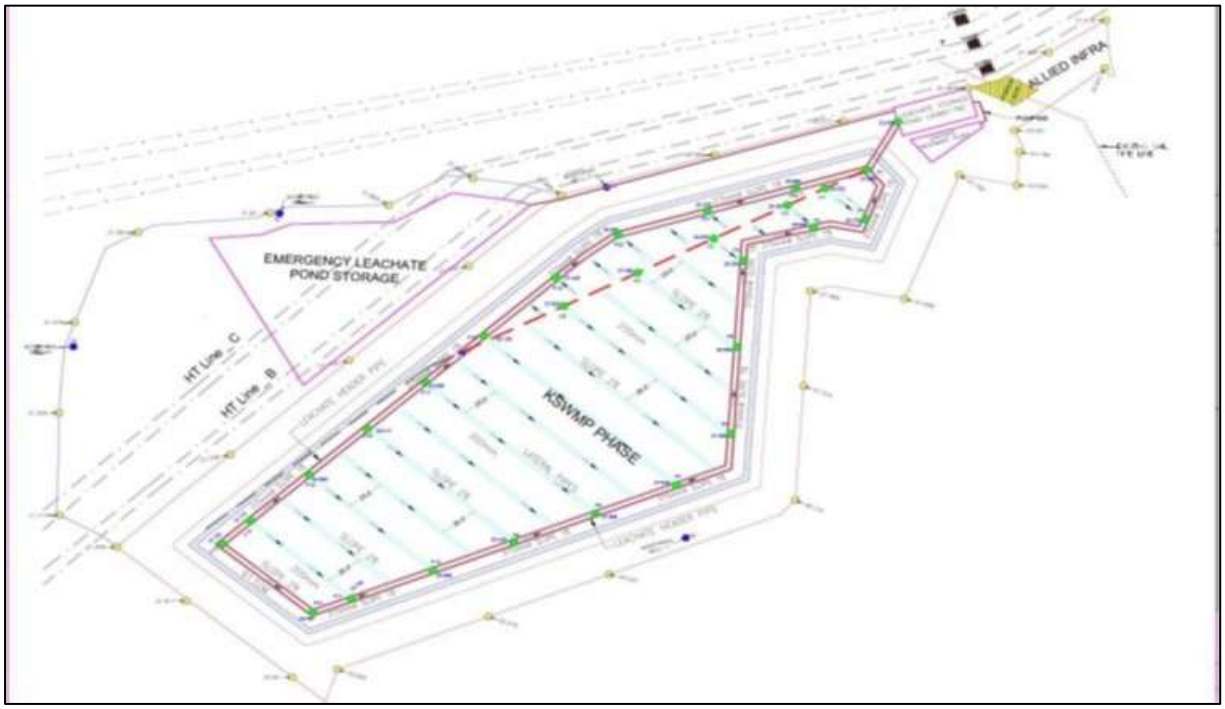


Figure 2-17 Landfill base slope & Leachate covering system (West to East peripheries)

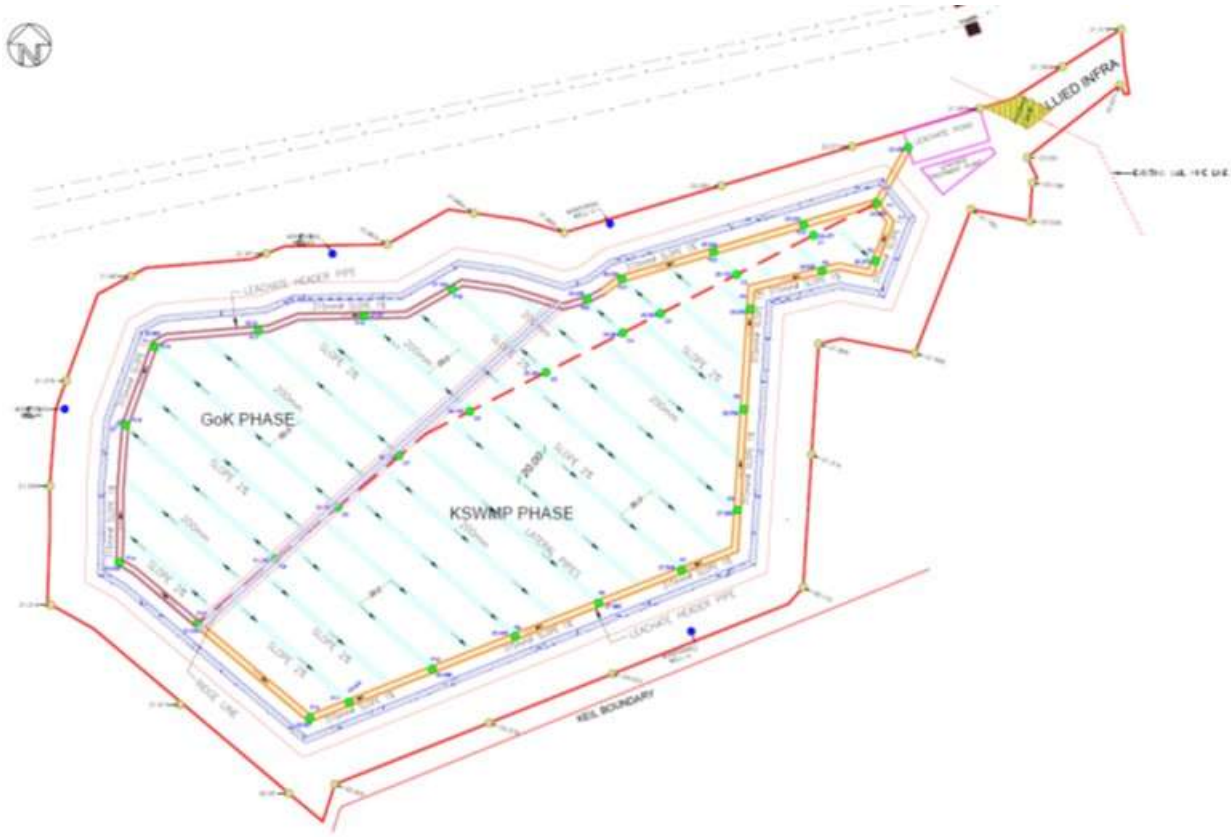


Figure 2-18 Combined Phase: SLF Base Plan

Cross-section of the SLF Base plan are shown in Figure 2-20 to show the typical arrangement of both side embankments, interim embankment, with Northern and Southern Header Leachate Pipe and Lateral Leachate collection Pipe.

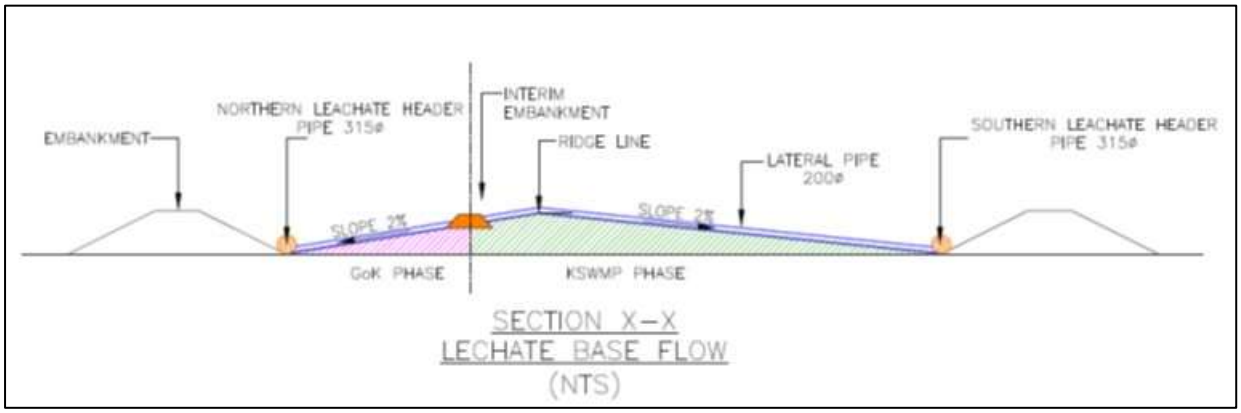


Figure 2-19 Typical Cross-section of SLF Base Plan with Interim Embankment, Header and Lateral Leachate Pipes

2.19.6 SLF Subgrade Preparation

After installation of PVDs and raising the existing ground by 3.65 meter by filling with suitable material, the subgrade of well compacted 0.3 m thick soil of good earth/ murrum will be provided.

The natural ground/filled up with soil as well as SLF subgrade of 0.3m thick will be levelled and compacted to a maximum dry density of 90–95%. Leachate and storm water must be ensured to drain through gravity from the base area by having a sufficient base slope of 1 to 2%, the compacted filled up soil and subgrade soil surface will be graded accordingly. There will be a 1V:100H longitudinal slope and 2V:100H lateral slope of the bottom soil subgrade of the SLF. With a roller, the slope and 300mm of soil will be compacted to 95% of proctor density. The SLF base liners along with base subgrade soil 300mm thick is shown in Fig. 2-22.

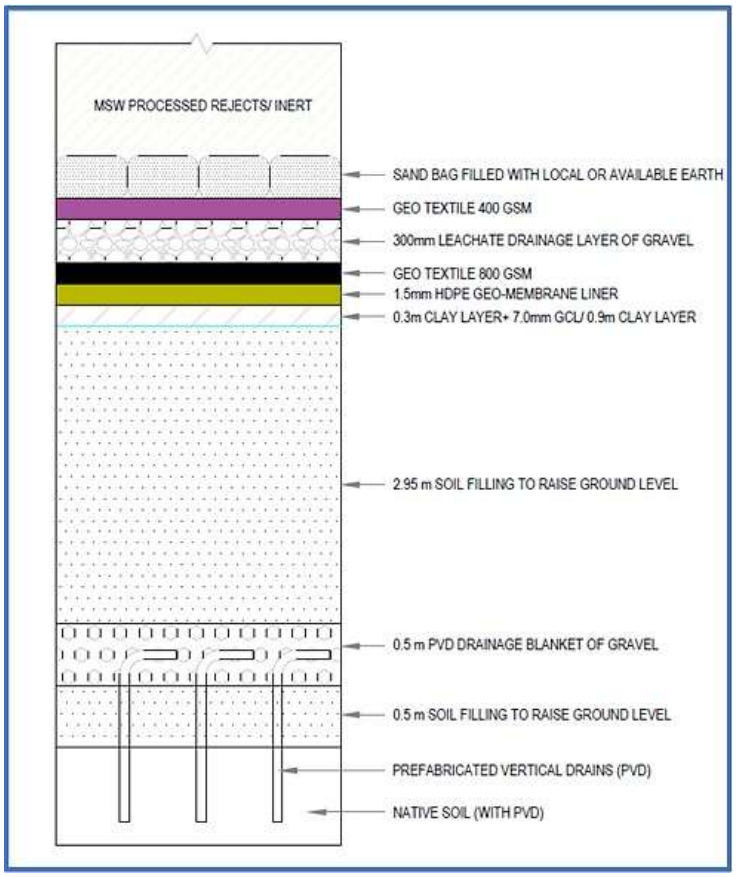


Figure 2-20 SLF Base Liners along with Base Subgrade soil 300mm thick

2.19.7 SLF Embankment and Base

The embankment as designed in FSR of height 3m, side slope 2H:1V with top width of 3m and bottom width of 15m will be constructed at site. The embankment section is shown in Figure 2-23. The maximum SLF height will be 23m. The SLF base of 0.3 m thick soil subgrade will be provided. The slope of embankment will be covered by plantation.

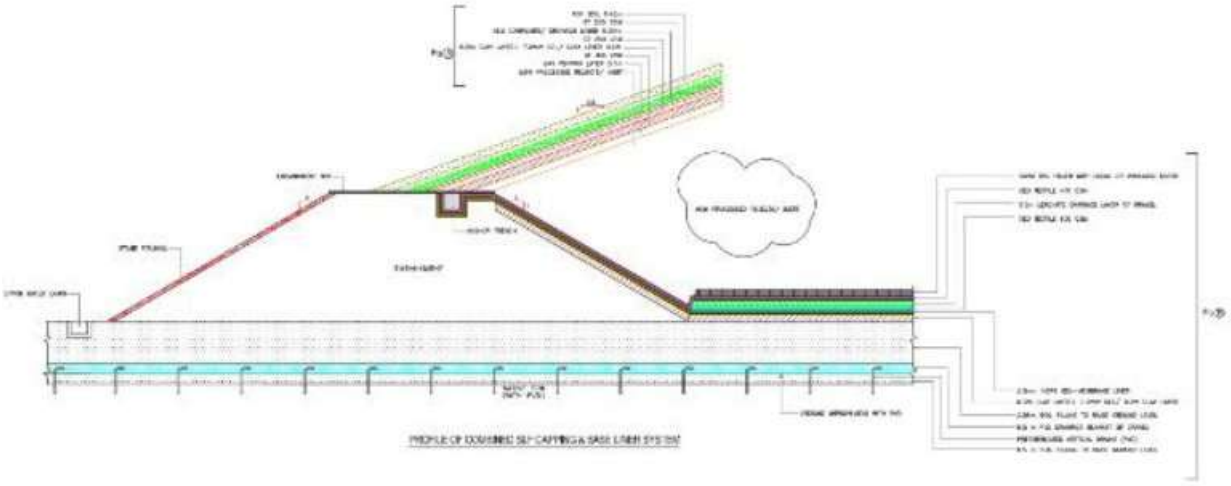


Figure 2-21 SLF Embankment section

2.19.8 Base Sealing/Liner System

i. As per SWM Manual 2016 base clay layer of 0.9m thickness of kf ≤1 x 10-7 cm per second (cm/s) is provided for the SLF base. However, it is proposed to replace the base clay layer of 0.9m thickness with clay layer of 0.3m thickness and Geo Clay Liner to reduce the dependence on good soil from borrow pit and reduce environment impact also.

ii. After construction of the SLF base subgrade of 300mm are made of compacted clay layer, the base liners such as Geo Clay Liner (GCL 7 mm Thickness with kf ≤5 x 10-9 cm per second (cm/s)) shall be supplied and installed for bottom lining above 300mm clay layer.

iii. Above GCL then HDPE Geomembrane on 1.5 mm thick shall be supplied and installed, the geomembrane layer is laid to avoid leachate seepage. Only HDPE geomembranes that meet the standards of the GRI GM 13 or ASTM (American Society for Testing and Materials) specifications would be utilized.

iv. Then above HDPE layer, the Geotextile of 800 GSM (GT-800 GSM) shall be supplied and installed as per SWM Manual 2016 as the landfill height is more than 20 meters. It shall act as a protective layer for the HDPE Geomembrane. The GT-800 GSM acts as a cushion shall prevent piercing of the HDPE Geomembrane liner by drainage gravels.

v. Above GT 800 GSM, then a 300mm thick layer of gravel or aggregates (size 25–50mm) of hydraulic conductivity of kf>1 x 10-2 cm/s as per SWM Manual 2016, page no. 381 shall be provided as leachate drainage media/layer so that any leachate produced from waste/rejects/inert shall be collected in a leachate collecting system.

vi. To collect the leachate and drain it to a leachate pond, the header and lateral HDPE pipes will be placed in the leachate drainage media/layer.

vii. The Geotextile of 400 GSM (GT-400 GSM) is provided as filtration and separation layer above the leachate drainage media/layer. It prevents clogging of leachate drainage media/layer and perforated leachate pipeline.

viii. As a protective layer 200 mm of soil or soil bags is proposed to protect GT-400 GSM from Rejects/ Inert and landfill vehicular movement.

ix. A leachate pond of sufficient capacity shall be provided to store leachate, from which it will be pumped to the Leachate Treatment Plant (LTP) for further treatment.

2.19.9 Leachate Drainage Layer

Above GT 800 GSM, a 300mm thick layer of gravel or aggregates (size 25–50mm) of hydraulic conductivity of >1 x 10^{-2} cm/s as per SWM Manual 2016, will be provided as leachate drainage media/layer so that any leachate produced from inert wastes will be collected in a leachate collecting system.

2.19.10 Estimation of Leachate

In order to fulfil the discharge standards, the leachate generation is estimated at rate of 26.23mm/sq.m/day. The leachate quantity estimated to the tune of 300KLD and will be treated in 400 KLD capacity of LTP.

The SLF footprint area considered for the leachate calculation is 25% of SLF footprint 18.14 acres (72,759 sqm). The Leachate quantity is estimated based on water balance method.

2.19.11 Leachate Drainage Header Pipelines

The leachate drainage header pipeline design calculations are based on manual on sewage and sewerage treatment_CPHEEO_MoUD_1993 and Manning's Formula. Accordingly, HDPE main header pipes of 315 mm is proposed to evacuate entire leachate from the SLF. The typical section of bottom leachate drainage layer & header pipe is shown in Fig. 2-24.

HDPE lateral pipes 200 mm size (PE-100) at 20m spacing of total length of 5105 meter will be placed in the drainage layer to collect the leachate as per SWM Manual 2016. It will carry leachate from SLF base to the main header pipe 315 mm size (PE-100) with total length of 1325 meter. The entire leachate through the main header pipe will flow to the leachate pond, from which it will be supplied to the leachate treatment plant for treatment, disposal, or reuse.

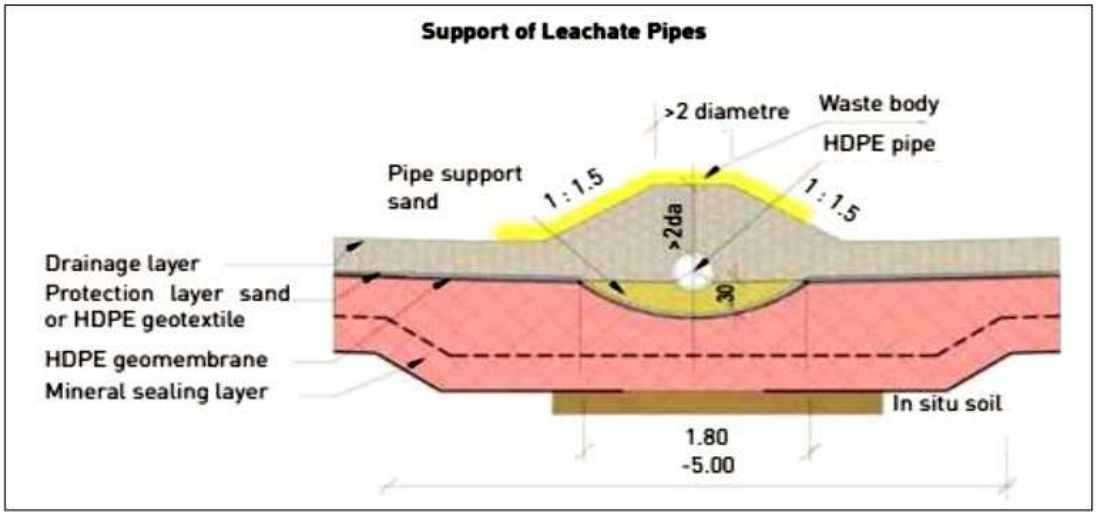


Figure 2-22 Typical section of Bottom Leachate Drainage layer & Header Pipe as per SWM Manual.

2.19.12 Leachate storage system

The leachate collection and solar evaporation pond is proposed for collection, storage and evaporation. The leachate pond is proposed for capacity of 1.8 days (Approximate 2 days) retention time. The leachate pond of 40m x 17m with height is considered as 1.2m. An emergency leachate holding tank of 22 days storage capacity is also proposed to accommodate additional quantity of leachate in case of excess rainfall. It is proposed to collect the leachate first in the leachate Storage Pond as presented below and irrigate the same on the sloping sidewall of the pond and evaporate the maximum possible leachate. When there's heavy rainfall, the volume of leachate can significantly increase, making it more important to have an effective leachate management system in place. The capacity of LTP is planned accordingly (LTP Capacity is expected at 400 KLD higher than the daily generation) to meet the highest infiltration due to heavy rainfall. The remaining leachate shall be supplied to the Leachate Treatment Plant (LTP) for treatment and disposal. The treated leachate shall be utilised for sprinkling, dust suppressing, and watering on the landscaping provided at the site and used as per PCB norms. The sludge and sediments settled at the bottom of leachate storage pond shall be disposed as per PCB norms, rules, guidelines and conditions of consent to establish and operate on regular interval.



Figure 2-23 Typical Leachate Evaporation Pond



Figure 2-24 Typical Monsoon Cover of Leachate Pond

The plan, X-X cross section and X-X cross section of the proposed Leachate Pond are shown in Figure 2-27, 2-28 & 2-29 respectively, the similar typical arrangement,

construction material and liner material is proposed for the emergency leachate pond as well.

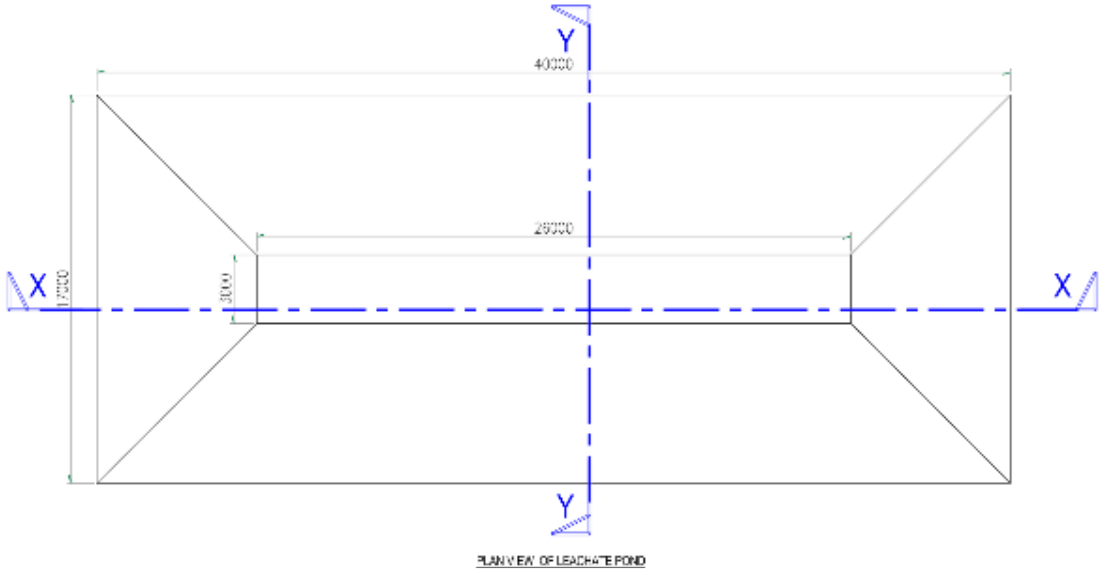


Figure 2-25 Plan of Leachate Pond

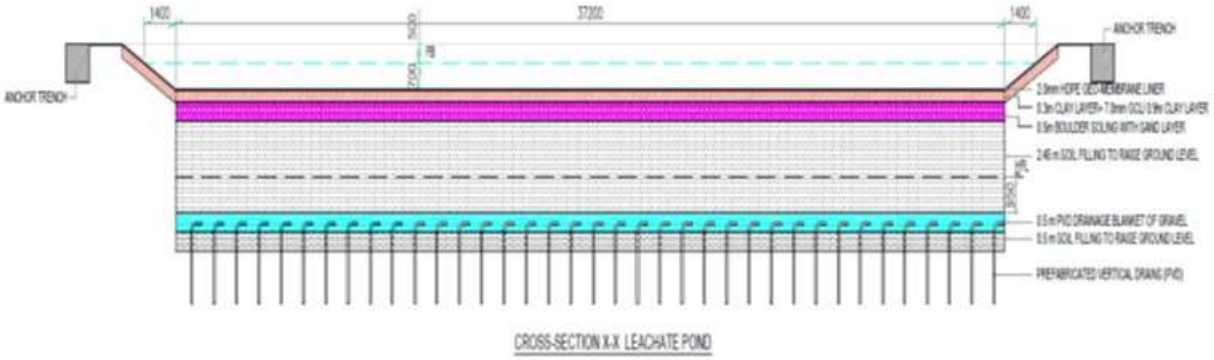


Figure 2-26 X-X Cross-section of Leachate Pond (Typical Arrangement)

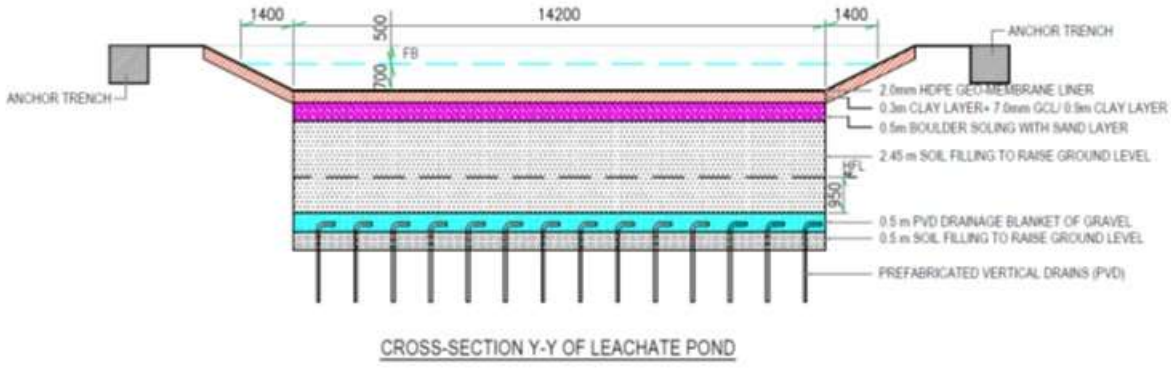


Figure 2-27 Y-Y Cross-section of the proposed Leachate Pond (Typical Arrangement)

2.19.13 Leachate Treatment Disposal System

The leachate treatment plant of capacity 400 KLD is planned for full leachate generation volume.

The Leachate Treatment Plant consist of following components,

1. Primary Treatment

The Primary Treatment System comprises of Screening, Equalization, Neutralisation, Primary flocculation.

2. Secondary Treatment

The Secondary Treatment System comprises of Anaerobic Digester, Moving Bed Bio Reactor, Secondary Flocculator, Sludge Handling.

3. Tertiary Treatment

The Tertiary Treatment System comprises of Chlorination, Multigrade Sand Filter, Activated Carbon Filter (ACF), Ultra Filtration (UF), Reverse Osmosis (RO), Multiple Effect Evaporator (MEE), Agitated Thin Film Dryer (ATFD).

The properties and amount of the leachate determine the sort of treatment facilities to be adopted. The concentration of biodegradable and non-biodegradable organic material, certain hazardous elements, ammonia and nitrate ions, sulphides, odorous chemicals, and suspended solids may typically need to be reduced (before to release). The inlet parameters considered for leachate treatment are mentioned here for reference purpose only taken from similar project. The typical inlet and outlet parameters considered for leachate treatment are mentioned as per SWM Rules, 2016 is given in the Table 2-18 & 2-19 below,

Table 2-17 Leachate Inlet Parameters

S. No	Parameters	Approximate Values
1	pH value	6.6
2	TDS (mg/l)	14350
3	TSS (mg/l)	182
4	COD (mg/l)	20000
5	BOD (mg/l)	8600
6	Chlorides (mg/l)	5088
7	Fluoride (mg/l)	0.62
8	Ammonical Nitrogen (mg/l)	318
9	Total Kjeldahl Nitrogen (mg/l)	878
10	Lead (mg/l)	0.07
11	Zinc (mg/l)	0.47
12	Cadmium (mg/l)	0.03
13	Nickel (mg/l)	6.79
14	Copper (mg/l)	3.59
15	Chromium (mg/l)	2.8

Outlet parameters as per SWM Rules 2016 is given in the table below

Table 2-18 LTP outlet/ Discharge Parameters

S. No	Parameter	Standards (Mode of Disposal)		
		Inland surface water	Public sewers	Land disposal
1	Suspended solids, mg/l, max	100	600	200
2	Dissolved solids (inorganic) mg/l, max.	2100	2100	2100
3	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
4	Ammonical nitrogen (as N), mg/l, max.	50	50	-
5	Total Kjeldahl nitrogen (as N), mg/l, max.	100	-	-
6	Biochemical oxygen demand (3 days at 270 C) max.(mg/l)	30	350	100
7	Chemical oxygen demand, mg/l, max.	250	-	-
8	Arsenic (as As), mg/l, max	0.2	0.2	0.2
9	Mercury (as Hg), mg/l, max	0.01	0.01	-
10	Lead (as Pb), mg/l, max	0.1	1.0	-
11	Cadmium (as Cd), mg/l, max	2.0	1.0	-
12	Total Chromium (as Cr), mg/l, max.	2.0	2.0	-
13	Copper (as Cu), mg/l, max.	3.0	3.0	-
14	Zinc (as Zn), mg/l, max.	5.0	15.0	-
15	Nickel (as Ni), mg/l, max	3.0	3.0	-
16	Cyanide (as CN), mg/l, max.	0.2	2.0	0.2
17	Chloride (as Cl), mg/l, max.	1000	1000	600
18	Fluoride (as F), mg/l, max	2.0	1.5	-
19	Phenolic compounds (as C6H5OH) mg/l, max.	1.0	5.0	-

2.19.13.1 Primary treatment

(i) Screening

The screening chamber is provided to arrest the floating materials from the leachate. The screen compartment is made of MS perforated material. The arrested material needs to be disposed off as per regulatory requirements. The bar screen chamber of 2.5 KL capacity is proposed for the project.

(ii) Equalization

The primary function of an equalization tank is to regulate and equalize the inflow of leachate, ensuring a consistent flow rate for downstream treatment processes. It also helps to achieve a more uniform composition, optimizing the efficiency of subsequent treatment steps. Additionally, the tank provides a buffer storage capacity to handle variations in leachate quantity and quality. Thus, shock loading in the treatment plant can be prevented. The equalization tanks of 400 KL capacity (2 tanks of 200 KL capacity) are proposed for the project.

(iii) Neutralization

The pH of leachate plays crucial role in the further treatment process. Hence, the equalized effluent needs to be neutralized further with acid/alkali in the neutralization tank. The 10 KL neutralization tank is proposed for the project.

(iv) Primary Flocculation

After neutralization the overflow goes to flash mixer followed by flocculator where coagulants and flocculants will be added. Flocculator is a mixer where we dose polymer to increase the size and weight of flocs. It consists of agitator to mix polymer with raw water. The 3.5 KL capacity of flash mixer and flocculator is proposed for the project.

After mixing the coagulants in the flocculator the flow goes to primary clariflocculator to remove suspended solids in the effluent. The clarified water will be collected in intermittent collection tank and then fed to two stage anaerobic reactor. The 70 KL of primary clarifier and 70 KL of intermittent collection tank is proposed for the project.

2.19.13.2 Secondary treatment

(i) Anaerobic digester

The anaerobic digester's where BOD/COD reduction can be achieved by virtue of anaerobic microbial activities. The reactor is equipped with PVC corrugated media of specific block dimensions. These are provided as the inert support media for bio-film attachment and growth and completely covered. Two anaerobic reactors of 2750 KL capacity are proposed for the project.

(ii) Moving Bed Bio Reactor (MBBR)

The overflow from anaerobic reactors goes to two stage Moving Bed Bio Reactors (MBBR) where further BOD/COD reduction can be achieved by virtue of aerobic microbial activities. The reactor some portion filled up with small carrier elements. The bio film develops on the elements, which move along with leachate in the reactor. The movement within the reactor is generated by providing aeration with the help of air diffusers placed at the bottom of the reactor. The thin bio film on the elements enables the bacteria to act upon the biodegradable mater in the effluent and reduce the BOD/COD content. Two MBBR tanks of 900 KL capacity are proposed for the project.

(iii) Secondary Flocculator

The bio-solids formed in the biological process in MBBR will be separated in the downstream secondary clarifier and reactive clarifier of proposed capacity of 70 KL tank.

(iv) Sludge Handling

The sludge generated in the reactors and settled in the primary, secondary clarifier and reactive clarifier will be pumped sludge thickener. The thickened sludge will be collected in sludge collection tanks, further to screw press for de-watering, and finally sent to the nearest TSDF's as per hazardous and other Wastes(Management and Transboundary Movement)Rules,2016. The flow of screw press for feed pump (2 nos.) and dewatering sludge (1 no.) of capacity 6 cum/hr is proposed for the project. The expected quantity of

sludge is about 6 kg/hr will be disposed in the drying bed provided along with LTP. The size of drying bed is 4m x 5m. The Sludge will be tested for Hazardous material by conducting (Toxicity Characteristic Leaching Procedure) TCLP test accordingly it will be disposed.

2.19.13.3 Tertiary Treatment

(i) Chlorination

Chlorine is powerful oxidizing agent and widely used for functions such as, disinfecting water, colour reduction, for microorganism's control, taste and odour removal and destruction of organic matter. The process of chlorination is provided as first step of disinfection for the leachate treatment plant. The chlorination contact tank of 70 KL capacity is proposed. The chlorine concentration level is maintained below 0.01 mg/l to avoid harm to aquatic life.

(ii) Multigrade Sand Filter

Filtration is a process that consists of solid liquid mixture through a porous material which retains the solid and allows the clear liquid to pass through. The porous media can be any filtering media like different grades of pebbles and quartz sand etc. The clear liquid is called filtrate. Backwashing with air scouring facility provided. The Multigrade sand filter capacity flow of 20 cum/hr is proposed for the project.

(iii) Activated Carbon Filter (ACF)

The leachate from the Multigrade sand filter will undergo additional filtration treatment in the ACF to remove colour and aroma. ACF possesses activated carbon, one of the most popular media for impurity absorption. Depending on the incoming impurity load, the activated carbon media's finite capacity of absorption will exhaust itself after lengthy use. The filter is operated by a manual valve. To eliminating adherent particles on the filter media, filter backwashing is done once per day. The ACF flow capacity of 20 cum/hr is proposed for the project.

(iv) Ultrafiltration (UF)

The filtered effluent will be collected in the storage tank (UF feed tank) and fed to Ultra filtration membranes through Micron filter. It will be collected in storage tank for further treatment. This system is dead end filtration system. There are no rejects. Rejects only consider by fast and back flushing. The ultra-filtration membranes are with small pore size (0.01 microns) and used to remove the suspended solids, bacteria, colloids, proteins, and carbohydrates. Generally, the observed System recovery is approximately 90%. The 120 KL UF feed tank is proposed for the project.

(v) Reverse Osmosis (RO)

The Ultra-Filtration product water will be collected in the storage tank (RO feed tank) and feed to RO system through the cartridge filter pH, antioxidant, and Anti scaling dosing system then leachate is pumped by high pressure pump to the reverse osmosis system. The RO membrane has small pore sizes (0.0001) which do not allow ions to higher sizes to pass through. The feed stream is split into two streams one is the permeate (product) which is low TDS and other is the reject containing all the rejected salts.

Two stage RO process is proposed for the project as shown in process flow diagram below. First stage RO (RO1) feed tank of capacity 120 KL is proposed whereas second stage RO (RO2) feed tank will be reject tank of RO1 of capacity 60 KL. The product of RO1 & RO2 will be collected in combined tank of capacity 150 KL which can be reused for gardening purpose or other industrial needs. The 80 KLD RO reject will be further treated using Multiple Effect Evaporator (MEE) system using coal-based boiler as steam

and distillate to be treated in Agitated Thin Film Dryer (ATFD) process. The powder salt remaining from the ATFD process will be sent to TSDF for disposal. The used membranes will be lifted by the suppliers. The MEE is proposed having 4 effect forced circulation system, ATFD will be of 10 m^2, boiler of 2 Tonnes capacity and cooling tower of 500 TR.

The sludge and sediments settled at the bottom of tertiary treatment unit shall be disposed in the Hazardous waste landfill as and when required. The RO product can be reused at the facility and excess can be discharged into the surface water body ensuring the quality of the same meets the discharge standard given by SWM rules 2016. The monitoring of the same is required to ensure the legislation compliances before discharging the same in environment. The general process flow diagram for LTP is shown in below image.

The process flow and capacity proposed of each unit depends up on the quality of the leachate influent which can be further modified based on detail characterization of the leachate. The general process flow diagram for LTP is shown in below Figure 2-30

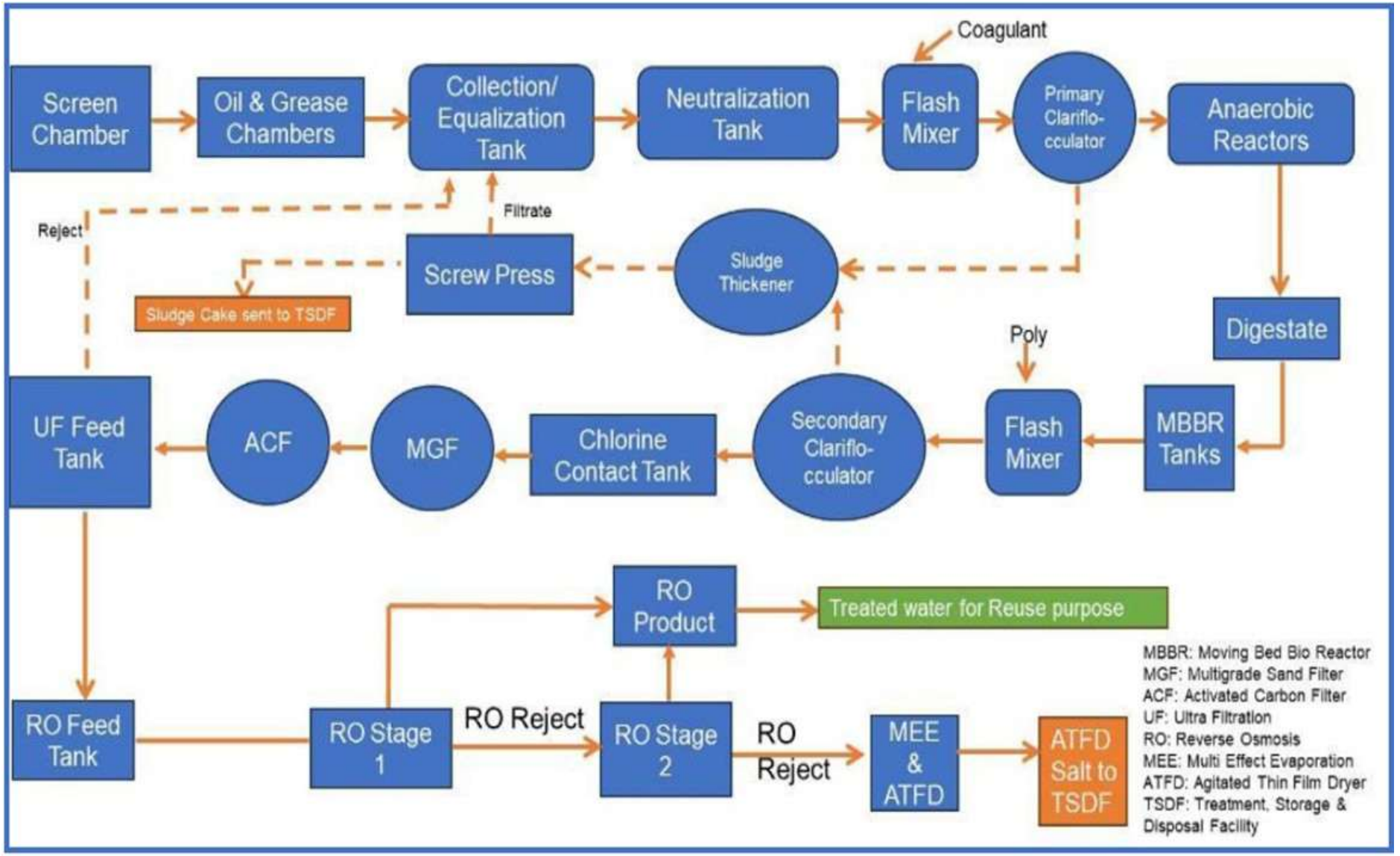


Figure 2-28 Leachate Treatment Plant – Process Flow Diagram

2.19.14 SLF Equipment

The following landfill equipment's are proposed for the landfill operations,

Table 2-19 SLF Equipment

Sl. No.	Description	Quantity in nos.
1	Landfill compactors	2
2	Dozer	2
3	Water tanker (5KL capacity)	2
4	Tippers (10.5 cum capacity)	2
5	Front end loader with back - hoe	2

2.19.15 Erosion Control System (Stone Pitching on Embankment)

The stone pitching will be provided on the outer slope side to the SLF embankment in order to avoid soil erosion.

2.19.15.1 Storm Water Drain & Storm water evacuation pipeline

Storm water drain of 1.1m depth x 1.2m width cross section is planned around the Scientific Landfill. Two Storm water drains from North-East to South-West flow direction are proposed on Northern and Southern side of SLF acting as garland drains. The total catchment of SLF is divided into two parts. Half surface run-off is consider flowing towards northern SWD and remaining half in southern SWD.
The proposed Storm Water Drain (SWD) will have minimum required slopes to direct rainwater into nearby Chithrapuzha river by gravity flow. The interception and diversion Hume pipes of 1.2 m diameter is proposed at every 100 m distance all around the perimeter towards north and north-west side of the SLF footprint area.

Assumptions for the Storm Water Drain:

Drain Length: Garland Drains Length of about 700m is considered (one on each South and North side) for proposed SWD planning.

Run-off Coefficient: 0.85 (Ref. Manual on sewage and sewerage treatment_CPHEEO_MoUD_ 2013)

Area of Drainage: Half of SLF Area about 4.91 Ha. (Note: Northern half of the SLF area shall contribute towards northern SWD and southern half of the SLF area shall contribute towards southern SWD. Hence half of the area is considered)

Maximum Intensity of Rainfall: Maximum intensity of rainfall 223 mm/hour is considered, the another scenario is 112 mm/hour is considered during normal rainfall. (Ref.: Paper: Rainfall intensity characteristics at coastal and high-altitude stations in Kerala)

Coefficient of Roughness: 0.015 (Ref. Manual on sewage and sewerage treatment_CPHEEO_MoUD_2013)

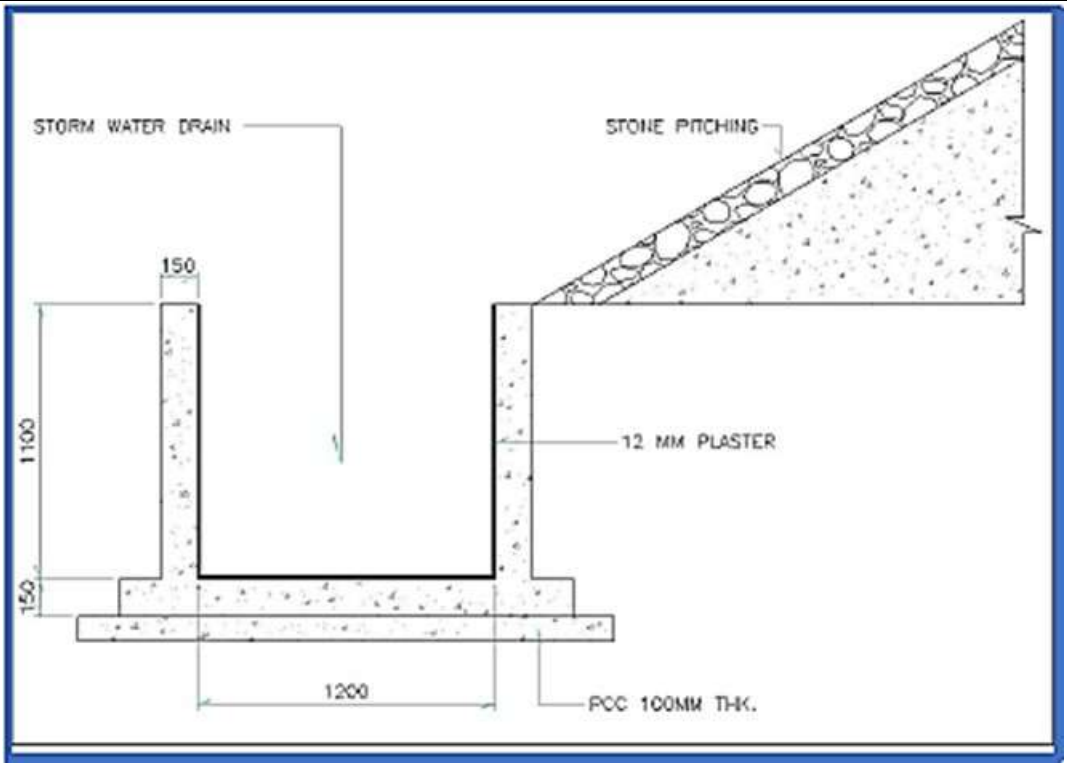


Figure 2-29 Cross section of Storm water drain

From the above parameters, it is estimated that the surface run-off will be to the tune of about 4694 cum/hr during normal rainfall and about 9306 cum/hr during torrential rainy days. The SWD are designed to meet the above flow. The cross section of SWD is shown in above Figure 2-31.

2.20 Flood Protection Dyke

The SLF Project site is going to be raised by around 3.95 m plus 1.3m for settlement fill. This total fill of 5.25m will have inbuilt Dyke of 4.5m. This flood protection Dyke/ Earthen Embankment of around 900 meter is provided below the green belt along Northern and Western periphery of the site to avoid influx of flood water, and for confinement of the filled-up soil material for the footprint of SLF. The Dyke will have cover of Geotextile 400 GSM and HDPE Geomembrane of 1.5 mm thickness to improve the imperviousness. Above the impervious layer of Geotextile and HDPE Geomembrane, Greenbelt of landscaping and plantation will be provided which will provide the additional strength to the Dyke. The cross section of flood protection dyke is shown in Figure 2-32.

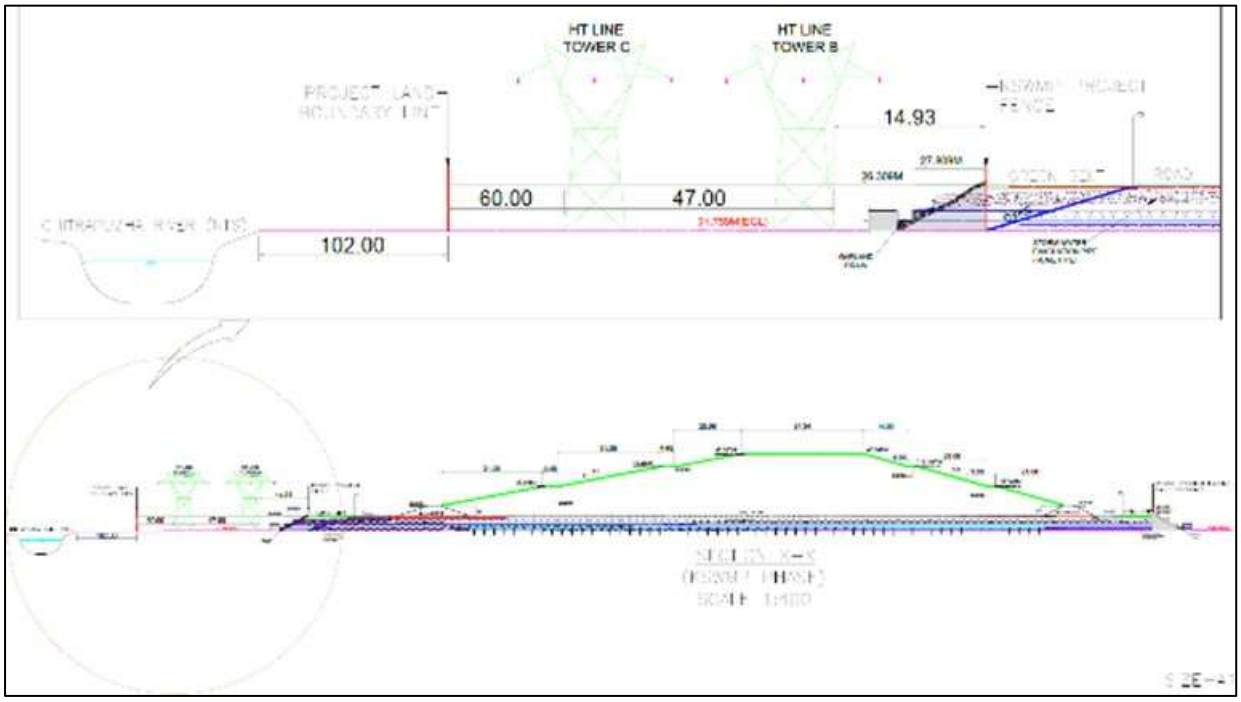


Figure 2-30 Cross Section of SLF - Drawing

2.21 Introduction for SLF Closure

Determination of the end use of a landfill site is an essential part of the plan for landfill closure and post closure maintenance. A closure and post-closure plan for landfills involves the following components:

- Plan for vegetative stabilization of the final landfill cover,
- Plan for management of surface water runoff with an effective drainage system,
- Plan for periodical inspection and maintenance of landfill cover (settlements) and facilities,
- Plan for quantity and quality of leachate monitoring in the landfill,
- Plan for quantity and quality of landfill gas monitoring,
- Plan for groundwater quality (up and down gradient), and
- Plan for surface water quality at the periphery of landfill and at receiving water bodies.

The regulatory limits for various parameters of quality and the monitoring frequency will have to be agreed or stipulated by the regulatory authorities.

2.22 Final Closure layers of Scientific Landfill

Once the waste has been filled to the designated capacity in the Scientific landfill, it must be capped/ closed to prevent rainwater ingress. To minimise storm water infiltration in the landfill body and to allow storm water drainage, a surface sealing system must be built following the final completion of each landfill portion. The primary goals of the final cover system are:

The closure cap liner system, for both the open dump site closures and the Scientific landfill closure, will consist of the layers as shown in the Figure 2-33 which is inline with the SWM 2016 Rules.

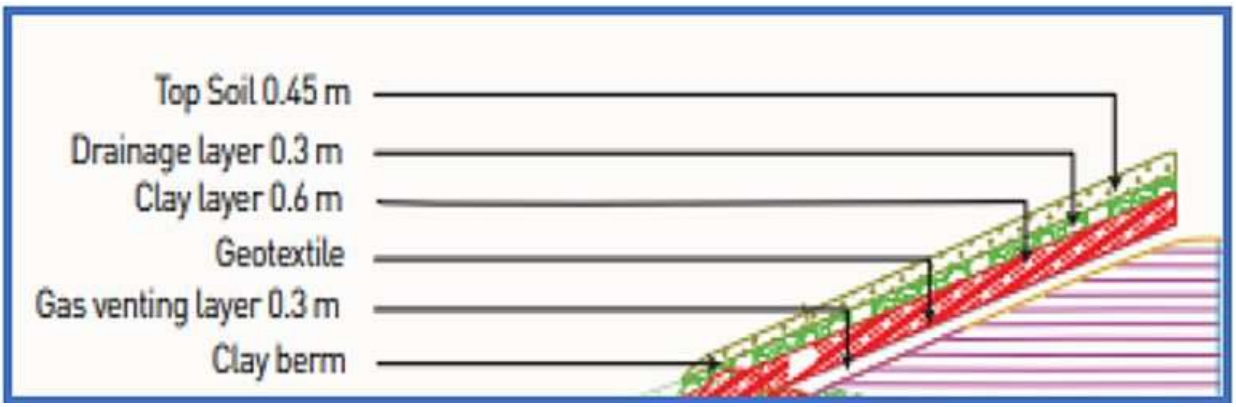


Figure 2-31 Typical Scientific Liner Layers as per SWM Manual

Further, the proposed capping layer is further optimized, made thinner and practically implementable (Slope Stability) on site to make it sustainable from environmental perspective. The proposed scientific capping liner layers is shown in Figure 2-34.

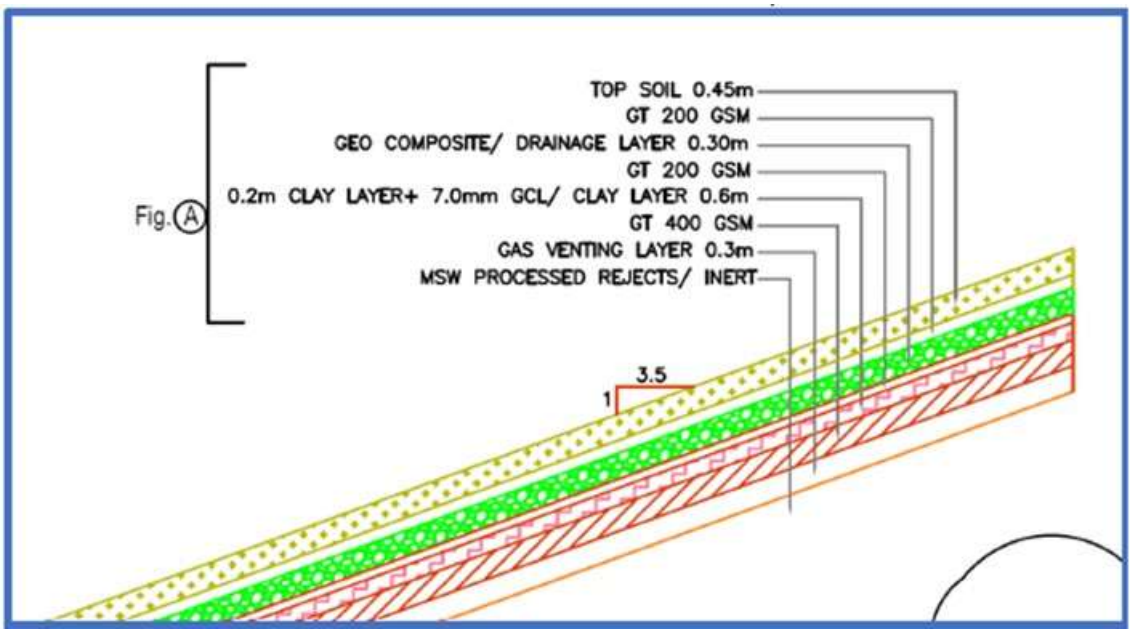


Figure 2-32 Proposed Scientific Capping Liner Layers

2.23 Functions of Closure Cap layers

2.24 Compacted Clay Liner (CCL)

The mineral material (60 cm) shall be clay or amended soil and should satisfy permeability requirements of k= 10^{-7} cm/s. However, due to dearth of good soil for clay barrier, it can be replaced by 300 mm thick compacted and further supplemented with Geosynthetic Clay Liner (GCL).

The first layer on top of the waste material will be 300 mm thick compacted soil. To function as an effective barrier, the CCL will have a low permeability. To attain this permeability, good quality soil must be utilised, and it must be compacted to 90% proctor density. Adequate testing must be performed to guarantee that the desired density is obtained. It also recommended to use 10% lime to improve soil qualities.

2.25 Geosynthetic Clay Liner (GCL)

GCL is advised in addition to CCL, since, it is difficult to obtain desired permeability using locally available soil. GCLs are hydraulic barriers that are factory manufactured and comprise of a layer of Bentonite or other very low permeability material and/or Geo-membranes that are mechanically bonded together by needling, stitching, or chemical

adhesives. GCL's single and clear primary function is that of a liquid barrier. To ensure proper GCL installation, all standard processes will be rigorously followed.

2.26 HDPE Geomembrane (GM) (optional)

Above the GCL, a 1.5 mm thick High Density Polyethylene Geomembrane (henceforth called liner). Extreme temperatures, wind, and precipitation should be avoided when installing liners. On-site hot wedge seaming should be the principal method of seaming.

2.27 Geo-Composite (GC)

Gas collection layer: a 15 cm thick granular gas drainage layer formed by crushed gravel or crushed demolition waste to facilitate gas collection. In the absence of Gravel, it can be replaced with Geocomposite drainage layer. Geo-composite is a drainage layer that allows rainwater to flow quickly from the closure area. Drainage composite for planar drainage made by thermobonding a draining core - HDPE geonet - with two nonwoven geotextiles (GTX) that operate as separation, filter, and protection layers. A drainage layer 5 mm thick with 450 GSM Geotextile will be provided.Vegetative soil layer

Vegetative soil layer: The top layer should be of vegetative soil of 45 cm thickness with the slope of top cover shall be 1:4 or 1:3:5. .This layer will aid in the growth of the grass. Grass will help to avoid erosion during the wet season.

In case 1:3 is provided for SLF capping profile, the vegetative layer soil will be easily eroded on a 1:3 slope, to avoid the same, Geocells for soil fortification are recommended to improve grass growth and avoid top layer erosion and ensure slope stability.

2.28 Coir mesh

Coir mesh is proposed on the surface of the scientific closure to reduce the erosion of top cover soil.

2.29 Storm Water Management

The Closure system is intended to reduce waste infiltration. The top two cover layers, topsoil and drainage layer, flow into the peripheral storm water gutter created around the SLF. On the side slopes and at the bottom, the trenches will be trapezoidal channels formed of brick construction. The storm water trenches will drain runoff just from the closure area and open into a neighbouring river. The storm water drains will open at the lowest portion, where the water will be carried to the storm water retention pit and subsequently released into the natural water channel.

The highest runoff will occur when the closure is completed, as the surface area will be at its greatest. The top of the closure will have a 2-5% slope. The top will be separated into numerous parts to ensure that rainwater does not soak into the closure and flows off as quickly as possible. This will aid in minimising infiltration and, as a result, the generation of leachate. There are drains provided at the bench to let water to flow smoothly into the storm drains positioned at the bottom of the closure. Storm water should be channelled into the nearest river, according on the site characteristics through a retention pond.

2.30 Landfill Gas Management

This landfill is proposed only for disposal of Inert and solid waste process rejects, however sometime organic matter may arrive. Due to the anaerobic decomposition of the organic material in the landfill, landfill gas is generated. Basically, this gas is consisting of methane and carbon dioxide. Both passive venting and gas collecting under suction pressure are methods for handling the gas.

Ambalamedu Landfill is expected to receive only rejects & inerts. There is very little organic content in rejects going into the SLF the chances of landfill gas generation are very low. As such it has been suggested to have a passive gas venting wells placed at every 2500 sqm intervals to remove the landfill gas. The details of passive vents are shown in Figure 2-35.

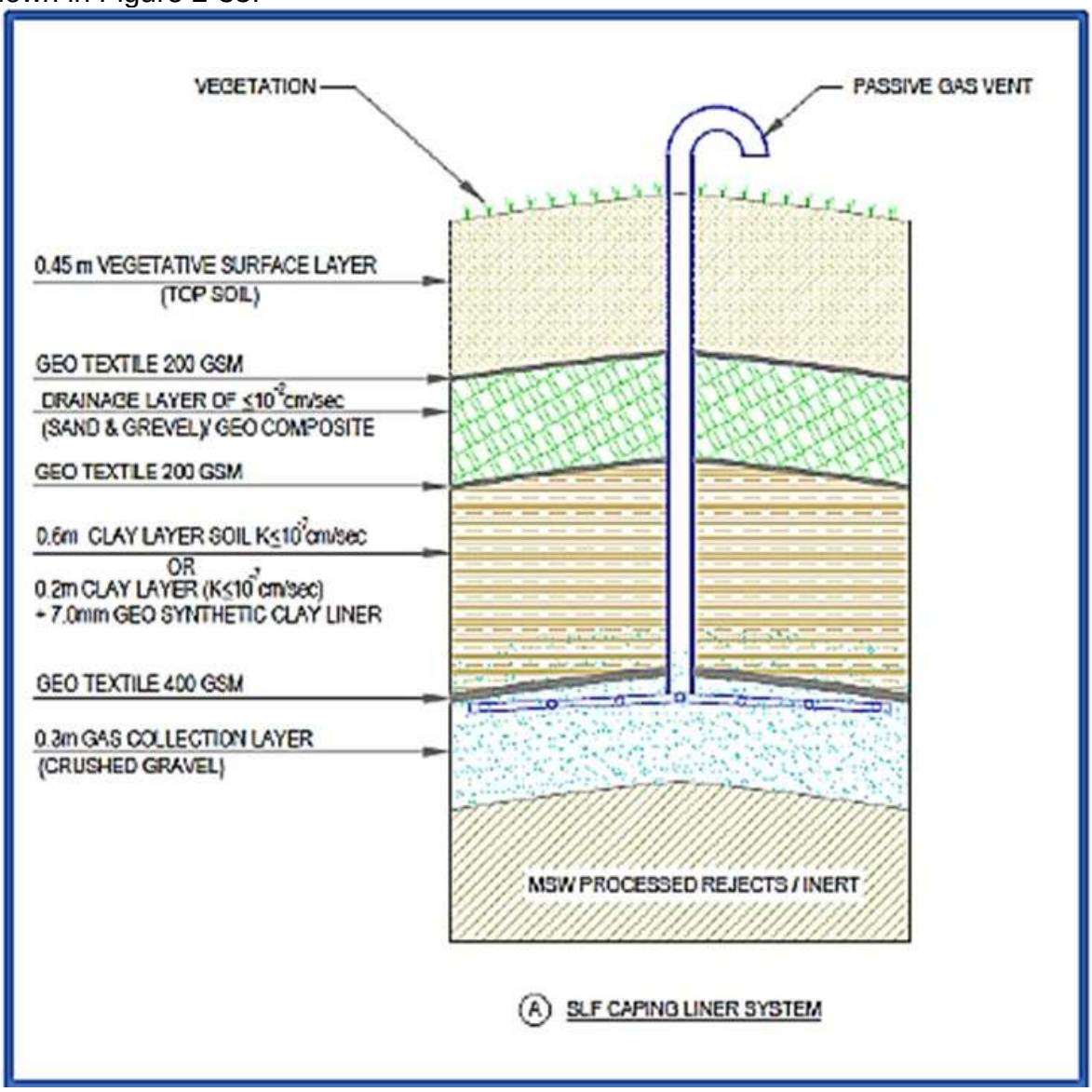


Figure 2-33 Passive Vents for Landfill

2.31 Raw material requirement

The construction raw materials required for the proposed SLF includes land filling (borrow materials) and other construction materials like sand, cement, steel and aggregate. About 7.0 Lakh cubic meter plus 3 lakh m^3 for preloading is estimated to borrow material which will be sourced from nearest filling earth mines which is having valid Environmental Clearance. The sand, cement, steel and aggregate requirements are approximately 283 tonnes, 65 tonnes, 1440 tonnes (course & fine aggregates) respectively.

2.32 Plantation

The Plantation of native species plant and trees are proposed with width of 10m wherever possible or else at the minimum of 2m along the periphery of the site as green buffer to control ambient air quaintly and for better aesthetics. Further after scientific closure and capping of the SLF Site, it shall have green landscape on SLF capping

which will add the further green space in the project area. The details of the same are presented in Table 2-36.

Table 2-20 Green Belt area

Sl. No.	Details	KSWMP Phase	
		Area (sqm)	%
1	Green Belt 1 – Along Boundary line (sq.m.)	11,548	11
2	Green Belt 2 – at allied infrastructure (sq.m.)	534	1
3	Landscaping on SLF Capping (sq.m.)	56,201	56
Total		68,283	68



Figure 2-34 Greenbelt & Capping Green Landscape

2.33 SLF Allied Infrastructure

2.33.1 Internal Road & Site Approach Road

Approach Road: A temporary access to the site is existing at present. A permanent approach road is planned to be developed. Concrete road of M-25 grade 200 mm thick and 7m wide is proposed for the approach road and internal road for vehicle movement to the SLF site and around proposed SLF embankment. One entry & one exit is

proposed in order to have smooth vehicular movement. The typical section of internal road and approach road is shown in Figure 2-37 The approach details are shown in general layout. Figure 2-7.

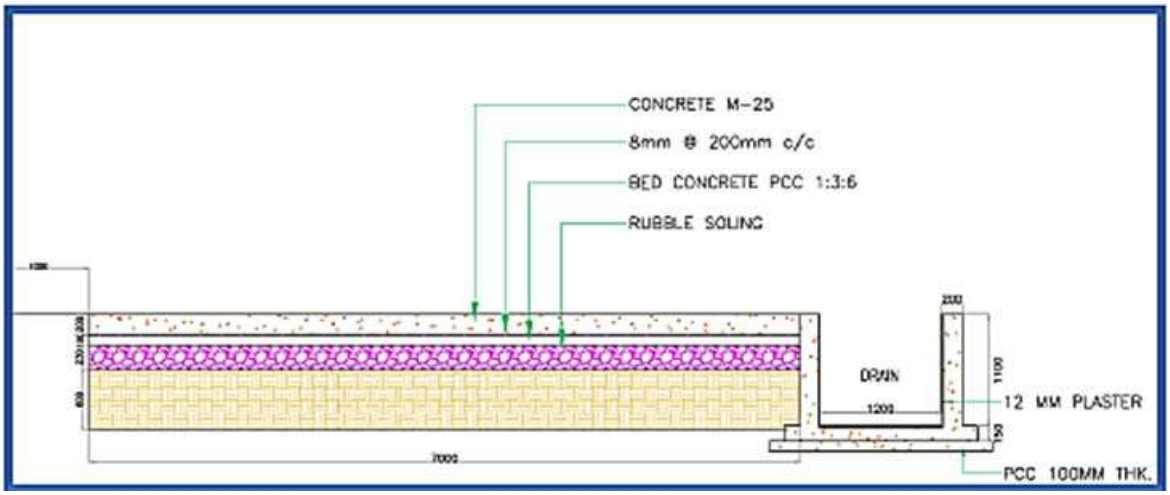


Figure 2-35 Typical section of concrete road

2.33.2 Compound Wall, Entry & Exit Gate

The project site would be surrounded by a boundary wall to keep out stray animals, prevent unauthorised entry, and regulate the movement of restricted vehicles. The steel gate of suitable width is proposed at exit and entry gate of the site.

2.33.3 Site office

A total of 316 sq.m of permanent site office is proposed in the infrastructure area, which will be useful during construction, O&M, and post closure period of the Landfill site.

2.33.4 Weighbridge & Security Surveillance

Two electro-mechanical weighbridges of 40 tonne capacity with load cells is proposed at the entrance of the site along with permanent civil building cabin for data entry and record keeping purpose. The weighbridge shall also have CCTV camera system, monitoring system and with backup of minimum 6 months. The CCTV camera mounted on elevated post is proposed at strategic location of the site for site monitoring and control. Two security cabins are proposed, one at entrance and second inside the site area at elevated location for better site control.

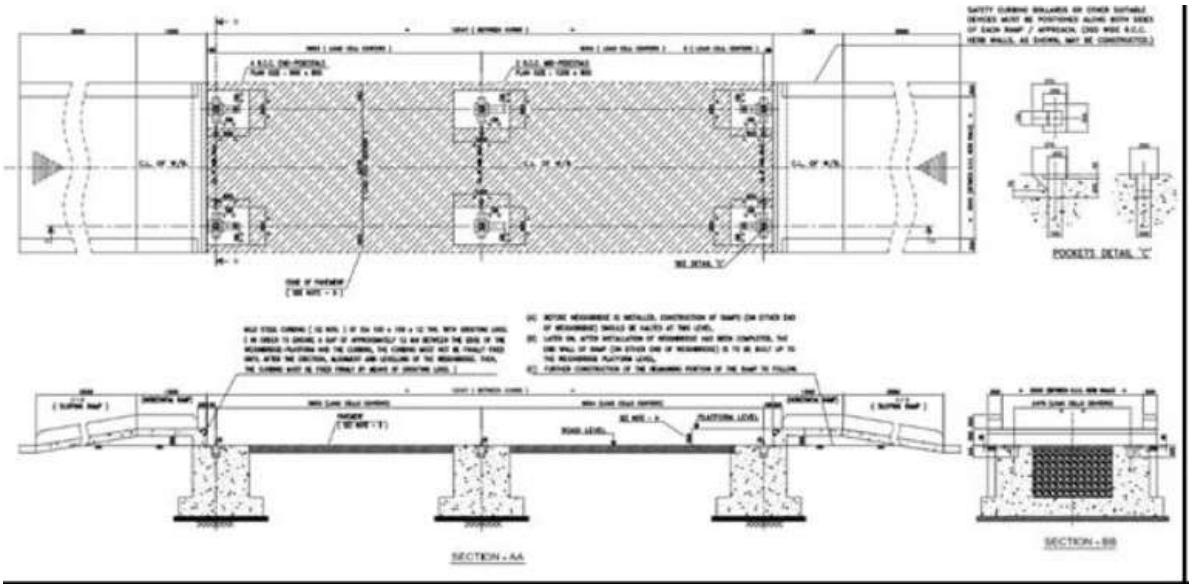


Figure 2-36 Weighbridge Details

2.33.4.1 Water Connection, Supply and Storage

Water connection for the potable water and sanitation purpose is proposed with four HDPE tanks of 2000 Litre capacity on elevated platforms at different strategic location.

The treated water from Leachate Treatment plant and Storm Water Retention pond shall be used for landscaping, sprinkling, dust suppression and wheel washing purposes.

2.33.5 Parking, Vehicle cleaning & Washing area and workshop

Vehicle parking, wheel cleaning area are proposed at the exit of the site with water supply tank, pump and water jet connection for the same. A workshop shed with store room, tool room, fuel storage room and equipment repair area is provided near the entrance of the site for repair of the landfill vehicles

2.33.6 Odor, Dust & Fire Control (Water tanker)

A water tanker of 5000 litre capacity with pump and jet spray and sprinkling arrangement is proposed for the dust suppression as well as for landfill fire control. The Parking area for the vehicles and equipments is shown in general layout.

2.33.7 Ground Water Monitoring Well/Piezometer

Piezometers of sufficient depth are proposed around the SLF site including minimum one at up gradient and three in the down gradient for water sample collection, monitoring and depth assessment for environmental monitoring purpose.

Piezometer will be constructed to monitor the quality of groundwater. Three piezometers will be constructed on the downgradient side of the landfill i.e. on the eastern side. One piezometer shall be constructed on the upgradient side i.e. on the western side of the landfill. The groundwater table varies from 1m to 8m depending upon the season; accordingly, the depth of piezometer shall be 10m below ground level. The piezometer shall be constructed 7m from the outside edge of the embankment.

2.34 SLF Equipment

The following landfill equipment are proposed for the landfill operations

Table 2-21 SLF Equipment

Sl. No.	Description	Unit	Quantity
1	Landfill compactors	Each	2
2	Dozer	Each	1
3	Water tanker (5KL) capacity	Each	2
4	Tippers (10.5 cu.m capacity)	Each	2
5	Front end loader with back-hoe	Each	2
6	Suction tanker	Each	4

2.35 Utilities

2.35.1 Water requirement

The water requirement during construction and operation phase is estimated for proposed SLF site at Ambalamedu. It shall cater for both the phases of SLF. The general assumptions for the same are given below,

The water requirement per head is considered based on following details as per Code of Basic Requirements for Water supply, Drainage and Sanitation

i) Factories where bathrooms are required to be provided 45 liter per head

ii) Factories where no bathrooms are required to be provided 30 liter per head

Summary of Water Requirement Calculations is given in the table below.

Table 2-22 Water Requirement during Construction

Sr. No	Item	Users	Water Requirement Lit/ user	Total Potable+ Sanitary Water	Processing, Washing, Cleaning Water
Water Requirement for Manpower					
1	Site Office	10	30	300	
2	Canteen Staff	10	45	450	
3	Staff with Incoming vehicles (Drivers& Cleaners) (Lit/Person)	50	30	1500	
4	Workers including security and other personnel (Lit/Person)	100	45	4500	
5	Workshop Personnel (Lit/Person)	8	30	240	
6	Workshop Machinery (Washing) (Lit/Machine)	2	200	400	
7	Workers Camp	200	70	14000	
Water Requirement for Processing					
8	Ground Raising	4	5000		20000
9	SLF Subgrade Preparation				3000
10	SLF Embankment Construction				3000
11	Internal Roads				2000
13	Tyre Washing Area (Lit/Vehicle)	50	100		5000
	Total (in Liters per day)			21390 ~22000	33000
	Total (in Cubic Meters per day)			22	33

Table 2-23 Water Requirement during Operation

Sl.No	Item	Users	Water Requirement in Litres/user	Total potable+ Sanitary Water	Processing, Washing, cleaning Water
1	Administrative Block	12	90	360	
2	Weigh Bridge	1	30	30	
3	Scale Room	1	30	30	
4	Tyre Washing system	2	30	60	
5	Security Room	4	30	120	
6	Restroom and Canteen	5	30	150	
7	Fire Fighting Station	2	30	60	
8	Power Room	1	30	30	
9	Leachate Treatment Plant	2	45	90	
10	Gardener	2	30	60	
11	Drivers & Helpers with Incoming vehicles	28	45	1260	
12	Drivers & helpers for vehicles at site	12	45	540	
13	Laboratory	3	45	135	
Water Requirement for processing					
1	Dust Supression	2	5000		10000
2	Green Belt (area in sqm) water requirement (l/sqm)	6500	3		19500
3	Vehicle workshop and washing area	4	30		120
	Total (in LPD)			**2925**	**29620**
	Say			**3000**	**30000**
	Total (in m^3 /day)			**3**	**30**

Drinking water requirement to the tune of 3 +/- 0.75 KLD will be supplied through KWA. The treated water from leachate treatment plant will be used for flushing, landscaping, sprinkling, dust suppression and wheel washing purposes. The excess water from the LTP will be available for nearby industries which will be explored in future. The water requirement during construction and operation phase is estimated to be 55 KLD and 33 KLD respectively. The water balance chart is shown in Figure 2-39.

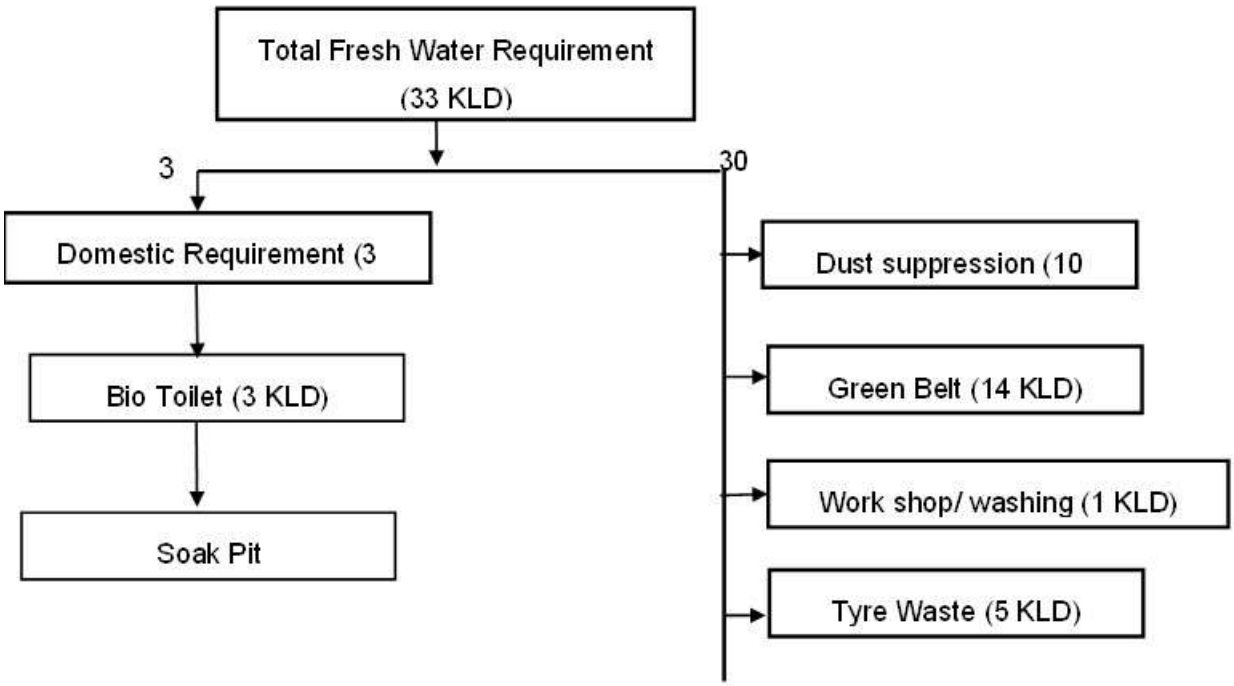


Figure 2-37 Water balance chart

2.35.2 Sewerage system

Two Sanitary blocks with bio toilet and bath arrangement for male and female with water supply tank are proposed at the entrance and exit of the site.

2.35.3 Power requirement

A three-phase electrical connection is proposed at the site, with sufficient cable size and feeders and other required infrastructure. The estimated power requirement for the Scientific Landfill is 88.52 KW which will be sourced from Kerala State Electricity Board (KSEB) Limited. Additionally, equal amount of 100 kVA DG set with dual burner will be envisaged to be meet any power failure.

2.36 Realignment/Shifting of EHT Approach

i. The re-alignment/shifting of EHT line is planned by KSWMP through Kerala State Electricity Board (KSEB). The procedure for shifting of EHT line is covered in EMP
ii. Existing GAIL gas pipeline – in the proximity to the footprint area of the proposed site. 5m Right of Way will be provided to ensure the safety of existing utilities.
iii. Development of approach road

2.36.1 Utility lines across the site

The major utility lines (GAIL Gas Pipeline, and EHT Lines) are passing very closely with the proposed landfill footprint area. The Electrical High-Tension Lines (EHT) of KSEB are passing through the SLF footprint area of the proposed land parcel resulting in lower volumetric capacity. There are five high-tension lines of 110kV at the site, three lines out of these five lines are crossing from the proposed land parcel as shown in the Figure 2-40.

- The re-alignment/shifting of EHT line is planned with the help of Kerala State Electricity Board (KSEB).
- The grid is proposed to be shifted away from the SLF ensuring a minimum horizontal clearance of 2.9m from the nearest object. The vertical clearance from

the lowest conductor to any object is a minimum 4.6m (refer KSEB and inserted as a footnote)

- As per the Environment Impact Assessment, the transmission lines do not attract the provisions of the EC. The work of EHT shifting is undertaken by Kerala State Electricity Board, through its certified contractors. The work is carried out following the Safety Manual published by the Central Electricity Authority, 2011.

The GAIL (KKBPL Gas Pipeline) is located adjacent on the eastern side of the proposed land parcel in the proximity to the footprint area of the proposed site. 5m Right of Way will be provided to ensure the safety of existing utilities.



Figure 2-38 Utility lines & HT lines across proposed SLF site

In addition to the above site constraining features, the proposed land parcel is not rectangular or square in shape, rather narrow on the north-east side and having EHT on the north-west side, hence the effective area available out of 25 Acres is around only 18.14 acres considering shifting of EHT Line A.

2.36.2 Shifting of EHT lines

The three Electrical High-Tension Lines (EHT) of KSEB are passing through the footprint area of the proposed land parcel. It is evident from the above figure that shifting of EHT Line A is necessary for the development of SLF.



Figure 2-39 Proposed Diversion of HT line

2.36.3 Airport Funnel

The proposed site is about 10.30 km from Naval Airport and 18.40 km from Cochin International Airport. The site does not fall under the landing and take-off funnel zone of Kochi International Airport as presented in Figure below. NOC from Naval Airport has been obtained and obtaining NoC from Cochin International Airport is in process.

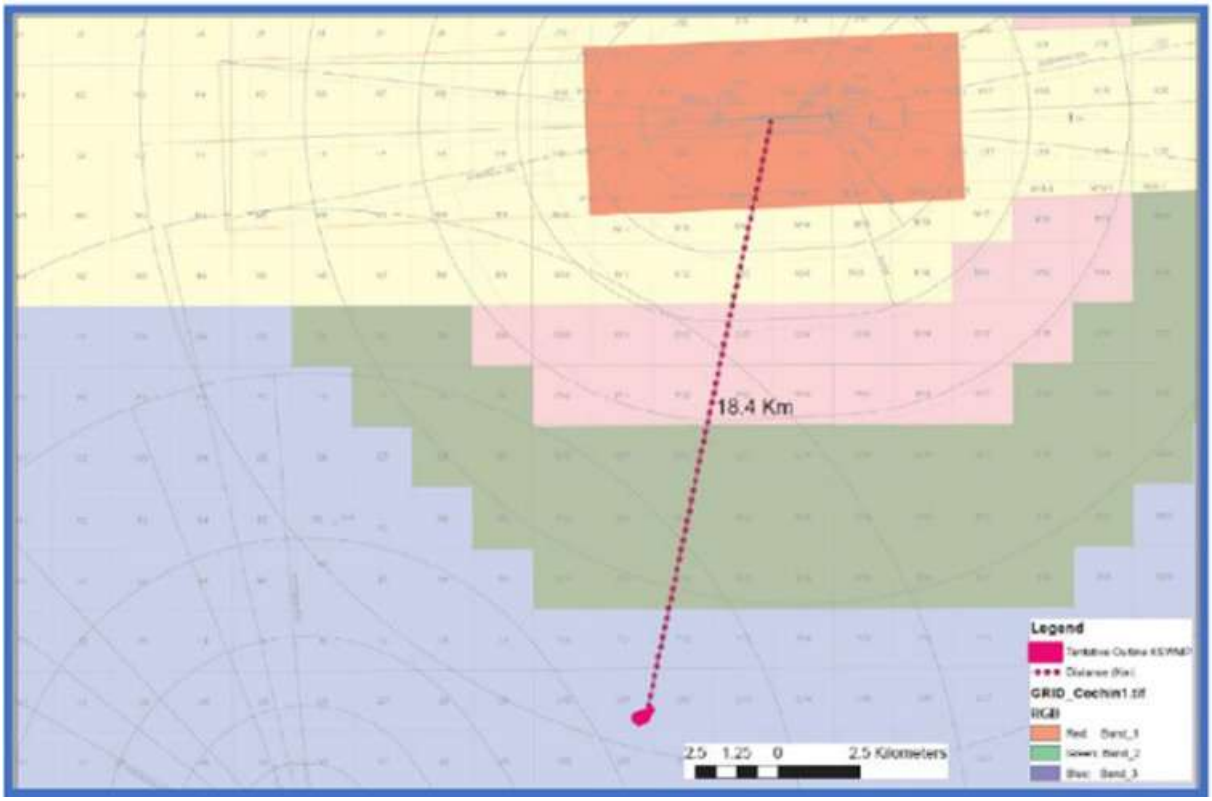


Figure 2-40 Distance of Airport from Proposed Site of Ambalamedu

2.37 Schedule and Project Cost

The estimated capital cost is about Rs 274.79 Crore. The project is scheduled to be completed in a period of 28 months. About 7.87 Crore is estimated for EMP covers pollution control and Corporate Environmental Responsibility (CER) measures[4].

[4] Corporate Environment Responsibility (CER) is a concept that suggests that it is the responsibility of the corporations/companies/departments operating within society to contribute towards economic, social and environmental development that creates positive impact on society at large.
Refer: https://environmentclearance.nic.in/ Source: MoEF & CC OM F. No. 22-65/2017-IA. III, dated 1st may 2018

3 Description of the Environment

3.1 General

This chapter illustrates the description of the existing environmental status of the study area with reference to the major environmental attributes. The existing environmental setting is considered to establish the baseline conditions which are described with respect to physical environment like air, water, noise, land, biological and socio-economic environment, traffic pattern studies. The monitoring of environmental parameters has been conducted within the 10 km radial distance from project site at village Ambalamedu of Ernakulam district of Kerala, in accordance with the guidelines issued by Ministry of Environment, Forests and Climate Change, CPCB and SPCB[5]. The study period is considered for the project is from December 2023 to February 2024 and baseline data has been collected represents for winter season. The impact identification always commences with the collection of atmospheric micro-meteorological conditions to Ground Water Quality covering all the environmental matrices as mentioned above. Based on the baseline data, environmental impact assessment is carried out, mitigation measures proposed and Environmental Management Plan is prepared for the proposed SLF project.

3.2 Scope of baseline Study

An area, covering a 10 km radius around the project site for the purpose of the baseline studies. Primary data on Micrometeorology, ambient air, noise, traffic, soil, water, flora-fauna & socio-economic data were collected by a team of experts. Secondary data was collected from various departments of State/Central Government Organizations, Semi-Government and Public Sector Organizations. The scope of the study has been carried out as per Standard/approved ToR by SEIAA Kerala vide ToR Identification no TO24B3401KL5888163N dated 08-08-2024. The Table 3-1 gives various environmental attributes considered for formulating environmental baseline, Table 3-2 gives the frequency and monitoring methodology for various environmental attributes and Table 3-3 gives the environmental settings of the project site.

Table 3-1 Environmental Attributes

S.No.	Attributes	Parameters	Source of data
1	Climatology & Meteorology	Wind speed, Wind direction, Dry bulb temperature, Wet bulb temperature, Relative Humidity, Rainfall, Solar radiation, Cloud cover and Environmental Lapse rate	Indian Meteorological Department and Site-specific Data-at project Site for 3 months
2	Geology	Geological Survey of India Details	Field survey and Secondary sources
3	Land use	Trend of land use change for different categories	Secondary data/Satellite imagery/Toposheet etc.
4	Ambient Air Quality (AAQ)	PM_{10}, $PM_{2.5}$, SO_x, NO_x, CO, CH_4.	Monitored data (8 locations)
5	Ambient noise quality	Noise levels in dB (A)	Monitored data (8 locations)
6	Water quality	Physical and chemical parameters	Monitored Data (Surface water – 3 locations and

Guidances [5] EIA notification dt 14th Sep.2006

S.No.	Attributes	Parameters	Source of data
			Ground water – 10 locations)
7	Soil	Soil types and samples analysed for physical and chemical parameters.	Analysis of soil samples at 8 locations
8	Ecology	Existing terrestrial flora and fauna and marine /aquatic flora and fauna within the study area	Field survey and Secondary sources
9	Socio economic aspects	Socioeconomic characteristics of the affected area	Based on field survey and data collected from secondary sources
10	Traffic studies	All Vehicle Counts	Based on the field survey at one location near to the project site.

Table 3-2 Frequency and Monitoring methodology

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
Meteorology				
Wind speed, Wind direction, Dry bulb temperature, Wet bulb temperature, Relative humidity, Rainfall, Solar radiation, Cloud cover and Environmental Laps	Project site	Continuous for 3 months	Weather monitors with the database	One season data collected (December 2023 to February 2024)
Air Environment				
Particulate Matter (PM_{10})	Requisite locations in the project influence area	24 hours- twice in a week for 3 months in non-monsoon season --	Gravimetric (High- volume sampler with Cyclone)	As per CPCB standards under 18th November 2009 Notification for National Ambient Air Quality Standards (NAAQS)
Particulate Matter ($PM_{2.5}$)			Gravimetric (low-volume sampler with Cyclone)	
Oxides of Sulphur (SO_x)			EPA Modified West & Geake method	
Oxides of Nitrogen (NO_x)			Arsenite Modified Jacob & Hochheiser	
Carbon Monoxide(CO)			Gas Analyzer (NDIR)	
H_2S			UV photometric	

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
CH_4			Gas Chromatography	
HC			Gas chromatography-mass spectrometry (GCMS)	
Noise				
Hourly equivalent noise levels	Requisite locations in the project influence area	Once in a season	Instrument: Sound level meter	IS: 4954 1968
Water Environment				
All parameters for water quality	Set of grab samples At requisite locations for ground and surface water	Once in season	Samples for water quality collected and analysed as per IS: 2488 (Part 1-5) methods for sampling and testing of Industrial effluents Standard methods for the examination of water and wastewater analysis published by American Public Health Association.	IS:10500:2012 (GW) DBU-CPCB Class B (SW)
Soil Environment				
All physical & chemical parameters for soil quality	Requisite soil samples were collected as per BIS specification within project influence area	Once in season	Collected and analysed as per soil analysis reference book, M.L. Jackson	
Biological Environment				
Terrestrial, Marine/ Aquatic Flora and Fauna	Requisite locations in the project influence area	Once in season	Analysed as per IUCN Red data book and MoEF&CC guidelines.	

Environmental Setting. The existing environmental setting around the project site is given in Table 3-3 and same is shown in Figure 3-1.

Table 3-3 Environmental Setting of the project site

S.No.	Particulars	Details
1	Present Land use	Open vacant land with shrubs and grasses
2	Topography	Mildly undulated terrain
3	Nearest habitation	Irumpanam – 1.7 km (SW)
4	Hills/ Forests/ National parks/Wildlife Sanctuaries/Ecological Sensitive Areas etc.	Mangalavanam Bird Sanctuary – 9.3 km (W)
5	Reservoir/Lake/River/Sea	Chithrapuzha Stream – 0.2 km (N&W) Kadambrayar river – 0.5 km (N) Ambalamedu Lake – 2 km (E) (Opp. direct) Thevara Canal – 7.4 km (WSW)
6	Archaeological Important Places	Mattanchery Dutch Palace – 15 KM
7	Seismicity	Seismic Zone – III (Moderate)



Figure 3-1 Environmental Setting of the project site covering 500m radius

3.3 Meteorology and Climate

3.3.1 Climate condition

Ernakulam experiences tropical monsoon climate. The city is hot and humid throughout the year with temperatures ranging from a low of 19.3 degrees Celsius in January to a high of 34.7 degrees Celsius in May. Rainfall is abundant in Ernakulam, with an average annual precipitation of 3,386 millimetres. The city experiences heavy rains from June to September, with the wet season lasting from June to early November. The dry season continues from November to May. The average relative humidity of Ernakulam is about 80 percent.

3.3.2 Regional meteorology

Historical data on meteorological parameters will also play an important role in environmental impact assessment. The region is bestowed with four seasons each characterized by a different set of weather conditions. This area is mainly receives rain from south west monsoon followed by north east monsoon. The various seasons encountered in this region as follows:

- Summer (Pre-monsoon): March to May
- Southwest Monsoon: June to September
- Post Monsoon: October to December
- Winter season: December to February

3.3.3 Kochi IMD Station

Since, the study area falls in Kochi and located nearest to site is considered for historical data. The regional meteorology summary details (from 1971 to 2000) monitored at nearest IMD station - Kochi are given in Table 3-4.

3.3.4 Annual weather data of Ernakulam district

Temperature

The average minimum and maximum temperature recorded at Kochi was 28.20°C and 30°C respectively. The low is 26.20°C and recorded in July. The annual weather data between 1991-2021 is shown in Table 3-4.

Rainfall

Kerala receives most of its annual rainfall during two monsoon seasons, Southwest monsoon season (June to September) and north east monsoon season (October to December).

The highest average rainfall over Kerala received in 1924. In case of Northeast monsoon season, the State average rainfall received during 2021 was highest ever in record since 1901. This was followed by 2010 and 1977.

Monthly extremes of temperature (^{o}C) and rainfall (mm) for Kochi station is shown in the Table 3-4. The 24-hour heaviest rainfall for a particular month in June 2010 is around 236.8 mm. Heaviest monthly total was recorded during year 1968 in the month of July, which was about 1499.6 mm.

State : Kerala **Station : Kochi**

Month	Tx	N	Date	Year	Tn	N	Date	Year	RF24	Date	Year	RF(T)	Year
JAN	36.4	1	22	2009	16.5	1	10	1964	94.6	15	1994	170.4	1994
FEB	35.7	1	10	1990	16.3	1	03	1967	141.6	27	2011	241.9	2011
MAR	36.0	1	27	1977	21.6	9	14	2011	119.0	14	2008	287.4	2008
APR	36.5	1	06	1998	21.2	1	7	2012	177.0	29	1956	468.1	2012
MAY	35.2	1	17	1991	21.1	1	17	1955	209.1	25	1965	884.6	2004
JUNE	34.2	1	1	1998	20.4	1	29	2010	236.8	03	1991	1491.9	1991
JULY	33.1	1	01	1977	17.6	1	29	2010	181.1	24	1969	1499.6	1968
AUG	32.5	1	11	1987	20.6	1	21	1967	143.3	5	1960	684.4	1961
SEP	34.2	1	14	2010	21.1	1	26	1988	183.7	24	2010	733.6	2007
OCT	34.6	1	16	2009	19.2	1	18	1984	212.1	9	1989	687.7	1993
NOV	35.0	2	23	2011	19.2	1	19	1967	151.4	20	1987	391.0	1997
DEC	35.2	1	8	2012	17.7	1	24	1971	121.4	8	1972	268.5	1972

Table 3-4 Monthly extremes of temperature (ºC) and rainfall (mm)

Note:
Tx: Highest maximum Temperature (ºC)
Tn: Lowest Minimum Temperature (oC)
N: No. of occasions when temperature values are repeated during the entire period
RF24: 24 hours Heaviest Rainfall for the particular month (mm)
RF(T): Heaviest Monthly Total Rainfall (mm)

Humidity

The humidity level ranges from maximum 89% from June to August and minimum of 74% in February.

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	26.5 °C (79.6) °F	27.3 °C (81.2) °F	28.2 °C (82.8) °F	28.1 °C (82.6) °F	27.3 °C (81.2) °F	25.9 °C (78.7) °F	25.5 °C (77.8) °F	25.4 °C (77.8) °F	25.8 °C (78.4) °F	26 °C (78.8) °F	26.2 °C (79.2) °F	26.2 °C (79.2) °F
Min. Temperature °C (°F)	23.2 °C (73.7) °F	24.1 °C (75.3) °F	25.3 °C (77.6) °F	25.8 °C (78.4) °F	25.6 °C (78) °F	24.7 °C (76.4) °F	24.2 °C (75.6) °F	24.1 °C (75.4) °F	24.2 °C (75.5) °F	24.2 °C (75.5) °F	24 °C (75.2) °F	23.4 °C (74) °F
Max. Temperature °C (°F)	29.9 °C (85.9) °F	30.8 °C (87.5) °F	31.5 °C (88.7) °F	31 °C (87.8) °F	29.7 °C (85.4) °F	27.8 °C (82) °F	27.3 °C (81.2) °F	27.3 °C (81.2) °F	27.9 °C (82.3) °F	28.3 °C (83) °F	28.8 °C (83.8) °F	29.3 °C (84.7) °F
Precipitation / Rainfall mm (in)	22 (0)	27 (1)	66 (2)	177 (6)	337 (13)	568 (22)	514 (20)	379 (14)	264 (10)	303 (11)	169 (6)	56 (2)
Humidity(%)	75%	74%	75%	81%	85%	89%	89%	89%	87%	87%	84%	79%
Rainy days (d)	4	6	12	19	20	21	22	21	20	20	15	7
avg. Sun hours (hours)	9.9	9.9	9.7	8.6	7.4	6.8	7.1	7.4	8.0	8.1	9.1	9.6

Table 3-5 Annual weather data of Ernakulam district (Data: 1991-2021)

Atmospheric Inversion Level

Inversions are a result of the vertical temperature profile of atmosphere. Temperature normally decreases as altitude increases in the troposphere. However, an increase of temperature may occur after certain altitude. This zone is termed as inversion which plays a major role in dispersion. Thus, the colder air layer which is below the warmer air results in a stable temperature profile that restricts vertical mixing. Because of the restricted mixing volumes of air due to the inversion, pollution becomes stagnant and does not dissipate. The mixing height is the height of vertical mixing of air and suspended particles above the ground. This height is determined by the observation of the atmospheric temperature profile. A parcel of air rising from the surface of the earth will rise at a given rate (called the dry-adiabatic lapse rate). As long as the parcel of air is warmer than the ambient temperature, it will continue to rise. However, once it becomes colder than the temperature of the environment, it will slow down and eventually stops. It is at this junction, where the temperature of the parcel crosses the curve denoting the vertical environmental temperature profile determines the mixing height. The spatial distribution of mixing height during winter, pre-monsoon and post monsoon season for 0800 and 1700 IST is shown in Fig. 3-3, 3-4 & 3-5 respectively.

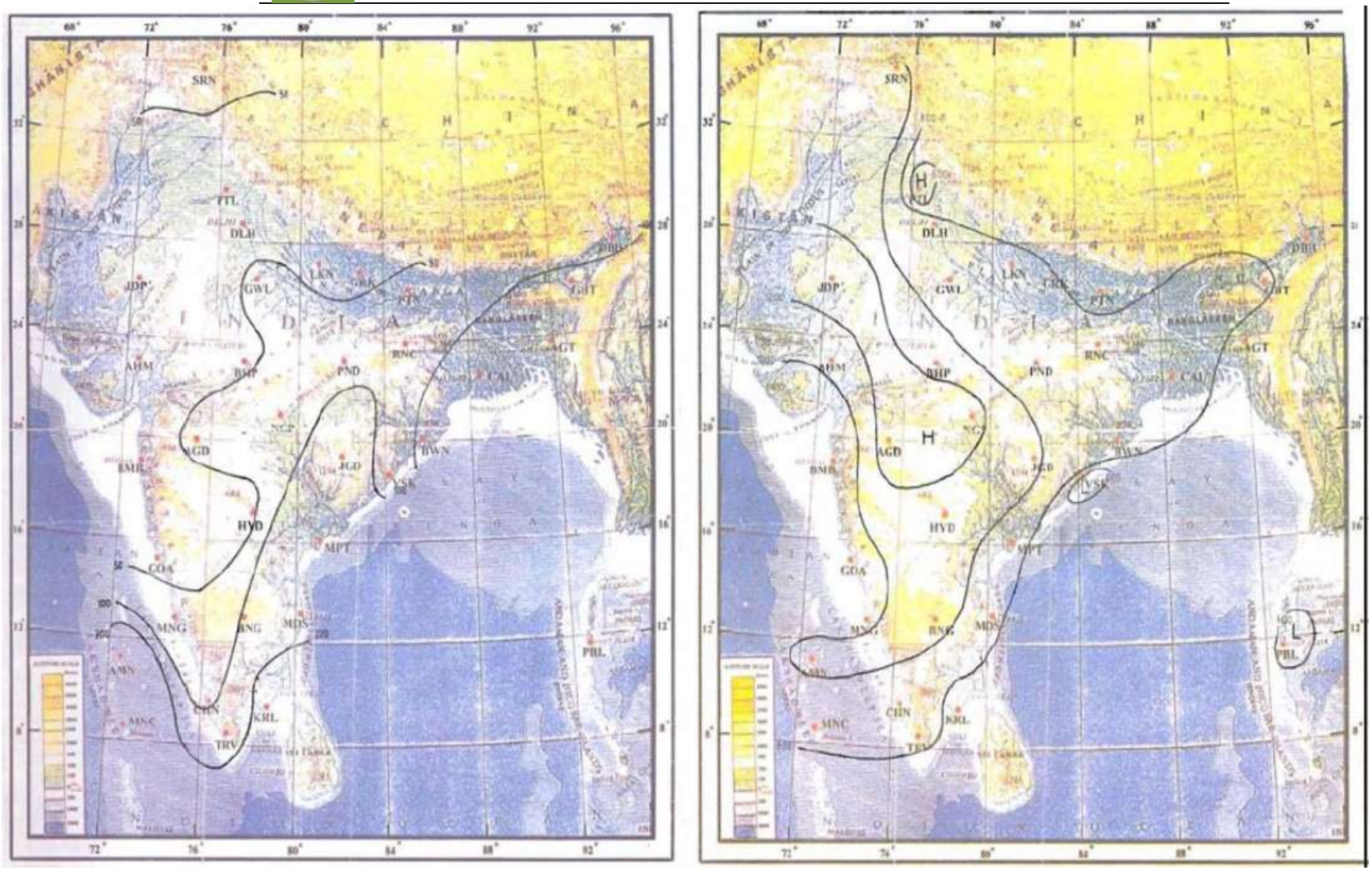


Figure 3-2 Spatial distribution of mixing height in winter season- 0800 IST and 1700 IST

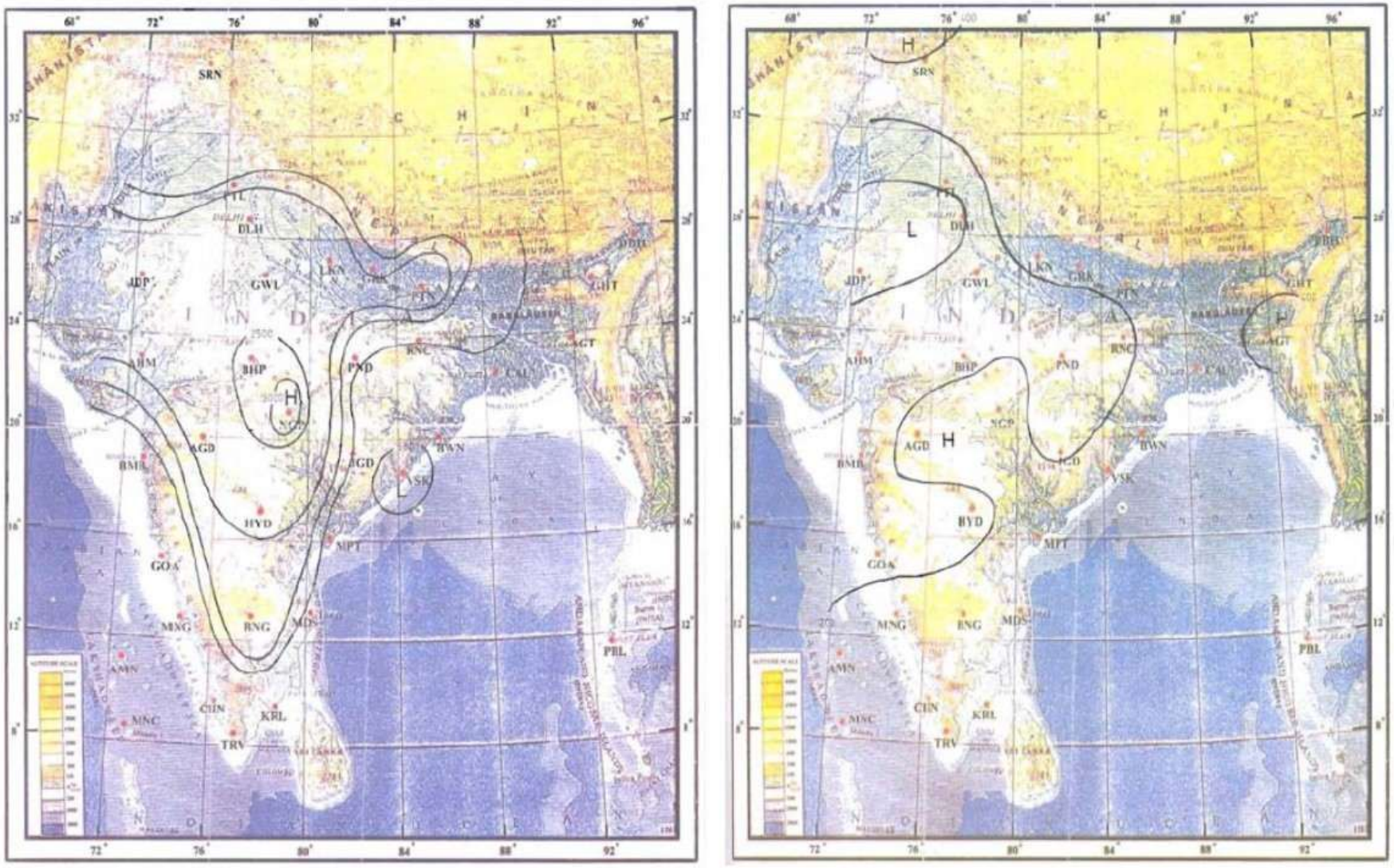


Figure 3-3 Spatial distribution of mixing height in pre-monsoon season- 0800 IST and 1700 IST

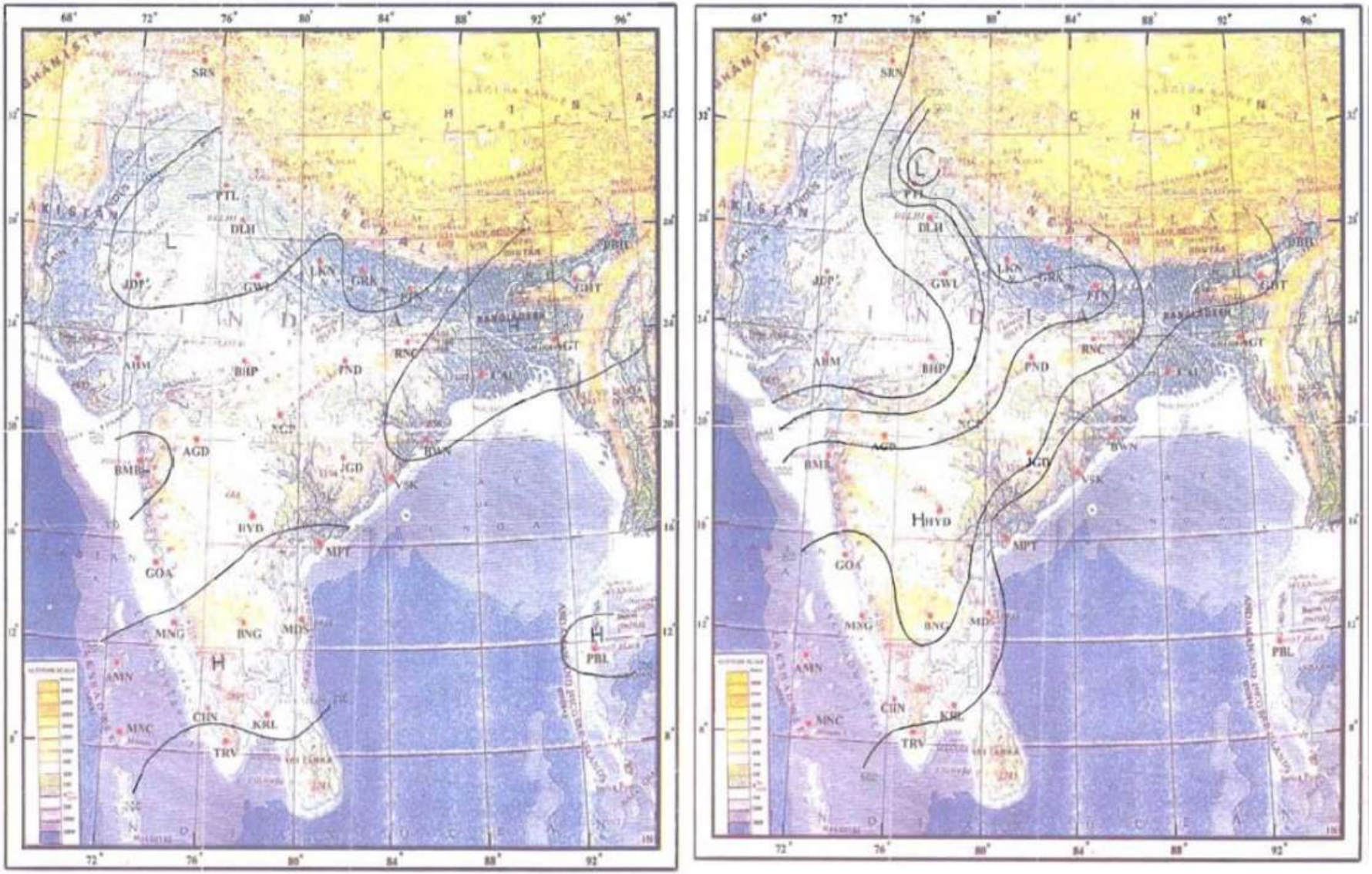
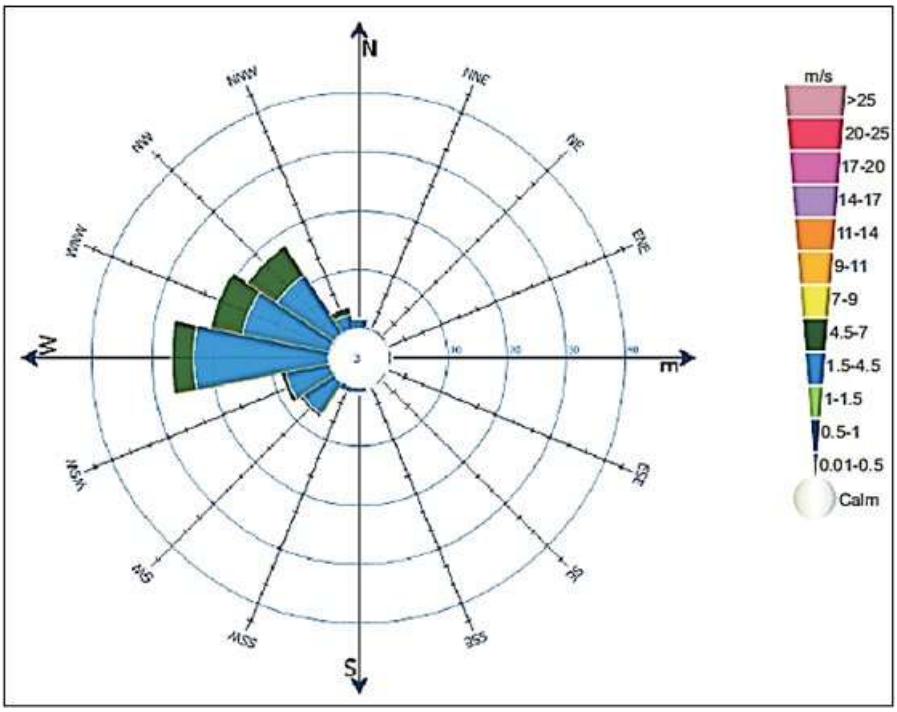


Figure 3-4 Spatial distribution of mixing height in pre-monsoon season- 0800 IST and 1700 IST

3.4 Wind Speed/Direction

The wind speed ranges from 6.7 to 10.9 km/hour with mean speed of 9.1 km/hour. The wind speed is high during the period from March to September. Annual wind rose prepared from daily surface wind data recorded at 1200 UTC for 1971 to 2000 for Cochin (Kochi) (NAS) indicates that the most frequently occurring direction is from west (W) followed by winds from West North West (WNW) and North West (NW). The frequency of winds from West (W), West North West (WNW), North West and West South West (WSW) are 27%, 21%, 18%, 18% and 9% respectively. Wind rarely blow from easterly direction. Annual strongest winds, those greater than 7 m/s comes from westerly direction. The annual wind rose pattern is shown Figure 3-6 and month wise wind speed is shown in Figure 3-7. The minimum average wind speed of 3 m/s occurs in November where max 4.3 m/s occurs during March and April month.



Source: IMD, Kochi

Figure 3-5 Annual wind rose pattern (Kochi)



Source: IMD, Kochi

Figure 3-6 Annual variations in average wind speed (in mps) at 1200 UTC during 1971 – 2000

3.4.1 Site specific Meteorology

The continuous weather monitoring station is installed at project site. On site monitoring is undertaken for various meteorological parameters in order to generate the site-specific data. The continuous monitoring station equipped to record wind speed, wind direction, temperature, humidity and rain fall and installed at the top of the building at the height of ~8 m above the ground level. The methodology adopted for monitoring surface observations was as per the Standard norms laid down by the Bureau of Indian Standards (IS 8829:1978) and IMD. The wind rose pattern for the period from December 2023 to February 2024 is shown in Fig. 3-7. From the wind rose, it can be observed that the wind is mainly from ESE and WNW.

Table 3-6 Monitoring Methodology of Meteorological Data

Sl. No.	Sampling Parameters	Sampling equipment	Detection level	Sampling Frequency	Methodology
1.	Temperature	Thermometer	-40°C to +65°C	Hourly	ABCTL/SOP/62
2.	Humidity	Relative Humidity meter	10% to 99%		
3.	Wind speed	Anemometer cup counter	1 KMPH to 240 KMPH		
4.	Wind Direction	Wind Vane	0° to 300°		
5.	Rainfall	Rain Gauge	0.5 mm to 9999 mm		

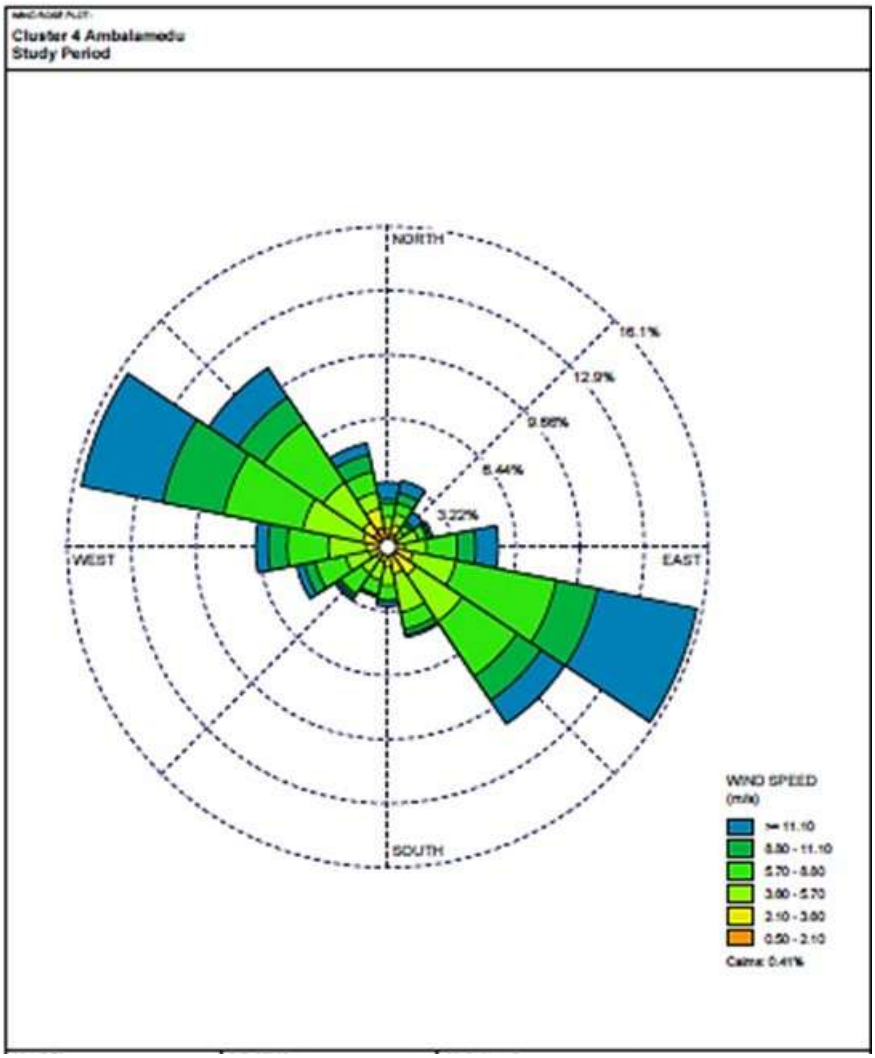
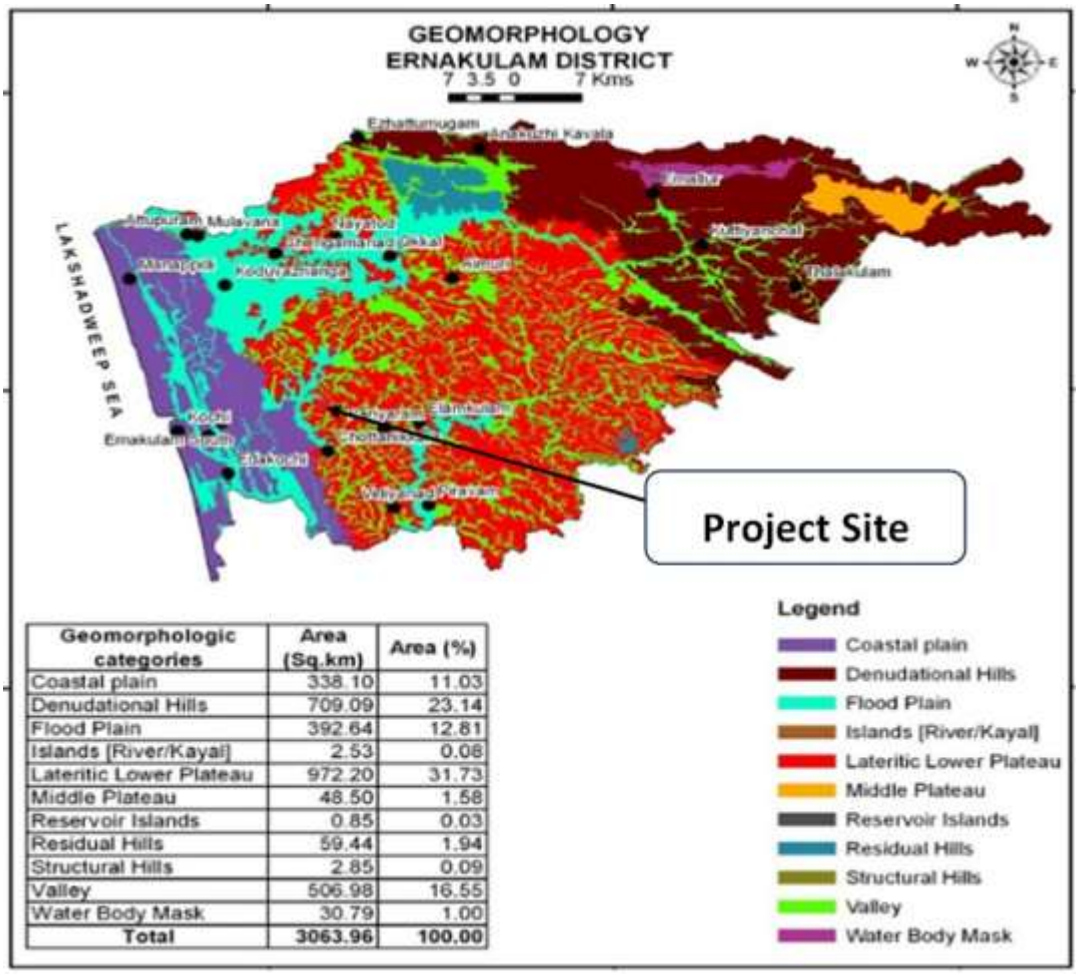


Table 3-7 Wind rose at project site for the study period

3.5 Physiography of the Region

3.5.1 Geomorphology

The district can be broadly divided into three physiographical units viz. (1) the Coastal plains (low lands) (2) the mid lands and (3) the high lands. The general elevation of the coast is less than 8m amsl and that of the midlands is between 8 and 76m amsl. The highlands are having the general elevation above 76m with the maximum of around 504m amsl. The entire taluks of Kochi fall under the coastal plain. The municipalities of Paravur and Tripunithura, township of Kalamasseri and the corporation of Kochi are located in the coastal plains. All the other taluks except the north-eastern parts of Kunnathunad taluk fall under the mid land area. The high land belt of the district is the Malayattoor reserve forest (40 km from the project site) in Koovappady block, which covers about 9% of the area of the district. The coastal belt is dotted with a host of islands ranging from largest Vypin islands of length 27 km to, smaller islands like Mulavukad, Vallarpadam, and Willingdon etc. The western coast of Vypin has the longest beach in Kochi namely, the Cherai Beach. The northern tip of Vypin (Munambam) has the largest fishing harbour of Kochi namely, the Munambam Fishing Harbour. Vypin is home for harbour related industrial establishments like, Kochi Refineries, and the Puthuvyp LNG terminal. The Geomorphology map of the Ernakulam District is given in Figure 3-8. From the figure, it is observed that the proposed project will be developed in Lateritic Lower lateau type of land (Red coloured region).



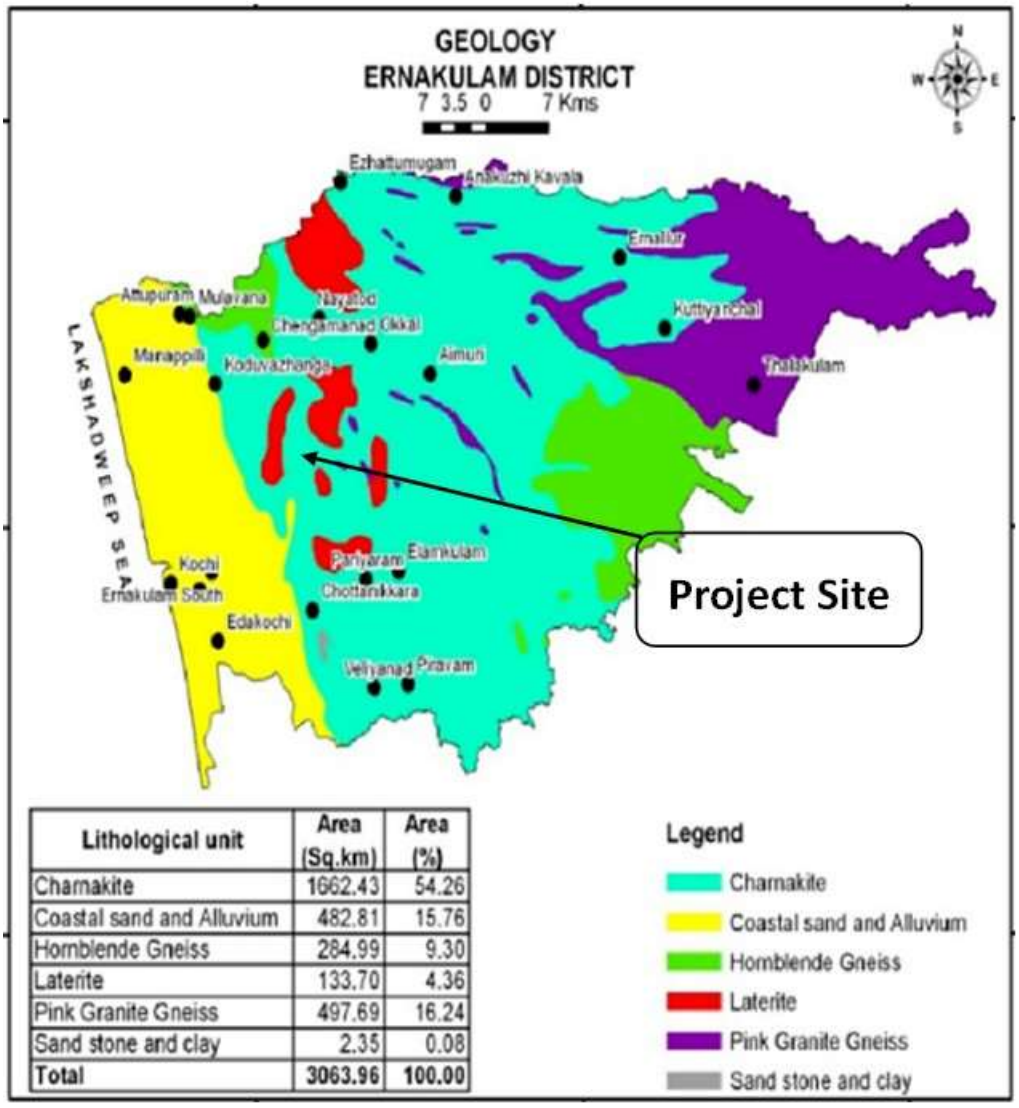
Geomorphologic categories	Area (Sq.km)	Area (%)
Coastal plain	338.10	11.03
Denudational Hills	709.09	23.14
Flood Plain	392.64	12.81
Islands [River/Kayal]	2.53	0.08
Lateritic Lower Plateau	972.20	31.73
Middle Plateau	48.50	1.58
Reservoir Islands	0.85	0.03
Residual Hills	59.44	1.94
Structural Hills	2.85	0.09
Valley	506.98	16.55
Water Body Mask	30.79	1.00
Total	**3063.96**	**100.00**

Source : CGWB Report, Kochi

Figure 3-7 Geomorphological map of Ernakulam district

3.6 Geology

Geologically two distinct litho units are discernible in the area. The eastern part is occupied by hard rocks representing Precambrian metamorphosed rocks while the coastal tract in the west is covered by soft rock or the unconsolidated coastal alluvium. Major part of the district is occupied by charnockite and migmatite groups of rocks of Precambrian age. The charnockite group is composed of pyroxene granulite, magnetite quartzite and charnockite. Charnockite, which is very widely distributed, is coarse grained, granulitic and dark coloured. Pyroxene granulite and magnetite quartzite occur as linear bands. Calc-gneiss and quartzite of khondalite group are the oldest rocks of the area and they are seen as linear lensoidal bodies within the charnockites. The migmatite group includes biotite gneiss and quartzofeldspathic gneiss which are next to charnockite in abundance. These older rocks are intruded by both acid (syenite) and basic (gabbro and dolerite) intrusive. Patchy outcrops of Warkalli beds, consisting of pebble bed, grit, friable sandstone and variegated clay is seen in the western part around Edappalli, Kalamasseri areas. Both the Warkalli beds as well as the basement rocks are subjected to intense lateritisation, which is confined to the midland region only. The coastal tract is covered by Quaternary sediments like beach sand, paleo-beach ridge deposits (sand), flood plain deposits (sand, silt, clay) and tidal deposits (clay, mud). The geology map of the study area is shown in Figure 3-9.



Lithological unit	Area (Sq.km)	Area (%)
Charnakite	1662.43	54.26
Coastal sand and Alluvium	482.81	15.76
Hornblende Gneiss	284.99	9.30
Laterite	133.70	4.36
Pink Granite Gneiss	497.69	16.24
Sand stone and clay	2.35	0.08
Total	**3063.96**	**100.00**

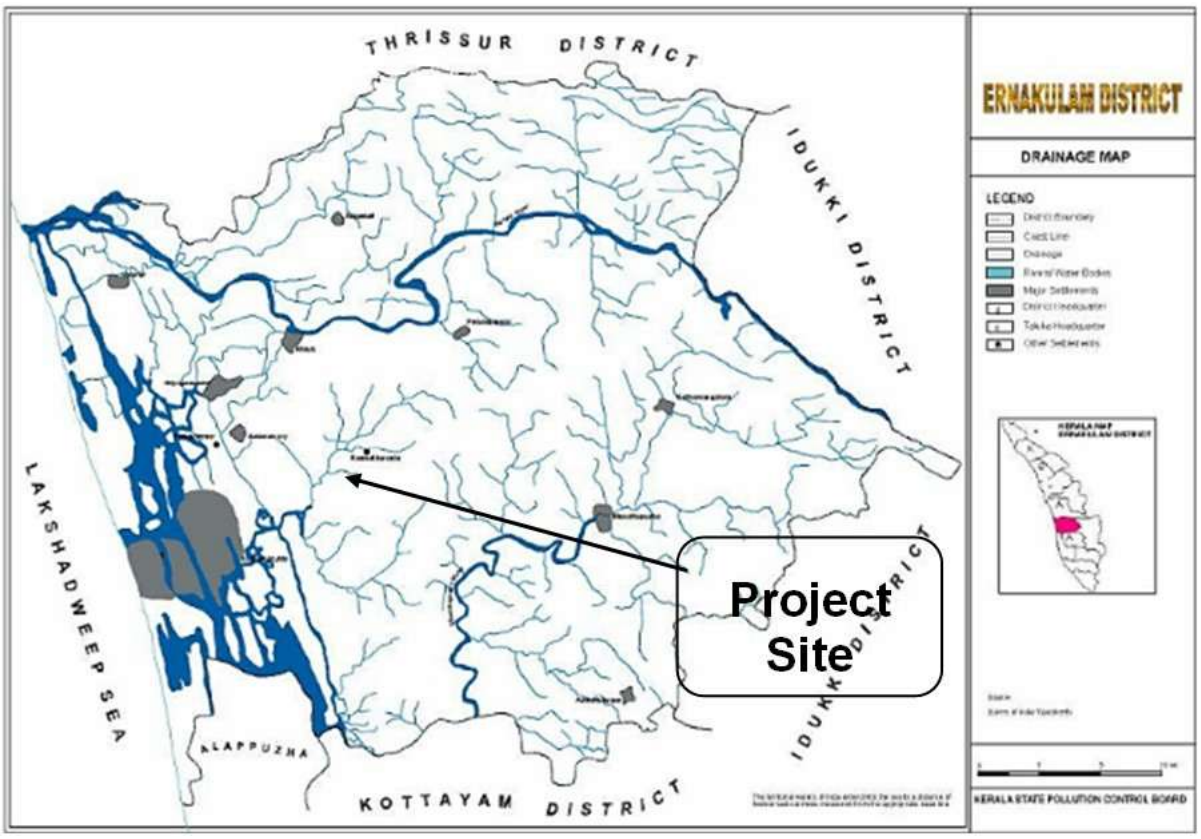
Source: CGWB Report, Kochi

Figure 3-8 Geological map of Ernakulam district

3.7 Drainage Pattern

The district is drained by the Periyar and its tributaries in the north and Muvattupuzha River in the south. Periyar, the longest river in the state with a total length of 244 km originates from the cardamom hills of the Western Ghats flows in a Northerly direction initially and then in North-west direction as it flows through Idukki district before entering Ernakulam district at Neriamangalam. In the district the river takes almost a straight-line course roughly in a North Western direction and at near Bhuthathankettu dam, it is joined by major tributaries Cheruthoni and Idamalayar. Further downstream at Aluva, the river bifurcates into two: the Marthandavarma and the Mangalapuzha branches. The Mangalapuzha branch joins Chalakkudy river and empties into the Lakshadweep Sea at Munambam, and the Marthandavarma branch flows southwards, through the Udhyogamandal area and joins the Cochin backwater system (part of Vembanad Lake) at Varapuzha. The Periyar is a perennial river and is source of drinking water for several major towns. The Idukki dam across the Periyar generates a significant proportion of Kerala's electrical power.

The Muvattupuzha river is formed by the confluence of Thodupuzha River, Kaliyar River and Kothamangalam river at Muvattupuzha. These rivers originate from the Thodupuzha reserve forest. The Muvattupuzha River takes a rough east-west course up to Ramamangalam and thereafter it flows towards south leaving the districts south of Pazhur. In the upstream areas the drainage pattern in both Periyar and Muvattupuzha basin are trellis to sub-trellis. In the lower reaches dendritic pattern of drainage is observed. The district level and project specific drainage pattern maps are shown in Figure 3-10 & 3-11 respectively. The project site is witnessed with dendritic pattern. From the drainage pattern, it is evident that the project area is bestowed with good drainage facilities and the area is not inundated by flood.



Source: CGWB Report, Kochi

Figure 3-9 Drainage map of Ernakulam district

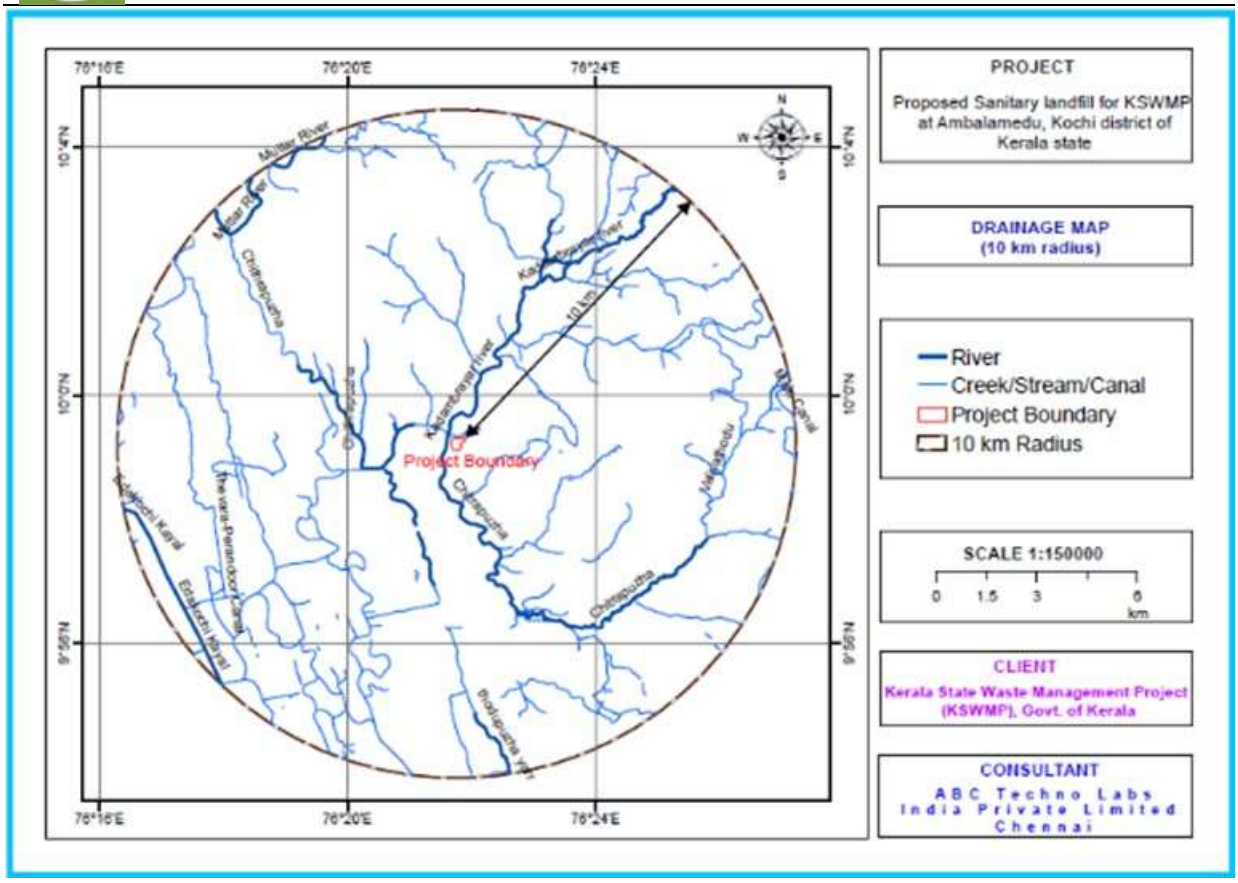


Figure 3-10 Drainage map with 10 km radius of the study area

From the drainage map it can be concluded, ephemeral drains which are located around the site not affected. It is also evident from the drainage map that, chitrapuzha river is located nearer to the site and facilitate the drainage system.

3.8 Watershed

The area of land which sheds water into a single outlet of a stream is known as the hydrological unit/watershed. The entire hydrological unit or micro watershed is the catchment area of a particular stream or river. It is an important step for assessment of environment and management in order to study the possible flooding and water pollution. The topo-sheet covering and google maps of the site has been collected and the hydrological unit/watershed has been delineated based on the drainage system of the hydrological unit/watershed as shown in Figure 3-12.

The surface water and groundwater interaction are the important component of the water cycle in a hydrological unit /watershed since the interaction is controlled by topography, geology, landform conditions, climate condition and human activities. To determine the general flow of the groundwater and surface water the hydrological Unit/watershed map has been studied.

Based on the delineation of the water shed, the proposed SLF site falls in the lower middle parts of the watershed which may have least influence on the flood plain of the Chithrapuzha. The flood map of the district was also reviewed and observed that the SLF site does not fall within the flood zone. According to the flood hazard vulnerability mapping of Kochi District using GIS and Remote Sensing, the SLF site falls in the least flood vulnerability zone. Hence, it can be concluded that the SLF site may have least influence on the flood plain of the Chithrapuzha.



Source: Flood Hazard Vulnerability Mapping of Ernakulam District (from TCE)

Figure 3-11 Google map with Watershed boundary, drainage, and location of SLF

3.8.1 Flood plain map

Flood map of 1 in 100-year return period from KSDMA is overlayed and shown in the Figure 3-13. The distance from the 100-year flood plain to proposed site is about 2.5 km.



Source: Flood Hazard Vulnerability Mapping of Ernakulam District (from TCE)

Figure 3-12 Flood Plain Map

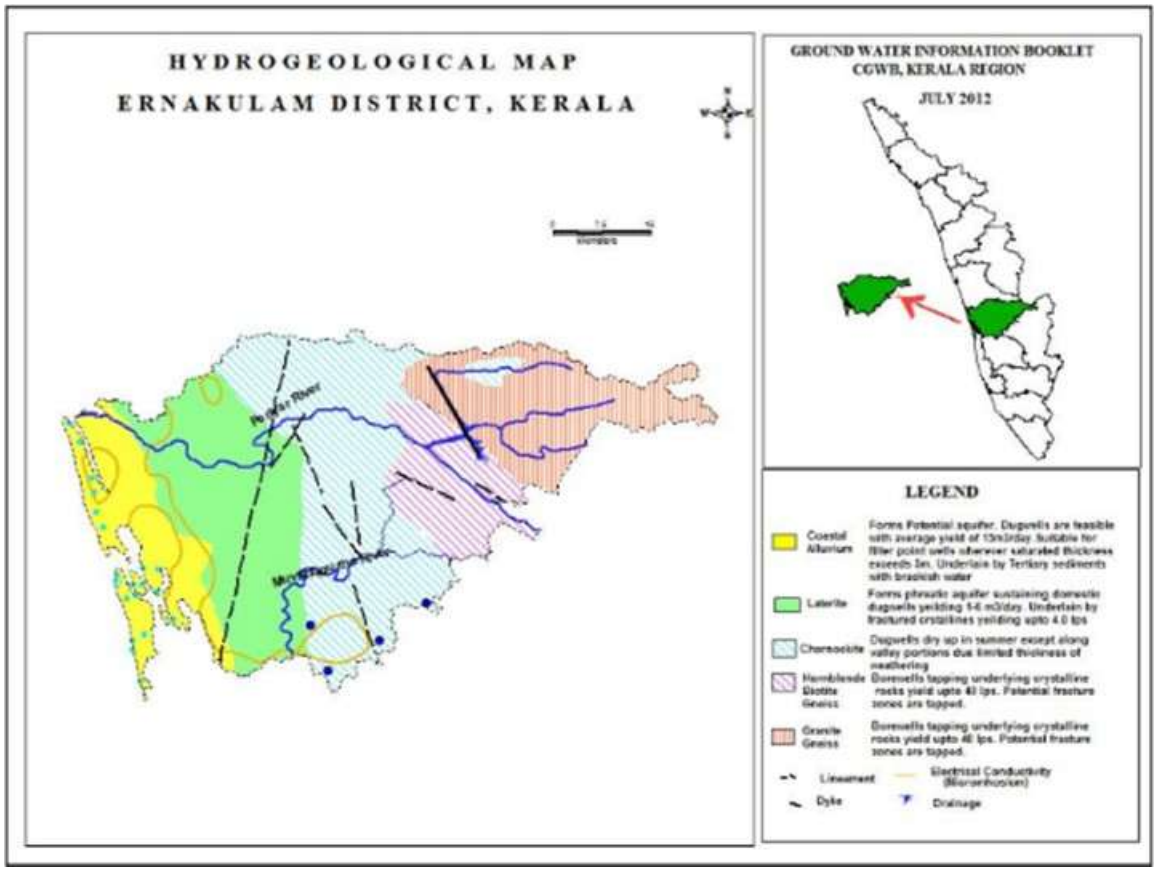
3.9 Hydrogeology

Groundwater generally occurs under phreatic conditions in weathered and fractured crystalline rocks, laterites and unconsolidated coastal sediments. It occurs under semi-confined to confined conditions in the deep-seated fractured aquifer of the crystalline rocks and tertiary sediments. The weathered zone in the crystalline below acts as good storage for groundwater. Based on nature of formation, the aquifer can be classified into hard rock aquifers and sedimentary aquifers. The hydrogeological map of the district is shown in Figure. 3-14.

3.9.1 Hard crystalline formation

The hard rock formation in general lack primary porosity. The water is stored in the secondary pores developed as a consequence of weathering in fractures, fissures and joints etc. The movement of groundwater is controlled by the extent of the interconnection of the fractures. In the shallow phreatic zone the depth of dug wells varies from 3.4 to 14.8 mbgl. The depth to water level in the wells ranges from 1.82 to 12.05 mbgl.

The studies by CGWB have indicated that the wells located at intersections of lineaments are most potential. Among the lineaments the E-W, NNE – SSW and NE – SW lineaments are potential whereas the NNW – SSW are least potential lineaments. The deep fractured rock has transmissivity ranging from 15.64 to 319 m^2 /day.



Source: Groundwater information booklet of Ernakulam district, Govt. of Kerala

Figure 3-13 Hydrogeological map of the district

3.10 Sedimentary formations

Exploratory drilling was carried out at 25 sites in sedimentary terrain for the district (Source: CGWB). The depth of wells drilled ranged from 58 to 296 mbgl. The sedimentary formations are confined to the coastal belt and the potential aquifers occurring at depth among are the Warkali and Vaikom beds.

3.11 Average depth of water level

The depth to water level in the district shows wide variation on account of the physiographical units in which the wells are located and undulating terrain in the mid land. Water level is shallower in western coastal part and is less than 2 mbgl in general although occasionally it is deeper at around 4 to 4.5 mbgl except for a small pocket in and around Chengamanad where it is more than 11mbgl.

In the eastern part of the district also it is observed that the water level is shallow and is following the riverine alluvial belt of Periyar river. In the midland region the water table is between 5 and 10mbgl and at isolated pockets and is found to be deeper levels of more than 10m depth.

Compared to the pre-monsoon period, in the post monsoon period the water level has risen in general. In the coastal belt, the water level is very shallow and less than 2 mbgl throughout. Besides in most areas of the district the water level has risen and is at depth of less than 5 mbgl. However in the isolated pockets in the northwestern segment of the district it is deeper than 10 m.

3.12 Groundwater Scenario

Groundwater generally occurs under phreatic conditions in weathered and fractured crystalline rocks, laterites and unconsolidated coastal sediments. It occurs under semiconfined to confined conditions in the deep seated fractured aquifer of the crystalline. The weathered zone in the crystalline below acts as good storage for groundwater. Based on nature of formation, the aquifer can be classified into hard rock aquifers and sedimentary aquifers. The district is endowed with good water resources as the rainfall is one of the highest in India and also two rivers Muvattupuzha and Peiryar are flowing in the district. Potential aquifers occur all along the coastal alluvium, whose thickness varies from a few metres to 100m. Depth to water table is 0-3m. Groundwater development in the area is mainly by means of dug wells. Laterites are the potential aquifers for groundwater. Depth to water level ranges from less than a metre to 3 metres. But the problem with laterites is groundwater drains off immediately after the rainy season. In crystalline groundwater occurs in the weathered and partly weathered, fractured and jointed rocks. Bore wells dug in potential fracture zones give high yields. There are about 55 National Hydrographic stations in the district i.e., roughly one for every 43.8 sq. km., which would monitor the water levels in the area.

3.13 Inventoried wells

The project site specific hydrogeological studies have been carried out in 10 km radius from the project site. During soil investigation studies at the site, eleven boreholes had been drilled upto a depth of 15m and the water levels have been recorded. Out of eleven, three bore holes have been taken for hydrogeological studies. The ground water regions are witnessed with surface water break in the North West and south as the site is surrounded by Chithrapuzha River. Hence, the groundwater table measurements are confined to eastern side. A total number of 34 wells have been inventoried and the location of the well latitude and longitude, diameter, type of well, water table level (pre & post monsoon) and total depth of the well are shown in Table 3-8. From the inventoried well, it can be seen the water level ranges from 0.75m to 10.28m during the pre-monsoon season. Whereas in post-monsoon the levels are recorded from 0.35m to 9.68m.

The Central ground water board had drilled 7 exploratory wells in Ernakulam district in the hard rock areas of the district as a part of its exploration programme to explore the deeper confined aquifer. The depth of the wells ranged from 131 to 201 mbgl. Most of these wells were drilled in the Charnockitic area. Fracture zones were encountered at depth ranging from 5 – 194 mbgl with yield ranging from 1 to 22 lps. The studies by

CGWB have indicated that the wells located at intersections of lineaments are most potential. Among the lineaments the E-W, NNE – SSW and NE – SW lineaments are potential whereas the NNW – SSW are least potential lineaments. The deep fractured rock has transmissivity ranging from15.64 to 319 m^2 /day.

The depth to water level in the district shows wide variation on account of the physiographical units in which the wells are located and undulating terrain in the mid land. Water level is shallower in western coastal part and is less than 2 mbgl in general although occasionally it is deeper at around 4 to 4.5 mbgl except for a small pocket in and around Chengamanad where it is more than 11 mbgl.

From the foregoing data, it can be observed the groundwater occurs at shallow water condition to the maximum level of 4.5m. during the present study, the level is almost corresponding to the levels of CGWB data. The total annual recharge of groundwater has been computed block- wise using average water level fluctuation in Groundwater Monitoring wells and specific yield of the respective aquifers and rainfall Infiltration method. The net annual groundwater availability is 557.35 MCM. As per CGWB, the groundwater exploitation falls in SAFE category.

In order to find out the groundwater movement direction, the observed levels are plotted and the groundwater contours have been drawn. From the groundwater contours, it can be seen the GW generally follows the topographical features and towards E direction. The groundwater movement is observed to be 4 to 5 m/d.

In order to ascertain the quality of groundwater 15 samples have been collected and tested for 22 parameters and the analytical values of the parameters are shown in the table. From the results, it is evident that the GW is free of any contamination.

Table 3-8 Location of inventoried well for measuring water table

S. No.	Well No.	Latitude	Longitude	Diameter of well (m)	H1 (Parapet Wall) (m)	H2 (Total Depth of Well) (m)	WL For Pre Monsoon (m)	WL For Post Monsoon (m)	MSL (m)	WL From MSL Pre Monsoon	WL From MSL Post Monsoon
1	Well 1	9.98610278	76.3627889	2.1	0.75	9.11	5.16	3.16	27.333	22	24
2	Well 2	9.977525	76.3555306	0.3	0.4	2.3	1.2	0.94	32.333	31	31
3	Well 3	9.98315833	76.3505278	0.9	0.73	5.5	3.47	2.83	34.667	31	32
4	Well 4	9.99478889	76.3472667	4	0.76	12	9.09	8.59	30.667	22	22
5	Well 5	10.02155	76.3682917	2.4	0.5	3.4	0.8	0.6	65.667	65	65
6	Well 6	10.0100667	76.4105722	2.1	0.3	13	6.6	6.1	50	43	44
7	Well 7	9.95545278	76.4020056	1.37	0.53	5.7	3.57	3.17	45.667	42	42
8	Well 8	9.92438333	76.3574194	1	0.62	4	0.78	0.28	33	32	33
9	Well 9	9.93300556	76.2985889	1.55	0.9	4	0.95	0.65	27.333	26	27
10	Well 10	9.98975278	76.4016083	2.2	0.82	15.24	10.28	9.68	76.333	66	67
11	Well 11	9.97483889	76.449675	2.04	0.82	8	5.28	4.88	68	63	63
12	Well 12	9.90193056	76.3866139	1.7	0.8	8	6.5	6.1	48	42	42
13	Well 13	9.96798889	76.3173556	0.7	0.2	4	0.75	0.35	24.667	24	24
14	Well 14	10.0020444	76.3010972	1.25	0.1	3.95	1.95	1.65	30.333	28	29
15	Well 15	10.0385333	76.3355333	5.5	0.88	9.8	5.42	5.02	27	22	22
16	Well 16	10.0619861	76.393325	1.35	1	4.95	1.95	1.65	44	42	42
17	Well 17	9.98405	76.2919194	0.9	0.65	3.65	1.25	1	28	27	27
18	Well 18	10.0250611	76.3184722	1.5	0.7	3.67	1.07	0.67	31.667	31	31
19	Well 19	10.04775	76.3643306	1.7	0.57	4.5	2.03	1.73	47.333	45	46
20	Well 20	9.9703	76.2858889	1.6	0.36	3	1.04	0.64	31	30	30
21	Well 21	10.0381306	76.4012222	4	0.8	15	9.5	9	29.667	20	21
22	Well 22	10.0471556	76.4232861	2.62	0.88	10	8.22	7.84	52.333	44	44
23	Well 23	10.0247556	76.4377333	2.2	1	10	5.7	5.5	48.667	43	43
24	Well 24	9.96093333	76.3587861	1.5	0.6	11.27	3.57	2.9	34	30	31
25	Well 25	9.95188056	76.3463083	1.1	0.78	6.5	3.22	2.72	34.667	31	32
26	Well 26	9.942175	76.3294333	0.9	0.35	3	0.85	0.45	28	27	28

S. No.	Well No.	Latitude	Longitude	Diameter of well (m)	H1 (Parapet Wall) (m)	H2 (Total Depth of Well) (m)	WL For Pre Monsoon (m)	WL For Post Monsoon (m)	MSL (m)	WL From MSL Pre Monsoon	WL From MSL Post Monsoon
27	Well 27	9.92994722	76.312775	1.08	0.65	5	1.45	0.97	35	34	34
28	Well 28	9.93839167	76.3760417	1.1	0.83	6	3.31	2.91	33.667	30	31
29	Well 29	9.97335556	76.4277472	2.1	0.65	7	3.15	2.75	46	43	43
30	Well 30	10.0079083	76.4484556	2.3	0.6	7.5	3.6	2.8	66.333	63	64
31	Well 31	9.9625	76.4387389	2.15	0.6	4.12	1.82	1.52	38.667	37	37
32	Well 32	9.92574444	76.3993917	2	0.5	10	7.2	6.75	51.667	44	45
33	Well 33	9.90731389	76.3663889	1.4	0.45	5	3.2	2.9	33.333	30	30
34	Well 34	9.91401389	76.4114222	2.5	0.9	8.5	6.63	6.23	60.333	54	54

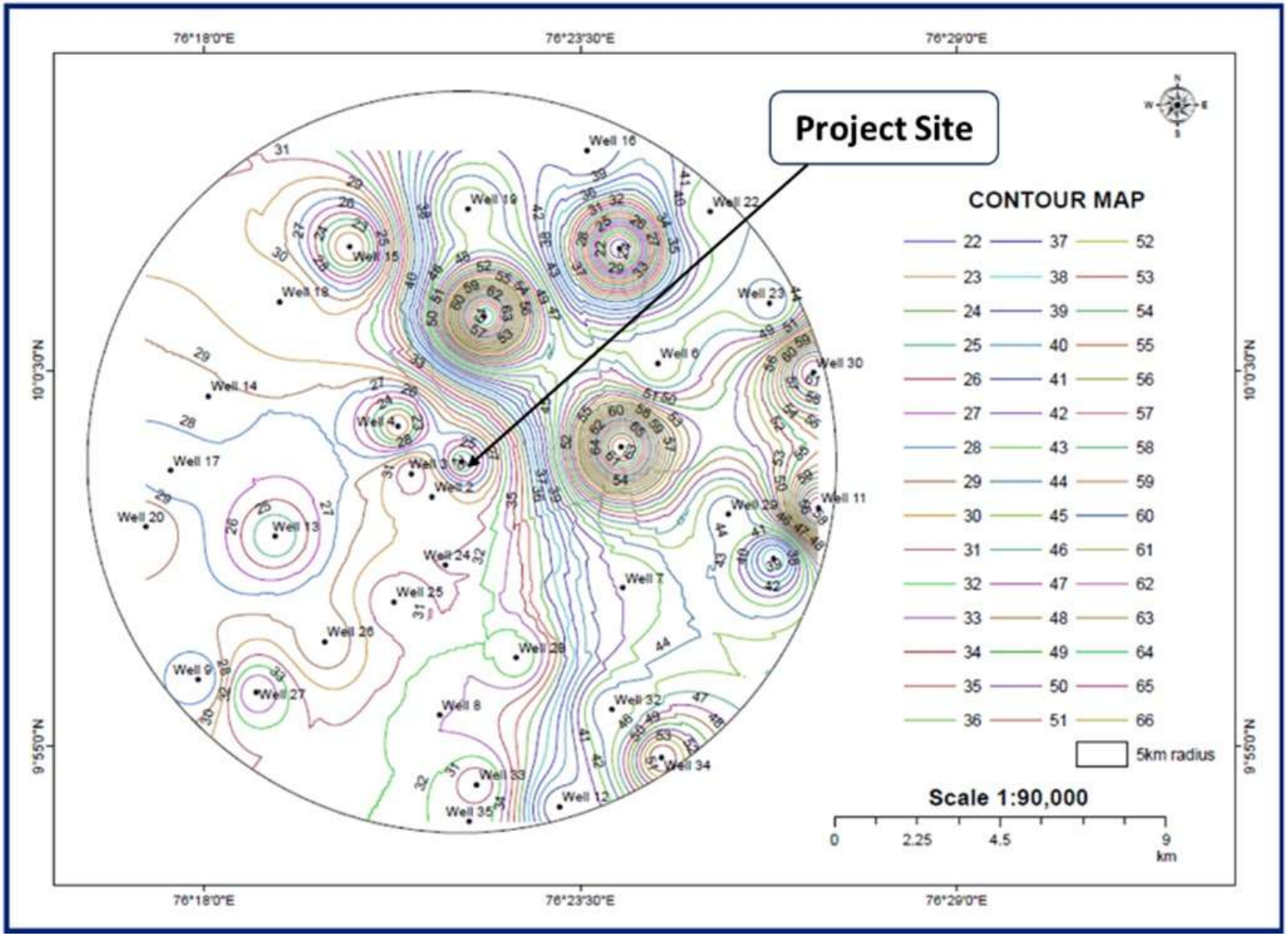
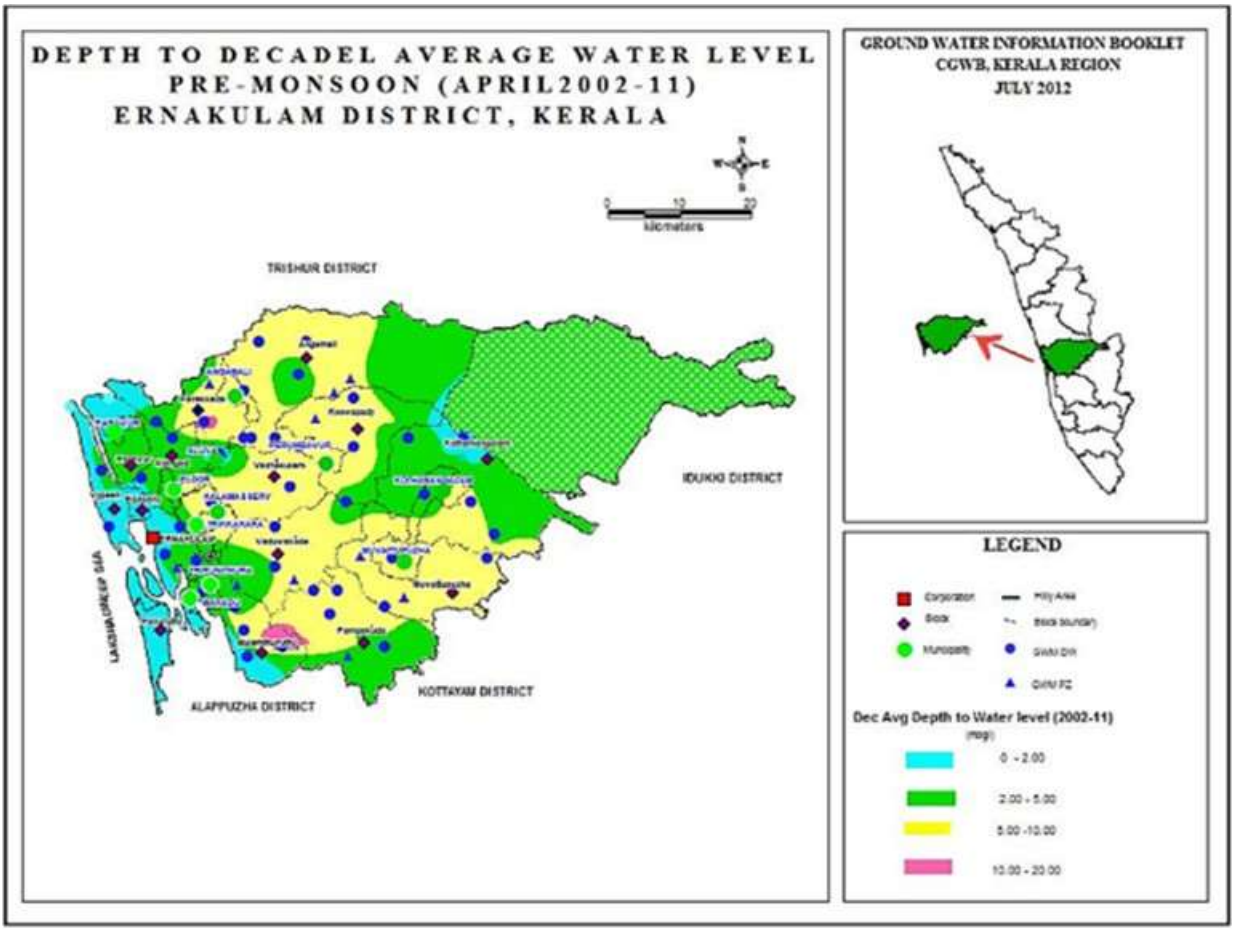


Figure 3-14 Contour map showing groundwater elevation

3.14 Ground Water Resources

3.14.1 Ground Water recharge

The groundwater resource of the district was computed jointly by CGWB and State Ground Water Department as on march 2009, as per the guidelines of the Ground water estimation Methodology 1997. The total annual recharge of groundwater has been computed block- wise using average water level fluctuation in Groundwater monitoring wells and specific yield of the respective aquifers for 2 blocks and rainfall infiltration method for 13 blocks. The net annual groundwater availability for the district is 557.35 Mixing Cell Model (MCM). The resources available varied from block to block depending on the geographical area of the block and ranges from 14.07 to 57.45 MCM. As per the methodology, the blocks are categorized as safe, semi critical, critical and over exploited on the basis of the stage of development and long-term groundwater trend of water level. There are no over-exploited blocks in the district. Among the three Semi-critical blocks, the long-term water level trend in Parakadavu and Paravoor blocks do not show declining trend. But in Vytilla block, although the stage of development is less than 75 %, the long-term trend of water level is showing significant declining trend due to which it is **classified as semi-critical. As per 2022 assessment, SLF site falls in Vaduvacode which is in safe category.** The net annual ground water availability as on March 2021 is shown in Table 3-9. The average depth of water level of the district during pre and post monsoon is shown in Figure 3-16 & 3-17 respectively.

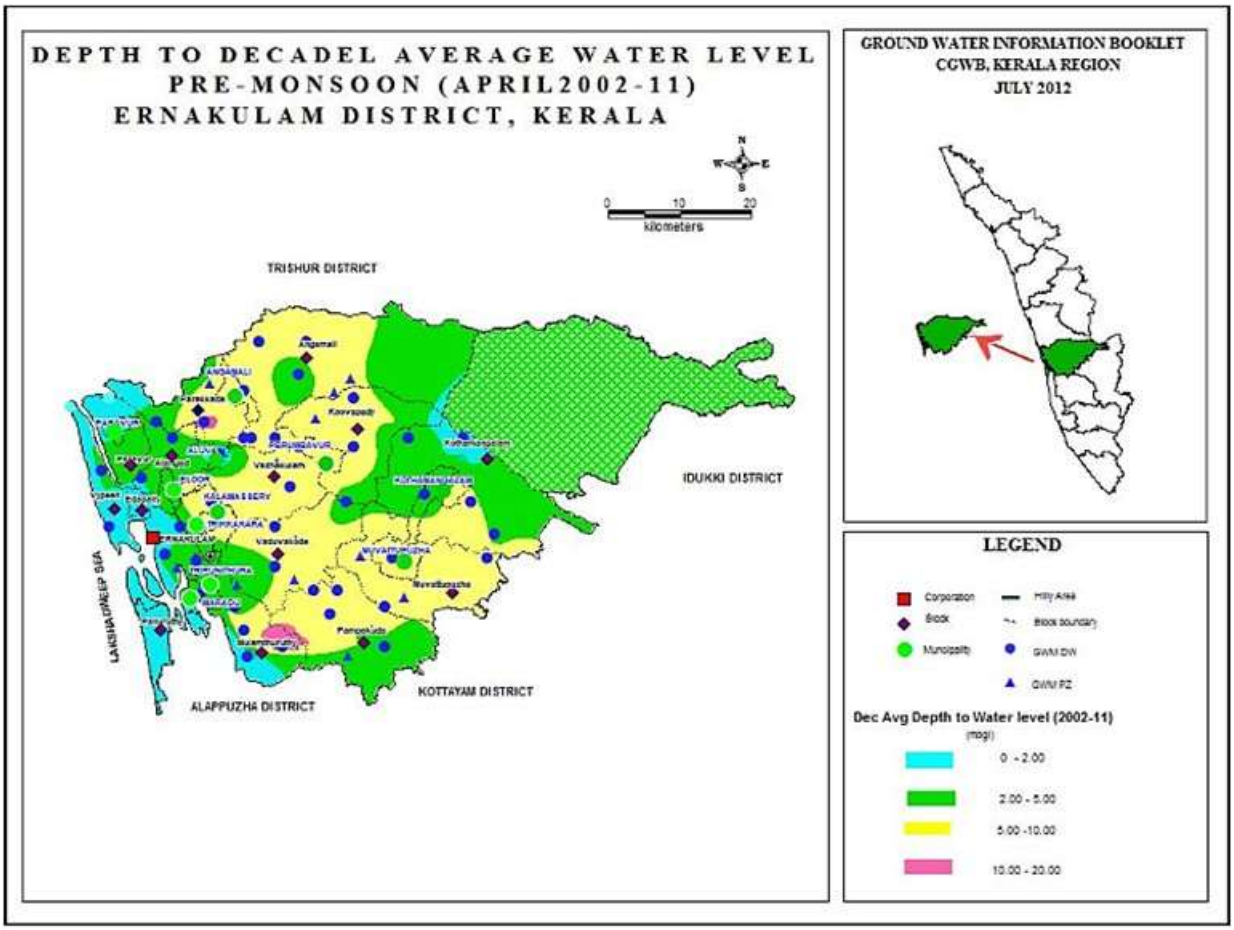


Source: Groundwater information booklet of Ernakulam district, Govt. of Kerala

Figure 3-15 Average depth of water level (Pre-Monsoon) of Ernakulam district

Table 3-9 Net Annual Ground Water Availability (MCM) as in March 2021

S.No	Block	Total Annual Recharge	Net Annual GW Availability	Existing gross draft for irrigation	Existing gross GW draft for domestic & industrial use	Existing gross groundwater draft for all uses	Stage of GW Development (%)	Categorization for future GW Development
1	Alangadu	25.88	23.29	5.66	8.33	13.99	60.05	Safe
2	Angamaly	56.86	51.18	9.10	10.93	20.04	39.15	Safe
3	Edappali	32.36	29.12	1.81	8.28	10.10	34.67	Safe
4	Koovapady	83.50	75.14	10.61	8.24	18.85	25.09	Safe
5	Kothamangalam	62.09	55.88	9.04	10.68	19.72	35.29	Safe
6	Mulamthuruthy	22.51	20.26	4.88	7.46	12.34	60.91	Safe
7	Moovattupuzha	49.50	44.55	12.13	8.58	20.71	46.48	Safe
8	Palluruthy	34.77	31.29	0.36	19.38	19.75	63.10	Safe
9	Pampakuda	55.29	49.76	10.04	7.55	17.59	35.63	Safe
10	Parakadavu	24.39	21.95	10.48	6.52	17.00	77.47	Semi-Critical
11	Paravoor	22.26	20.04	8.84	8.42	17.25	86.10	Semi-Critical
12	**Vaduvacode**	**63.83**	**57.45**	**6.44**	**7.19**	**13.63**	**23.73**	**Safe**
13	Vazhakulam	53.2	47.93	11.63	9.72	21.35	45.68	Safe
14	Vypin	18.45	16.60	10.19	9.28	10.31	62.05	Safe
15	Vytilla	14.81	14.07	1.03	6.10	7.13	50.68	Semi-Critical



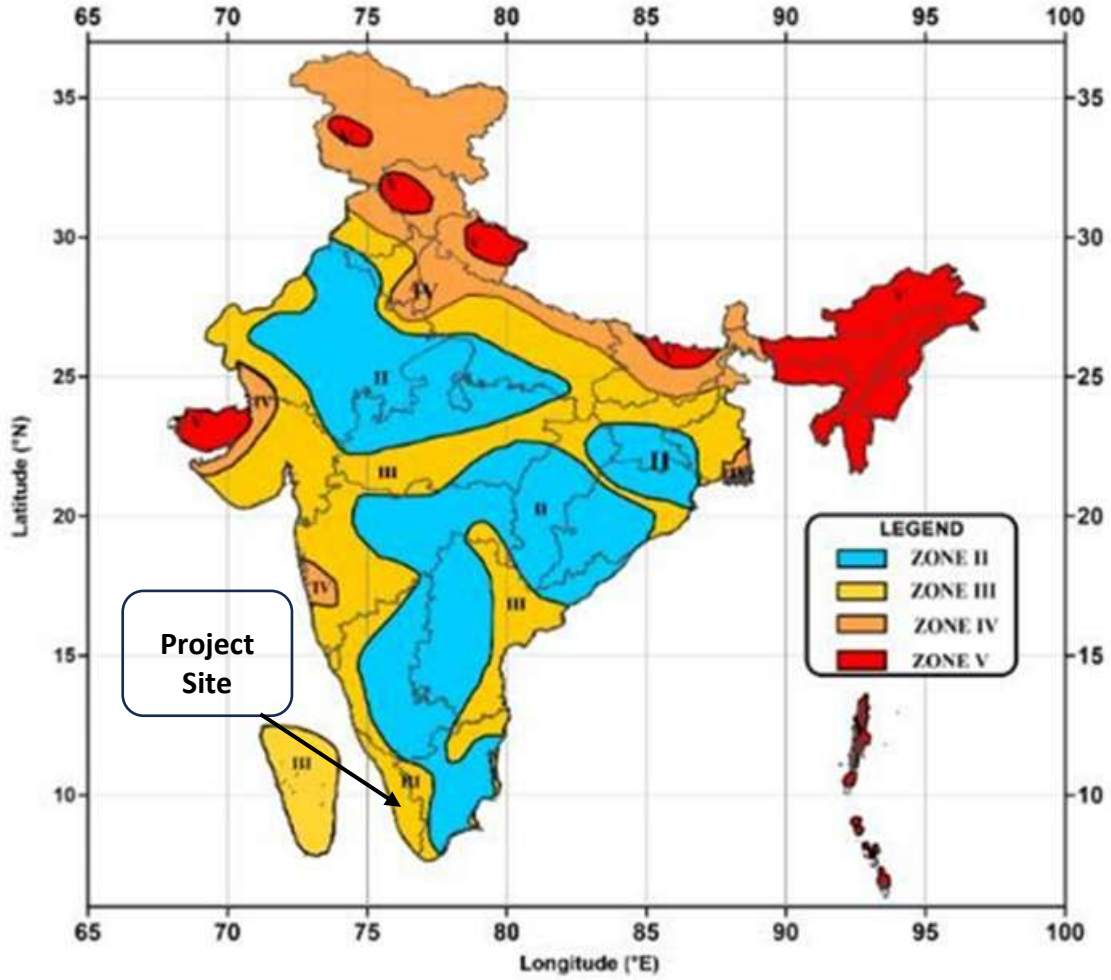
Source: Groundwater information booklet of Ernakulam district, Govt. of Kerala

Figure 3-16 Average depth of water level (Pre-Monsoon) of Ernakulam district

3.15 Natural hazards

3.15.1 Seismicity

Inline with Seismic zonation map of the country (state wise) the study area is categorized in the seismic zone III, which is classified as having a moderate damage risk zone accordingly the SLF will be designed.



Source: Ministry of Earth Sciences, as per IS 1893:2002

Figure 3-17 Map showing Seismic tectonic zone

3.15.2 Floods

As per District Disaster Management Plan, 2015 the Vadavucode taluk does not falls under flood prone area. The highest flood w.r.t site is expected 1.65m.

3.15.3 Land Use Pattern

The land use pattern is studied for 10 km radius area from the project site to determine the present land use pattern and to analyse the impacts on land use due to the proposed SLF and to give recommendations for optimizing the future land use pattern.

3.15.4 Land Use pattern based on Remote Sensing data

Remote sensing satellite imageries were collected and interpreted for the 10 km radius study area for analysing the land use pattern of the study area. Based on the satellite data IRS-P6 Geo-Coded FCC on 1:50000 scale of LISS III was acquired December 2023; Land use/Land cover maps have been prepared.

The present land use/land cover maps were prepared based on the classification system of National standards. For explanation for each type of the land use category as given in Table 3.10 were considered.

3.15.5 Data Requirements

IRS-P6 Geo-Coded FCC on 1:50000 scale of LISS III was acquired December 2023 and was used for the mapping and interpretation. Besides, other collateral data as available in the form of maps, charts and census records other reports and especially topographical survey of India maps on 1:50000 scale are used. In addition to this, ground truth survey was also conducted to verify and confirm the ground features.

Table 3-10 Land Use Categories

Sl.No.	Level – 1	Level - 2
1	Built – up Land	Town/Cities
		Villages
		Institution/Industry/Go down etc.,
		Plotted Area/Layout
2	Agriculture Land	Double Crop Land/Irrigated Area
		Plantation
		Fallow
3	Forest	Evergreen/Semi evergreen
		Deciduous
		Forest Plantation
4	Wastelands	Rocky/Stony waste
		Land with / without scrubs
		Saline/sandy & Marshy/swampy
5	Water Bodies	River/Stream
		Lake/Reservoir/Tanks
6	Others	Orchard/Other Plantation
		Shifting cultivation
		Salt Pans, Snow covered/Glacial
		Barren/Vacant Land

3.15.6 Methodology

The methodology adopted for preparation of LU/LC thematic map is monoscopic visual interpretation of geo coded scenes of IRS-P6 Satellite LISS-III and field observations are taken. The various steps involved in the study are preparatory field work, field survey and post field work.

3.15.7 Pre field-Interpretation of satellite data

The False Colour Composite (FCC) of IRS-P6 satellite data at 1:50000 scale are used for pre field interpretation work. Drawing the help of toposheets, geology, and geomorphology by using the image elements the features are identified and delineated the boundaries. Each feature is identified on image by their image elements like tone, texture, colour, shape, size, pattern and association. A legend in terms of land use/land cover, physiography and erosion was formulated. The sample areas for field check are selected covering all the physiography, land use/land cover feature cum image characteristics.

3.15.8 Ground truth verification

Both toposheets and imagery were taken for field verification and a transverse plan using existing road network was made to cover as many representative sample areas as many representative sample areas as possible to observe the broad land use features and to adjust the sample areas according to field conditions. Detailed field

observations and investigations were carried out and noted the land use features on the imagery.

3.15.9 Post Field Work

The final interpreted and classified thematic map was cartographed. The cartographic map was coloured with standard colour coding and detailed description of feature with standard symbols. All the classes noted and marked by the standard legend on the map.

3.15.10 Final Output

The final output would be the land use/land cover map on 1:50000 scale, numerals were given different colour code for each category as shown in map. Area estimation of all features of land use/land cover categories was noted.

3.15.11 Observations

The main interpreted LU/LC classes of the study area and their respective areas are given in Sq.km is shown in Table 3-11. The land use pattern within 10 km radius based on IRS-P6 is shown in Figure 3-10. From the LU/LC studies it could be corroborated that, the project area falls under grass land and covers about 1.12 Sq.km and the built-up area is predominant to the extent of 221.42 Sq.km (about 70.34%). River and canal system occupies about 15.23 sq.km. The second predominant land is agricultural land which is about 23.06 sq.km.

Table 3-11 Land Use Pattern of Study Area

Sl. No.	Particulars of Land use	Area in Sq.km	Percentage
1	Built up	221.42	70.34
2	Industrial Area	11.75	3.73
3	Agriculture Land	23.06	7.32
4	Wetland	9.39	2.98
5	Scrub Land	8.44	2.68
6	Barren Land/Wasteland	0.03	0.05
7	Tank/Pond/Reservoir	8.13	2.58
8	River/Canal/Stream	15.23	4.83
9	Grassland	1.12	0.35
10	Others (Marine drive structures, Arc island, Open land without scrub)	16.19	5.14
	Total Area	**314.76**	**100.00**

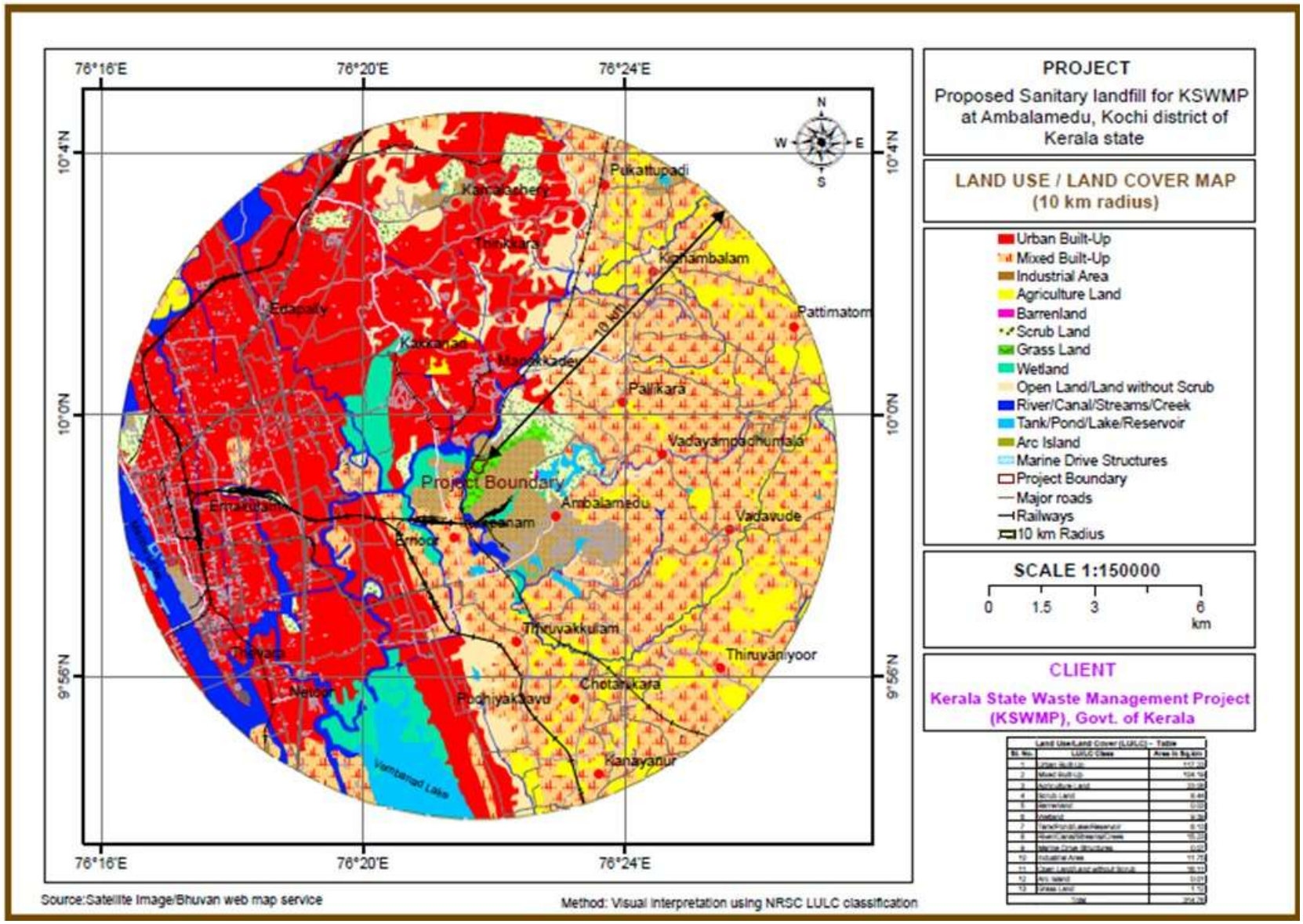


Figure 3-18 Land use Land cover map covering 10 km radius of SLF site

3.16 Air Environment

The prime objective of baseline air monitoring is to evaluate the existing air quality of the study area. This will also be useful for assessing the conformity to standards of the ambient air quality on completion of the proposed project. This section describes the selection of sampling locations, the methodology adopted for sampling, analysis techniques and frequency of sampling. Ambient air quality of the study area has been assessed through a network of eight (8) ambient air quality stations designed keeping in view the meteorological conditions of the study region and others such as major habitation, environment sensitivity etc. The AAQ locations selected based on the predominant wind directions and major habitation area. The methodology adopted for the air quality survey is given below:

3.16.1 Selection of sampling locations for AAQ

In order to fix the locations of the monitoring stations, a model suggested by Houghland and Stephens (Ref: The Design of Air Quality Monitoring Network; R.E. Munn, 1981) is used. This model suggests setting up of monitoring stations at those locations where ground level concentration (GLC) is high. The probability factor was found by determining the "coverage factor" for potential monitoring locations around the project, which are likely to be affected due to air pollutants from the project. The coverage factor for all potential locations was calculated by the following formula:

$$Ajk = Freq.\ (k) / (1 + Dj)$$

Where,

- Ajk = Coverage factor of the monitoring site in the kth downwind sector
- Freq. (k) = Frequency of wind direction in the kth sector.
- Dj = Distance (km) from the source (project) to the site.

The wind rose data of IMD Kochi observatory was used to calculate the Ajk values of all potential AAQ monitoring stations. Stations were set up all around the project site.

Possible stations covering all downwind directions and in varying distances up to a limited stretch from the project site were tested with this mathematical model. The list of selected AAQ Stations is given in Table 3-12. Eight locations were identified for establishing Ambient Air Quality monitoring network as shown in the Table 3-12.

Based on the above wind rose all the environmental attributes have selected for baseline data generation. The locations for air quality monitoring were scientifically selected based on the following considerations using climatological data.

- Topography/terrain of the study area
- Considering up & down wind direction
- Human Settlements & sensitive areas
- Location of industries and their emission magnitude
- Accessibility of monitoring site
- Resource Availability
- Representativeness of the region for establishing baseline status
- Representativeness with respect to likely impact areas.

Table 3-12 Ambient Air Quality Monitoring Locations

Code	Location Name	Latitude	Longitude	Distance (km)	Direction	Remarks
AAQ 1	Thrikathra	9°59'8.39"N	76°21'30.88"E	0.41	W (UW)	Industrial
AAQ 2	Thrippunithura	9°59'4.47"N	76°20'46.67"E	1.6	W (UW)	Industrial
AAQ 3	FACT Road	9°59'8.65"N	76°22'2.93"E	0.48	E (DW)	Industrial

Code	Location Name	Latitude	Longitude	Distance (km)	Direction	Remarks
AAQ 4	Puthenkurish Karimugal road	9°59'25.94"N	76°24'28.25"E	4.6	ENE (DW)	Residential
AAQ 5	Chottanikkara	9°56'19.76"N	76°22'53.99"E	5.4	SSE (CW)	Residential
AAQ 6	Valanjambalam	9°57'54.41"N	76°17'24.94"E	7.95	WSW (UW)	Commercial
AAQ 7	Pallikkara	10°1'12.22"N	76°25'10.35"E	6.83	NNE (CW)	Residential
AAQ8	Edappally	10°1'59.68"N	76°18'47.09"E	7.30	NW (UW)	Residential

UW – Upwind, DW – Downwind, CW – Crosswind

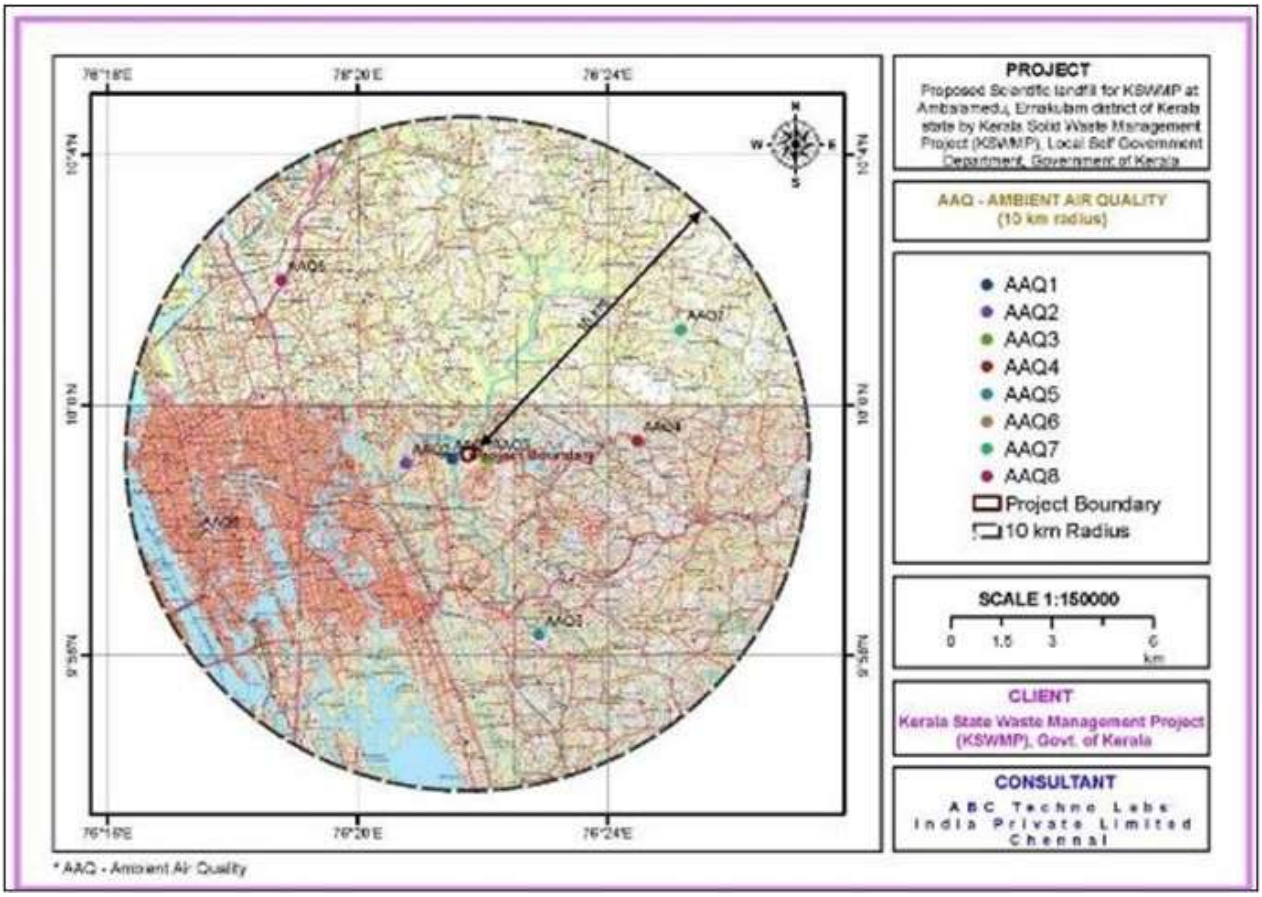


Figure 3-19 Ambient Air Quality Monitoring Locations

3.16.2 Parameters for Sampling and Frequency

Ambient air quality monitoring was carried out at a frequency of two days in a week (Figure 3-21) at each location continuously at 24-hours for three months. The baseline data of air environment was generated for the parameters namely Particulate Matter size less than 10 µm (PM_{10}) and 2.5 µm ($PM_{2.5}$), Sulphur Di-oxide (SO_X), Nitrogen Di-oxide (NO_X), Carbon Monoxide (CO), Ammonia (NH_3), Ozone (O_3), Lead (Pb), Benzene (C_6H_6), Benzo alpha pyrene (BaP), Arsenic (As), Nickel (Ni), Methane, Volatile Organic Compounds (VOCs). Concentrations of pollutant parameter monitored have been compared with National Ambient Air Quality standards.



Figure 3-20 Ambient air quality monitoring photographs

3.16.3 Instruments used for sampling

Respirable Dust Samplers APM 460 BL of Envirotech, Fine Particulate Samplers APM 550 of Envirotech & Combo PM_{10} & $PM_{2.5}$ sampler and AAS 271 of Envirotech were used for monitoring the Particulate matter PM_{10} & $PM_{2.5}$. The Gaseous pollutant samplers AAS 109 of Ecotech & APM 411 along with APM 460 Envirotech were used for sampling of gaseous pollutant like SOx, NO_X, O_3, NH_3, VOCs & Beneze, Methane. Carbon Monoxide was measured by electro chemical sensor method. The instruments used for monitoring are periodically calibrated every year as per NABL requirement.

3.16.4 Sampling & Analytical Techniques

The sampling and analytical techniques used for the monitoring of Ambient Air Quality is given in the below Table 3-13. The power supply for operation of AAQ instruments were utilized from nearest available sources like Government buildings, Panchayat office, Schools or residential buildings at each AAQ station.

Table 3-13 Techniques used for Ambient Air Quality Monitoring

Sl. No.	Parameters	Instruments/ Apparatus used	Method followed	Reference	Minimum detection limits
1	Particulate Matter (PM_{10}), µg/m^3	Respirable Dust Sampler (RDS), balance	Gravimetric (High-Volume with Cyclone)	NAAQS Monitoring & Analysis Guidelines	5 µg/m^3
2	Particulate Matter (PM_{10}), µg/m^3	PM2.5 Sampler (Fine dust sampler), balance	Gravimetric (Fine particulate Sampler)	NAAQS Monitoring & Analysis Guidelines	5 µg/m^3
3	Oxides of Sulphur (SOx), µg/m^3	RDS with Impinger tubes, Spectro photometer	Improved West & Gaecke Method	NAAQS Monitoring & Analysis Guidelines	5 µg/m^3
4	Oxides of Nitrogen (NOx), µg/m^3	RDS with Impinger tubes, Spectro photometer	Jacobs & Hochheiser Modified (Sodium Arsenite) Method	NAAQS Monitoring & Analysis Guidelines	5 µg/m^3
5	Carbon Monoxide (CO), mg/m^3	CO Analyser	NDIR Method	NAAQS Monitoring & Analysis Guidelines	1 µg/m^3
6	Ozone (O_3), µg/m^3	Ozone analyser	UV photometric	IS 5182 part 9, 1974	5 µg/m^3

Sl. No.	Parameters	Instruments/ Apparatus used	Method followed	Reference	Minimum detection limits
7	Nickel, Arsenic, ng/m^3 Lead, µg/m^3	AAS	AAS Method after sampling on EPM 2000 F.P.	IS 5182 part 10, 1999	1 ng/m^3
8	Ammonia (NH3), µg/m^3	Spectropho-tometer	Indophenol Method	AAFA Edition 21st	10 µg/m^3
9	Benzo-a-Pyrine (BaP), µg/m^3	HPLC	Solvent extraction followed by HPLC	IS 5182 part 12, 2004	0.01 ng/m^3
10	Benzene, µg/m^3	Gas Chromatography	Chromatography	Methods of Air Sampling & analysis; 3rd Edition 1998; Edited: J.P. Lodge Jr; Lewis Publishers	0.1 µg/m^3
11	VOCs, µg/m^3	GC-MS	ABCTL/INS/SOP/ 035	-	1 µg/m^3
12	Methane HC, µg/m^3	GC-MS	ABCTL/INS/SOP/ 038	-	1 µg/m^3

3.16.5 Results of Ambient Air Quality

The maximum, minimum and average with 98 percentile values of monitored data for all the locations are presented in Table 3-14.

Table 3-14 Summary of Ambient Air Quality Results

Code	Location Name	$PM_{2.5}$ µg / m^3				PM_{10} µg / m^3				SOx µg / m^3				NO_x µg / m^3			
		Min	Max	Avg	98 Percentile	Min	Max	Avg	98 Percentile	Min	Max	Avg	98 Percentile	Min	Max	Avg	98 Percentile
AAQ 1	Project Site	17	22	19.88	22	37	48	41.96	47.54	5.1	7.3	6.05	7.25	12.7	14.7	13.55	14.65
AAQ 2	Thrippunithura	19	24	21.67	24	40	51	45.67	51	5.9	7.7	6.75	7.60	13.7	17.2	15.09	17.06
AAQ 3	FACT Road	21	28	24.46	28	43	62	52.25	61.54	7.3	10.6	9.16	10.55	14.6	19.4	16.81	19.26
AAQ 4	Near Puthenkurish Karimugal road	17	24	20.83	24	37	51	44.54	51	5.1	7.7	6.38	7.42	13.6	16.7	14.80	16.51
AAQ 5	Chottanikkara,	20	27	23.54	27	42	57	49.88	57	6.8	9.2	7.84	9.01	13.9	18.1	16.09	17.96
AAQ 6	Valanjambalam	24	31	27.38	31	49	64	57.75	63.54	8.4	11.6	9.93	11.50	16.9	22.9	19.99	22.71
AAQ 7	Pallikkara	20	27	23.42	26.54	41	56	49.54	56	7.3	9.6	8.29	9.55	13.9	17.2	15.65	17.10
AAQ 8	Edappally	22	27	24.63	27	46	58	52.46	58	7.9	9.7	8.85	9.60	14.3	19.4	17.38	19.4
CPCB / MoEF Standards																	
Industrial / Residential / Rural and Other Area		60				100				80				80			

Code	Location Name	NH_3 , µg / m^3				Ozone, µg / m^3				CO, mg / m^3				Lead, µg / m^3			
		Min	Max	Avg	98 Percentile	Min	Max	Avg	98 Percentile	Min	Max	Avg	98 Percentile	Min	Max	Avg	98 Percentile
AAQ 1	Project Site	BDL (<5)				9.1	11.9	13.55	14.65	BDL(<0.1)				BDL (<0.1)			
AAQ 2	Thrippunithura	BDL (<5)				10.1	14.6	12.14	14.32	0.11	0.17	0.14	0.17	BDL (<0.1)			
AAQ 3	FACT Road	BDL (<5)				12.1	15.8	13.73	15.70	0.12	0.28	0.18	0.26	BDL (<0.1)			
AAQ 4	Near Puthenkurish Karimugal road	BDL (<5)				10.2	13.6	12.13	13.46	BDL(<0.1)				BDL (<0.1)			
AAQ 5	Chottanikkara,	BDL (<5)				12.2	14.9	13.37	14.85	0.14	0.26	0.20	0.25	BDL (<0.1)			
AAQ 6	Valanjambalam	BDL (<5)				12.9	16.9	15.30	16.62	0.16	0.31	0.24	0.31	BDL (<0.1)			
AAQ 7	Pallikkara	BDL (<5)				11.1	14.2	12.71	14.01	0.14	0.27	0.21	0.26	BDL (<0.1)			
AAQ 8	Edappally	BDL (<5)				12.5	15.6	14.25	15.6	0.15	0.29	0.22	0.29	BDL (<0.1)			
CPCB / MoEF Standards																	
Industrial / Residential / Rural and Other Area		400				100				2				1			

3.16.6 Interpretation of Data Obtained

The results of the monitored data indicates that the ambient air quality of the project region in general is in conformity with the National Ambient Air Quality Standards with present level of activities. Ambient Air Quality Monitoring reveals that;

The maximum and minimum concentrations of PM_{10} and $PM_{2.5}$ for all the 8 AAQ stations were observed between 37 µg/m^3 to 64 µg/m^3 and 17 µg/m^3 to 31 µg/m^3 respectively.

PM_{10}: The maximum value for PM_{10} of 64 µg/m^3 is observed at Valanjambalam Junction, Ravipuram, (AAQ6) station and the minimum value observed at Puthenkurish Karimugal Road (AAQ4) and Project Site (AAQ1) 37µg/m^3.

$PM_{2.5}$: The maximum value for $PM_{2.5}$ of 31µg/m^3 was also observed at Valanjambalam Junction, Ravipuram, (AAQ6) station and the minimum value observed at Puthenkurish Karimugal Road (AAQ4) and Project Site (AAQ1) 17µg/m^3.

SOx: The maximum value of SO_x concentrations was observed at Valanjambalam Junction, Ravipuram, (AAQ6) station as 11.6 µg/m^3 and the minimum value observed at Puthenkurish Karimugal Road (AAQ4) 5.1 µg/m^3.

NOx: The maximum value of NOx concentrations was observed at Valanjambalam Junction, Ravipuram, (AAQ6) station as 22.9 µg/m^3 and the minimum value observed at Puthenkurish Karimugal Road (AAQ4) 12.7µg/m^3.

CO: The maximum value of CO concentrations was observed at Valanjambalam Junction, Ravipuram, (AAQ6) station as 0.31 µg/m^3 and the minimum value observed at Puthenkurish Karimugal Road (AAQ4) and Project Site (AAQ1) is BDL (<0.1). The max. value of AAQ pollutants is observed at AAQ6 station which is located at proximity of road junction. The min. concentration of AAQ value are observed at AAQ1 (project site) and AAQ4 (Puthenkurish Karimugal road) as these sites relatively undisturbed by manmade activities.

To maintain the ambient air quality of the area within the NAAQS, air pollution control practices like sprinkling of water on the haulage road and using paved road, controlled speed of vehicles and pollution under check will be adopted during the construction period of SLF. Conventional pollutants are not expected from SLF during operation phase.

3.17 Noise Environment

The main objective of monitoring of ambient noise levels was to establish the baseline noise levels in the surrounding areas and to assess the total noise level in the environment of the study area. The measurements were carried out using Type 1 noise level integrated sound level meter. Monitoring was done at each location during the study period for 24 hrs on hourly basis to obtain hourly equivalent sound pressure level. A digital noise level meter was used to record the noise levels. From these values, day time and night time and 24 hrs. Leq. values were calculated. Day time is considered from 0600 hrs to 2200 hrs and night from 2200 hrs to 0600 hrs.

3.17.1 Identification of sampling locations

A preliminary reconnaissance survey was undertaken to identify the major noise sources in the area. The noise monitoring has been conducted at eight locations within study area which are presented in Table 3-15 and shown in Figure 3-22. The noise level monitoring photographs are shown in Figure 3-23.

Table 3-15 Noise Quality Monitoring locations

Code	Location Name	Latitude	Longitude	Distance (km)	Direction	Remarks
N 1	Project site	9°59'8.39"N	76°21'30.88"E	0.41	W	Industrial
N 2	Thrippunithura	9°59'4.47"N	76°20'46.67"E	1.6	W	Industrial
N 3	FACT Road	9°59'8.65"N	76°22'2.93"E	0.48	E	Industrial
N 4	Puthenkurish Karimugal road	9°59'25.94"N	76°24'28.25"E	4.6	ENE	Residential
N 5	Chottanikkara,	9°56'19.76"N	76°22'53.99"E	5.4	SSE	Residential
N 6	Valanjambalam	9°57'54.41"N	76°17'24.94"E	7.95	WSW	Commercial
N 7	Pallikkara	10°1'12.22"N	76°25'10.35"E	6.83	NNE	Residential
N 8	Edappally	10°1'59.68"N	76°18'47.09"E	7.30	NW	Residential

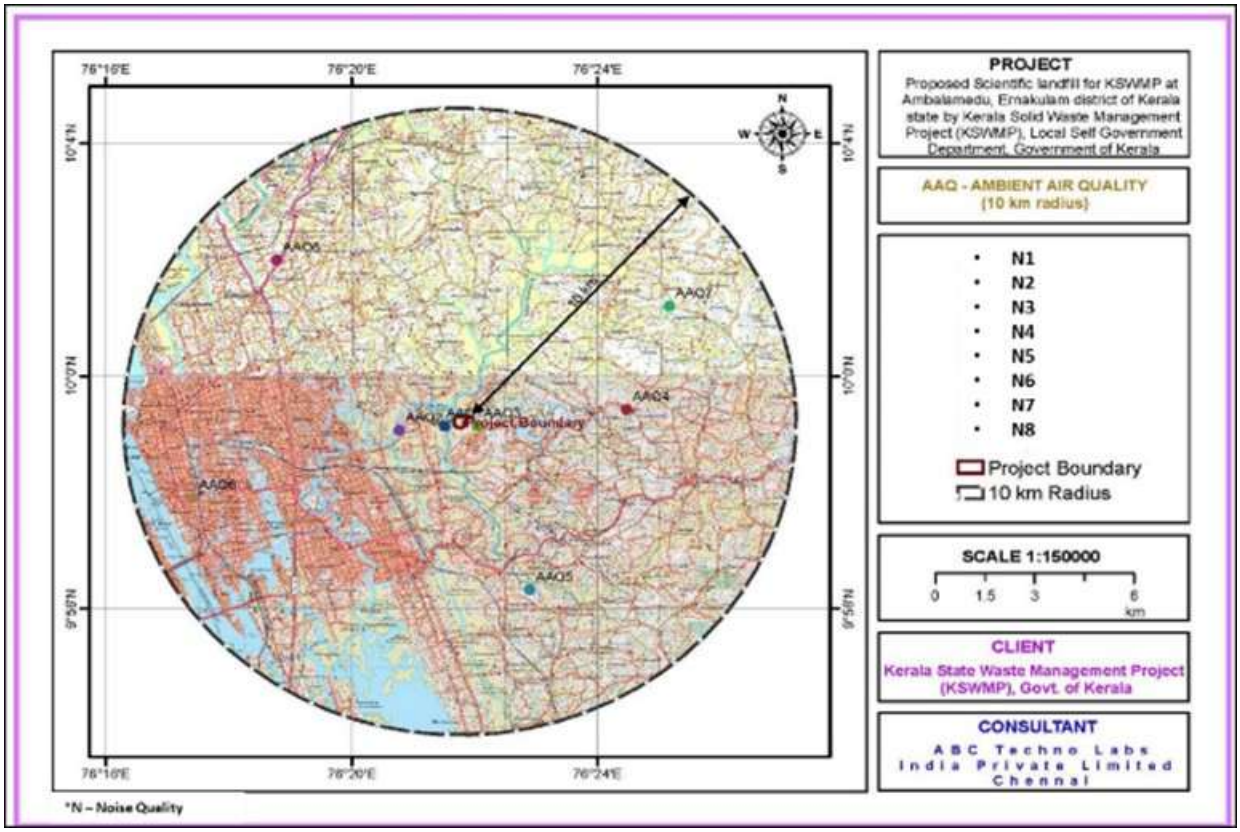


Figure 3-21 Noise Quality Monitoring locations



Figure 3-22 Noise level monitoring photographs

3.17.2 Method of Monitoring

Noise, in general, is sound which is composed of many frequency components of various types of loudness distributed over the audible frequency range. Equivalent

sound pressure levels of day time i.e. Leq (day) and night time Leq (night) are calculated from the hourly measured noise level and compared to Ambient Noise Level Standards as per the "Noise Pollution (Regulation and Control) Rules, 2000" stipulated for daytime and night time for residential land use.

Sound Pressure Level (SPL) measurements were measured at all eight locations. The readings were taken for every hour for 24 hours. The day noise levels have been monitored during 6 am to 10 pm and night levels during 10 pm to 6 am at all the locations covered in10 km radius of the study area. The noise levels were measured once during the study period. These readings were later tabulated and the frequency distribution table was prepared. Finally, 24 hourly values for various noise parameters viz. Leq. day and Leq. night were calculated.

For noise levels measured over a given period of time, it is possible to describe important features of noise using statistical quantities. This is calculated using the percent of the time certain noise levels exceed the time interval. The notations for the statistical quantities of noise levels are described below:

- L10 is the noise level exceeded 10 percent of the time
- L50 is the noise level exceeded 50 percent of the time and
- L90 is the noise level exceeded 90 percent of the time

3.17.2.1 Equivalent Sound Pressure Level (Leq)

The Leq is the equivalent continuous sound level, which is equivalent to the same sound energy as the actual fluctuating sound measured in the same period. This is necessary because of noise from the source often fluctuates widely during a given period of time. This is calculated from the following equation:

$$Leq = L50 + (L10 - L90)^2/60$$

3.17.2.2 Parameters Measured during Monitoring

For noise levels measured over a given period of the time interval, it is possible to describe important features of noise using statistical quantities. This is calculated using the percent of the time, certain noise levels are exceeded during the time interval. The notation for the statistical quantities of noise levels is described below:
Hourly Leq day: Equivalent noise levels between 06.00 hours to 22.00 hours.
Leq night: Equivalent noise levels between 22.00 hours to 06.00 hours

3.17.2.3 Results

The summary of computed ambient noise level parameters like Leq. day and Leq. night are presented in Table 3-16 and compared to the standards specified by CPCB.

Table 3-16 Noise Quality Monitoring Results

Code	Sample Location	Leq [dB(A)]		
		Leq Day	Leq Night	Leq Avg
N1	Project Site	47.9	41.6	46.6
N2	Thrippunithura	51.6	44.2	50.2
N3	FACT Road	56.7	46.9	55.2
N4	Near Puthenkurish Karimugal	49.3	44.3	48.2
N5	Chottanikkara	48.4	44.1	47.4
N6	Valanjambalam	58.3	48.4	56.8
N7	Pallikkara	54.6	47.2	53.2
N8	Edappally	56.4	47.7	54.9

Table 3-17 Ambient Noise Standards

Zone Classification	Leq day dB(A)	Leq night dB(A)
Industrial Area	75	70

Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

3.17.3 Interpretation of Data

The noise levels recorded at all locations were within the limits of ambient noise as per Noise Regulation (Pollution & Control) Rules, 2000.

The maximum Leq. values at study area for day and night time was observed to be 58.3 dB(A) (N6) & 48.4 dB(A) (N6) respectively, and minimum Leq. values at study area for day and night time was observed to be 47.9 dB(A) at N1 & 41.6 dB(A) at N1 respectively. However, the recorded noise levels were found within the limits.

- The noise levels recorded at all locations were within the NAAQS limits.
- With the construction and operation of SLF, the noise level within the project site will have some impacts on the nearby areas.
- However, with suitable control measures and EMP, the noise levels will be reduced and the impacts can be minimized.

3.18 Water Environment

The quality of ground and surface water is influenced by surface and sub-surface environmental conditions. The quantity and quality of water entering the underground regime is another important parameter which influences underground water quality. Water sampling has been conducted to establish baseline water quality in the area. Water analysis was carried out for physical and chemical parameters as per the methods prescribed in IS and “Standard Methods for the Examination of Water and Wastewater (American Public Health Association)”. The water samples were collected as grab samples and were analysed for physical, chemical and biological characteristics. The locations of Ground Water (GW) and Surface Water (SW) sampling is given the Figure. 3-24.

3.18.1 Sampling Locations

The sampling locations were selected based on reconnaissance survey with the following consideration:

- Location of the surface water courses.
- Location of residential areas representing different activities.

The details of the water sampling stations are presented in the Table 3-18 and the sampling collection photographs are shown in Figure 3-25.

Table 3-18 Water Quality Monitoring locations

Code	Location Name	Latitude	Longitude	Distance (km)	Dir.	Remarks
Ground Water						
GW1	Thrikathra	9°59'8.39"N	76°21'30.88"E	0.41	W	Industrial
GW2	Thrippunithura	9°59'4.47"N	76°20'46.67"E	1.6	W	Industrial
GW3	FACT road	9°59'8.65"N	76°22'2.93"E	0.48	E	Residential
GW4	Puthenkurish Karimugal road	9°59'25.94"N	76°24'28.25"E	4.6	ENE	Residential
GW5	Thrippunithura	9°56'19.76"N	76°22'53.99"E	5.4	SSE	Commercial
GW6	Valanjambalam	9°57'54.41"N	76°17'24.94"E	7.95	WSW	Residential
GW7	Pallikkara	10° 1'12.22"N	76°25'10.35"E	6.83	NNE	Residential
GW8	Koonamthai,	10° 1'59.68"N	76°18'47.09"E	7.30	NW	Remarks
GW9	Chittethukara	10°00'07.60"N	76°21'00.95"E	6.82	ENE	Residential
GW10	(CISF Colony)	09°58’13.85”N	76°21’40.83”E	7.33	NW	Residential

Code	Location Name	Latitude	Longitude	Distance (km)	Dir.	Remarks
Surface water (lake)						
SW1	Chitrapuzhariver	9°59'11.43"N	76°21'36.64"E	0.12	-	Upstream
SW2	Ambalamedu lake	9°59'2.20"N	76°22'41.07"E	1.72	-	Still water
SW3	Sasthamugal	9°57'10.69"N	76°22'24.33"E	3.93	-	Upstream

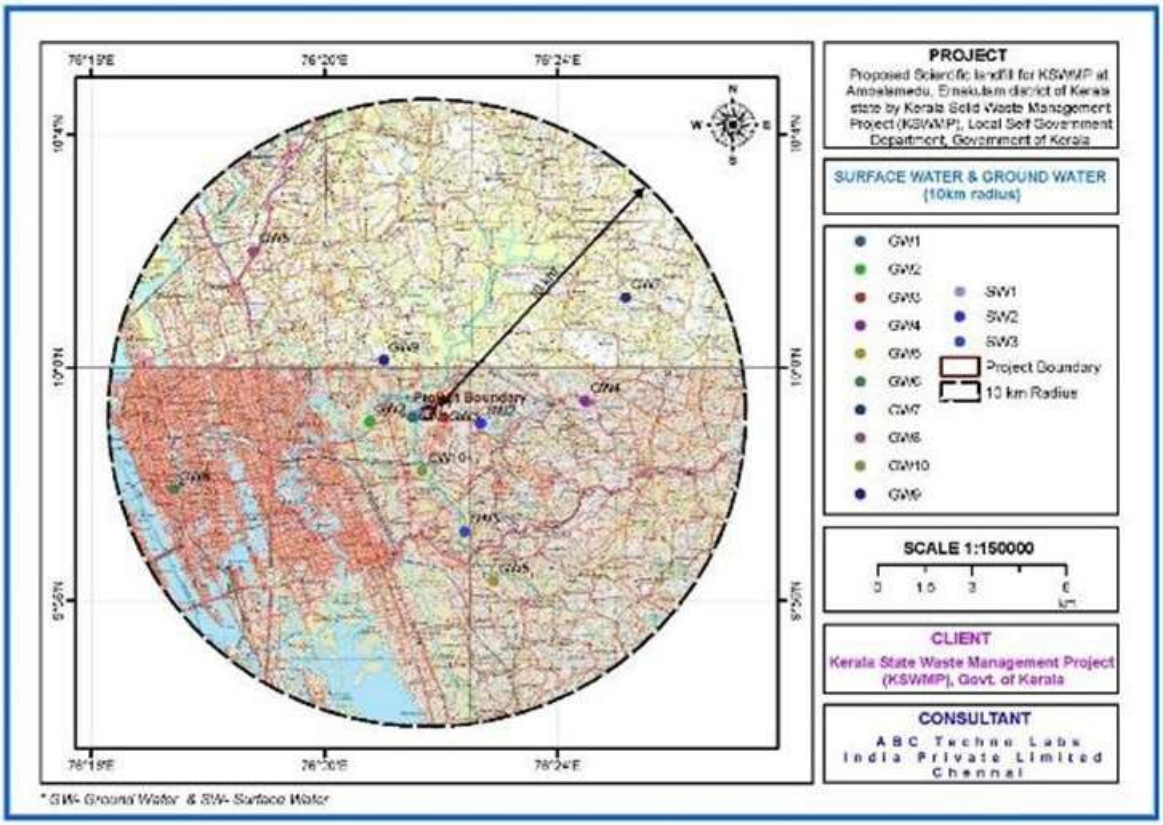


Figure 3-23 Ground & Surface water samples locations



Figure 3-24 Surface & Groundwater samples collection photographs

Groundwater samples for chemical analysis were collected in polyethylene carboys. Water samples collected for metal content were acidified with 1 ml HNO_3. Physio-chemical and heavy metal have been analysed for ground water quality in the study area as per IS:10500 – 2012.

3.18.2 Ground Water Results

The physiochemical characteristics of groundwater collected from 9 locations in the study area are presented in the Table 3.19 (GW1 to GW5) & Table 3-20 (GW6 to GW10) and is compared with the standards (IS 10500: Indian Standards/Specific for Drinking water) reference values.

Table 3-19 Analytical results of ground water samples (GW1 to GW5)

S. No	Parameters	Unit	Limits as per IS 10500:2012		GW1	GW2	GW3	GW4	GW5
			Acceptable	Permissible					
1	Colour	Hazen	5	15	BDL(<1)	1	BDL (<1)	2	<1
2	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	No Odour Observed		
3	Turbidity	NTU	1	5	BDL(<0.5)	BDL(<0.5)	0.7	BDL(<0.5)	0.5
4	pH at 25 °C	-	6.5-8.5	No Relaxation	7.22	7.15	7.51	7.06	7.33
5	Conductivity at 25 °C	µS/cm	Not Specified		631	832	789	470	1014
6	Total dissolved solids	mg/l	500	2000	360	481	458	268	582
7	Total Suspended solids	mg/l	Not Specified		<2				
8	Total Alkalinity as CaCO3	mg/l	200	600	140	152	182	104	280
9	Total Hardness as CaCO3	mg/l	200	600	164	230	206	123	330
10	Calcium as Ca	mg/l	75	200	41	64	58	44	89
11	Magnesium as Mg	mg/l	30	100	14.9	17	15	3.2	26
12	Chloride as Cl-	mg/l	250	1000	114	135	124	84	147
13	Sulphate as SO4	mg/l	200	400	30	48	56	18	48
14	Nitrate as NO3	mg/l	45	No Relaxation	2	6	4	1	4
15	Iron as Fe	mg/l	0.3	No Relaxation	0.16	0.26	0.16	BDL(<0.05)	0.11
16	Manganese as Mn	mg/l	0.1	0.3	BDL(<0.01)				
17	Fluoride as F	mg/l	1	1.5	0.21	0.19	0.21	0.13	0.21
18	Sodium as Na	mg/l	Not Specified		78	101	83	55	98
19	Potassium as K	mg/l	Not Specified		1.6	2.8	2.0	1.3	2.1
20	Barium as Ba	mg/l	0.7	No Relaxation	BDL(<0.1)				
21	Boron as B	mg/l	0.5	1.0	BDL(<0.1)				
22	Phosphorous as PO4	mg/l	Not Specified		0.18	0.12	0.08	0.10	0.21
23	Nickel as Ni	mg/l	0.02	No relaxation	BDL(<0.01)				
24	Silver a Ag	mg/l	0.1	No relaxation	BDL(<0.02)				
25	Aluminium as Al	mg/l	0.03	0.2	BDL(<0.03)				
26	Cadmium as Cd	mg/l	0.003	No relaxation	BDL(<0.003)				
27	Lead as Pb	mg/l	0.01	No Relaxation	BDL(<0.01)				
28	Copper as Cu	mg/l	0.05	1.5	BDL(<0.03)				
29	Zinc as Zn	mg/l	5	15	0.07	0.06	0.05	0.06	0.11
30	Total Chromium as Cr	mg/l	0.05	No Relaxation	BDL(<0.03)				
31	Arsenic as As	mg/l	0.01	0.05	BDL(<0.01)				
32	Cyanide as CN	mg/l	Not Specified	Not Specified	BDL(<0.02)	BDL(<0.05)	BDL(<0.05)	BDL(<0.05)	BDL(<0.05)
33	Selenium as Se	mg/l	0.01	No Relaxation	BDL(<0.01)				
34	Mercury as Hg	mg/l	0.001	No Relaxation	BDL(<0.001)				

S. No	Parameters	Unit	Limits as per IS 10500:2012		GW1	GW2	GW3	GW4	GW5
			Acceptable	Permissible					
35	Anionic Surfactants as MBAS	mg/l	0.20	1.0	BDL(<0.025)				
36	Phenolic Compounds as Phenol	mg/l	0.001	No Relaxation	BDL(<0.001)				
37	Total Coliforms	MPN/ 100ml	Absent/100 ml	Absent/100 ml	<2				
38	E.coli	MPN/ 100ml	Absent/100 ml	Absent/100 ml	<2				

Table 3-20 Analytical results of ground water samples (GW6 to GW10)

S. No	Parameters	Unit	Limits as per IS 10500:2012		GW6	GW7	GW8	GW9	GW10
			Acceptable	Permissible					
1	Colour	Hazen	5	15	<1				
2	Odour	-	Agreeable	Agreeable	No Odour Observed				
3	Turbidity	NTU	1	5	0.6	BDL(<0.5)	0.5	BDL(<0.5)	1
4	pH at 25 °C	-	6.5-8.5	No Relaxation	7.48	7.38	7.68	7.14	6.89
5	Conductivity at 25 °C	µS/cm	Not Specified		507	607	1135	597	978
6	Total dissolved solids	mg/l	500	2000	289	334	650	317	536
7	Total Suspended solids	mg/l	Not Specified		<2				
8	Total Alkalinity as CaCO3	mg/l	200	600	110	118	220	130	170
9	Total Hardness as CaCO3	mg/l	200	600	142	171	316	158	240
10	Calcium as Ca	mg/l	75	200	39	50	82	49	63
11	Magnesium as Mg	mg/l	30	100	10.8	11.2	27	8.6	20
12	Chloride as Cl-	mg/l	250	1000	90	104	194	96	164
13	Sulphate as SO4	mg/l	200	400	23	26	72	20	71
14	Nitrate as NO3	mg/l	45	No Relaxation	2	2	7	1	5
15	Iron as Fe	mg/l	0.3	No Relaxation	BDL(<0.05)	0.04	0.25	0.07	0.16
16	Manganese as Mn	mg/l	0.1	0.3	BDL(<0.01)				
17	Fluoride as F	mg/l	1	1.5	0.14	0.16	0.22	0.19	0.22
18	Sodium as Na	mg/l	Not Specified		57	72	132	63	108
19	Potassium as K	mg/l	Not Specified		1.3	2.2	3.1	1.8	3.7
20	Barium as Ba	mg/l	0.7	No Relaxation	BDL(<0.1)				
21	Boron as B	mg/l	0.5	1.0	BDL(<0.1)				
22	Phosphorous as PO4	mg/l	Not Specified		0.14	0.15	0.14	0.11	0.24
23	Nickel as Ni	mg/l	0.02	No relaxation	BDL(<0.01)				
24	Silver a Ag	mg/l	0.1	No relaxation	BDL(<0.02)				
25	Aluminium as Al	mg/l	0.03	0.2	BDL(<0.03)				
26	Cadmium as Cd	mg/l	0.003	No relaxation	BDL(<0.003)				

S. No	Parameters	Unit	Limits as per IS 10500:2012		GW6	GW7	GW8	GW9	GW10
			Acceptable	Permissible					
27	Lead as Pb	mg/l	0.01	No Relaxation	BDL(<0.01)				
28	Copper as Cu	mg/l	0.05	1.5	BDL(<0.03)				
29	Zinc as Zn	mg/l	5	15	0.06	0.18	0.14	0.07	0.10
30	Total Chromium as Cr	mg/l	0.05	No Relaxation	BDL(<0.03)				
31	Arsenic as As	mg/l	0.01	0.05	BDL(<0.01)				
32	Cyanide as CN	mg/l	Not Specified	Not Specified	BDL(<0.05)				
33	Selenium as Se	mg/l	0.01	No Relaxation	BDL(<0.01)				
34	Mercury as Hg	mg/l	0.001	No Relaxation	BDL(<0.001)				
35	Anionic Surfactants as MBAS	mg/l	0.20	1.0	BDL(<0.025)				
36	Phenolic Compounds as Phenol	mg/l	0.001	No Relaxation	BDL(<0.001)				
37	Total Coliforms	MPN/ 100ml	Absent/100 ml	Absent/100 ml	<2				
38	E.coli	MPN/ 100ml	Absent/100 ml	Absent/100 ml	<2				

3.18.3 Interpretation of Groundwater sample results

Physical parameters

- **Colour:** The colour of groundwater samples was <1 to 2 Hazen unit and meets the acceptable limit of drinking water standards.
- **Turbidity:** The turbidity of water samples ranges from BDL (<0.5) to 0.7 NTU and meets permissible limit at all the groundwater sampling locations.
- **Odour:** Groundwater samples were found agreeable at GW 1, GW 2 and odourless at rest of the locations.
- **pH:** The pH value of all groundwater samples ranges from 7.06 to 7.51 and meets the acceptable limit of drinking water standards.
- **Total Dissolved Solids (TDS):** The TDS in groundwater samples range from 268 to 582 mg/l and meets the permissible limit of drinking water standards.

Chemical parameters

- **Total Hardness:** The total hardness of ground water samples range between 123 to 330 mg/l, meets the permissible limit of 600 mg/l at all groundwater sampling locations of drinking water standards.
- **Chlorides:** The chloride content in groundwater samples range from 84 to 147 mg/l, meets the permissible limit of 1000 mg/l at all groundwater sampling locations.
- **Sulphates:** Sulphate content in groundwater sample ranges from 18 to 56 mg/l, meets the acceptable limit of 200 mg/l at all the ground water sampling locations.
- **Calcium:** The Calcium content in ground water sample ranges from 39 to 89 mg/l, meets the permissible limit of 200 mg/l at all groundwater sampling locations.
- **Magnesium:** The Magnesium content in ground water samples range from 3.2 to 26 mg/l, meets the acceptable limit of 30 mg/l.
- **Nitrate:** Nitrate content in groundwater samples ranges from 1 to 6 mg/l, meets the acceptable limit of 45 mg/l at all the groundwater sampling locations.
- **Iron:** The iron content in all ground water sample ranges from BDL (< 0.05 mg/l) to 0.26 mg/l and meets the acceptable limit of 0.3 mg/l.
- **Manganese:** Manganese content in groundwater samples found to be Below Detection Level (<0.01 mg/l) and meets the acceptable limit of drinking water standards.
- **Fluoride:** Fluoride content in groundwater samples ranges from 0.14 to 0.22 mg/l, meets the acceptable limit of drinking water standards.
- **Sodium:** Sodium content in groundwater samples ranges from 57 to 132 mg/l.
- **Potassium:** Potassium content in groundwater samples ranges from 1.3 to 3.7 mg/l.
- **Zinc:** Zinc content in groundwater sample ranges from 0.05 to 0.18 mg/l, meets the acceptable limit 5 mg/l at all the groundwater sampling locations.

Biological parameters

- **Total coliform:** Total coliform content found to be <2 MPN/100m at all the groundwater sampling locations

Other heavy metals

Aluminium, Selenium, Phenolic Compounds, Copper, Cadmium, Mercury, Nickel, Total Arsenic, Total Chromium and Cyanide in all groundwater samples were found below detection limit.

3.19 Surface water quality

To assess physio-chemical and bacteriological characteristics of surface water in the study area, samples were collected from the above location once during the monitoring period. The surface water sources are river/lakes for common usage of the people. And compared with surface water quality criteria as per CPCB norms. Sample had been collected and tested for pH, dissolved oxygen content and preserved with the addition of nitric acid for testing metal constituents at the laboratory. The collected samples were analyzed in accordance with Indian Standards for 39 parameters and the result had been compared with recent CPCB norms class “B” for surface water quality criteria for Class A to E is given in Table 3-21.

Table 3-21 Surface Water Quality as per Designated-Best of Use-CPCB

S.No.	Parameter	Class A	Class B	Class C	Class D	Class E
1	pH	6.5–8.5	6.5–8.5	6.0-9.0	6.5–8.5	6.5–8.5
2	Dissolved Oxygen, mg/l, min.	6	5	4	4	-
3	BOD, 5 days at 20° C, max.	2	3	3	-	-
4	Total coliform, MPN/100 ml, max	50	500	5000	-	-
5	Free ammonia (as N), mg/l, max	-	-	-	1.2	-
6	Electrical conductivity, µmhos/cm, max	-	-	-	-	2250
7	Sodium absorption ratio, max.	-	-	-	-	26
8	Boron (as B), mg/l, max.	-	-	-	-	2

Class A	Drinking water source without conventional treatment but after disinfection
Class B	Outdoor bathing (organized)
Class C	Drinking water source after conventional treatment and after disinfection
Class D	Propagation of Wild life and Fisheries
Class E	Irrigation, Industrial Cooling, and Controlled Waste Disposal
Below E	Not meeting A, B, C, D and E Criteria

3.19.1 Surface water sampling locations

It was planned that the sampling locations are selected in such a way that it adequately covers the major water sources in the study area. A total of three (3) surface water locations were considered for sample collection and the same is represented in Table 3-18, were selected for sampling location is shown in Figure 3-24.

Table 3-22 Analytical results of surface water samples

S.No	Parameters	Unit	SW1	SW2	SW3	Standards
1	Temperature	°C	26.6	27	25.3	-
2	Colour	Hazen	35	5	6	-
3	Odour	-	No Odour Observed			-
4	pH at 25°C	-	7.98	7.14	7.42	6.5-8.5
5	Electrical Conductivity	µS/cm	1102	568	405	-
6	Turbidity	NTU	5.5	1	1.2	-
7	Total Dissolved Solids	mg/l	636	322	231	
8	Total Hardness as $CaCO_3$	mg/l	280	140	92	-
9	Total Alkalinity as $CaCO_3$	mg/l	210	106	80	-
10	Chloride as Cl	mg/l	196	105	76	-
11	Sulphate as SO_4	mg/l	58	24	12	-
12	Fluoride as F	mg/l	0.38	0.18	0.13	-
13	Nitrate as NO_3	mg/l	18	16	05	-
14	Ammonia as NH_3	mg/l	2.41	0.24	0.05	-
15	Phosphate as PO_4	mg/l	1.96	0.33	0.17	--
16	Sodium as Na	mg/l	130	60	52	-
17	Potassium as K	mg/l	7.2	5.2	3.3	-
18	Calcium as Ca	mg/l	74	35	30	-
19	Magnesium as Mg	mg/l	23	13	4.1	-
20	Iron as Fe	mg/l	1.14	0.08	0.10	-
21	Manganese as Mn	mg/l	0.18	BDL(<0.02)	BDL(<0.02)	-
22	Total Suspended Solids	mg/l	8	BDL(<1)	BDL(<1)	-
23	Dissolved Oxygen as O2	mg/l	5.3	6.7	6.3	5
24	Chemical Oxygen Demand	mg/l	62	14	16	-
25	Bio-Chemical Oxygen Demand @ 27°C for 3 days	mg/l	10	BDL(<2)		3
26	Phenolic compounds as C6H5OH	mg/l	BDL(<0.001)			-
27	Copper as Cu	mg/l	0.14	BDL(<0.03)	BDL(<0.03)	-
28	Mercury as Hg	mg/l	BDL(<0.001)			-
29	Cadmium as Cd	mg/l	BDL(<0.003)			-
30	Selenium as Se	mg/l	BDL(<0.01)			-
31	Total Arsenic as As	mg/l	BDL(<0.01)			-
32	Cyanide as CN	mg/l	BDL(<0.02)			-
33	Lead as Pb	mg/l	0.09	BDL(<0.01)		-
34	Zinc as Zn	mg/l	0.27	0.10	0.14	-
35	Total Chromium as Cr	mg/l	0.07	BDL(<0.03)		-
36	Nickel as Ni	mg/l	BDL(<0.02)			-
37	Oil & Grease	mg/l	BDL(<1)			-
38	Total Coliform	MPN/ 100ml	>1600	>1600	1600	500
39	Faecal Coliform		>1600	500	240	-

3.19.2 Interpretation of Surface Water sample results

Physical parameters

- **Colour:** The colour of surface water samples were found to be between 5 to 36 Hazen units.
- **Odour:** Surface water samples were found odourless.
- **Turbidity:** The turbidity of surface water samples were found in the range 1.0 to 5.5 NTU which doesn't meet the tolerance limits.
- **pH:** The pH value of all surface water samples ranges from 7.14 to 7.98.
- **Electrical Conductivity:** Electrical conductivity in surface water samples ranges from 405 µS/cm to 1102 µS/cm.
- **Total Dissolved Solids (TDS):** The TDS in surface water samples range from 231 to 636 mg/l.

Biological Parameters

Total Coliform Count: Total Coliform Count in surface water samples were found to be 1600 to >1600 MPN/100ml.

Faecal Coliform: Faecal Coliform in surface water samples were found to be 240 to >1600 MPN/100ml.

Other parameters

Aluminium, Selenium, Phenolic Compounds, PCBs, PAH, Mineral oil, Pesticides and Cadmium, Mercury, Nickel, Total Arsenic, Total Chromium, Selenium, Cyanide in all surface water samples were found below detection limit (BDL).

In summary the results of surface water samples were compared to DBU of CPCB CLASS – B parameters and observed that Total Coliform is exceeding the limit of 500, and biological oxygen demand is exceeding in SW1 by 7mg/l. the reason could be attributable to untreated discharge of sewage in the upstream of chithtrapuzha river.

3.20 Soil Environment

The present study of the soil quality establishes the baseline characteristics and this will help in future in identifying the incremental concentrations if any, due to the operation of the proposed SLF. The sampling locations have been identified with the following objectives;

- To determine the baseline soil characteristics of the study area and
- To determine the impact of the proposed project activities within study area of 10km radius

3.20.1 Methodology adopted for soil quality

For studying soil quality of the region, eight (8) sampling locations were selected to assess the soil conditions in and vicinity of the project area based on various land use conditions. The physical and chemical concentrations were determined. The samples were collected from different specified depths viz., 30 cm, 60 cm and 90 cm. The samples were analysed for physical and chemical characteristics. The samples have been analysed as per the established scientific methods for physio-chemical parameters. The soil sampling locations are given in Table 3-23 & Figure 3-26 and standards of Indian Council of Agricultural Research soil classification is shown in Table 3-25.

Table 3-23 Soil sampling locations

Code	Location Name	Latitude	Longitude	Distance (km)	Direction	Remarks
S1	Thrikathra (Project site)	9°59'8.39"N	76°21'30.88"E	0.41	W	Barren
S2	Thrippunithura	9°59'4.47"N	76°20'46.67"E	1.6	W	Agricultural
S3	FACT road	9°59'8.65"N	76°22'2.93"E	0.48	E	Near Gypsum waste dump area
S4	Puthenkurish Karimugal road	9°59'25.94"N	76°24'28.25"E	4.6	ENE	Plantation area
S5	Thrippunithura	9°56'19.76"N	76°22'53.99"E	5.4	SSE	
S6	Valanjambalam	9°57'54.41"N	76°17'24.94"E	7.95	WSW	Built-up area
S7	Pallikkara	10°1'12.22"N	76°25'10.35"E	6.83	NNE	Agricultural
S8	Edappally	10°1'59.68"N	76°18'47.09"E	7.30	NW	Built-up area

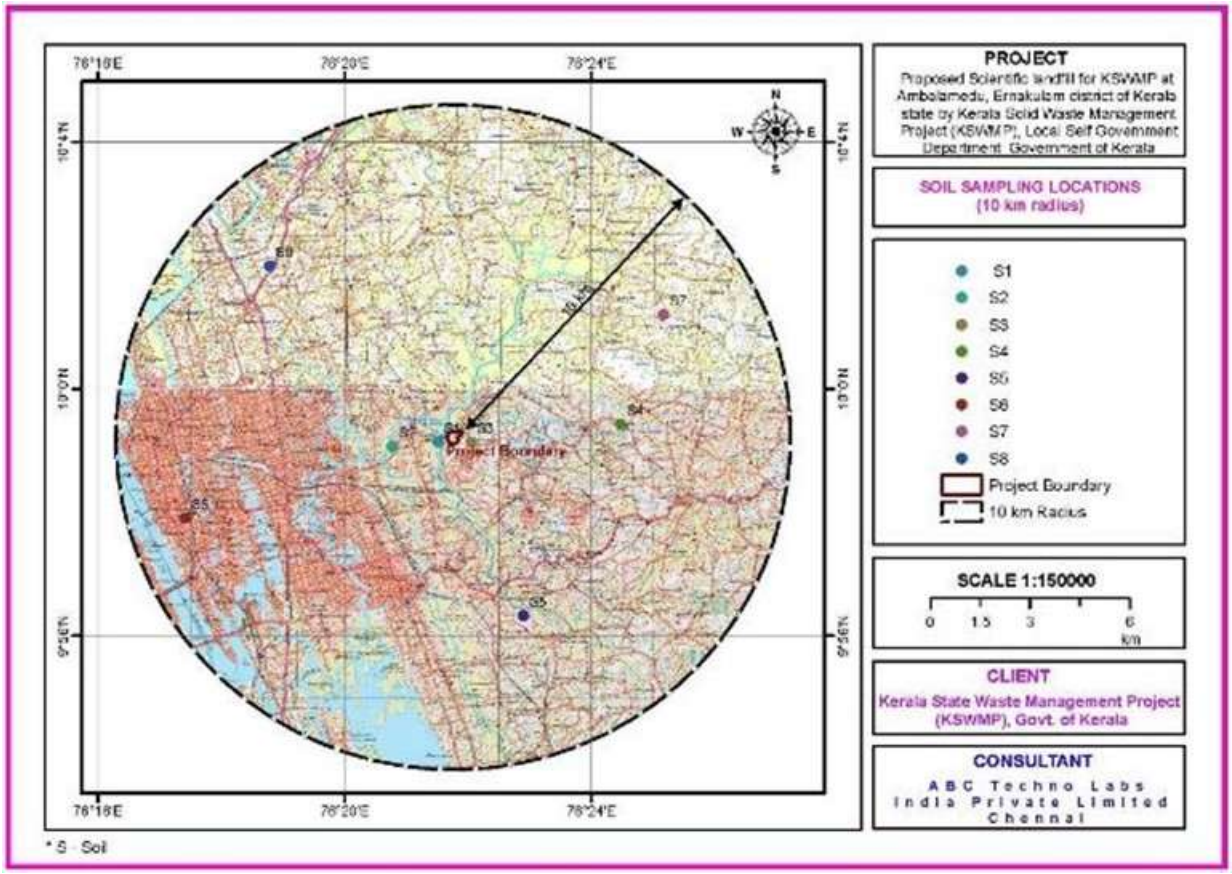


Figure 3-25 Soil sampling locations



Figure 3-26 Soil sampling photographs

Table 3-24 Analytical results of soil samples

Sl. No	Parameters	S1	S2	S3	S4	S5	S6	S7	S8
1	pH	7.14	7.34	6.49	7.45	7.33	6.97	7.41	7.68
2	Bulk Density, g/cc	1.26	1.36	1.38	1.22	1.37	1.34	1.25	1.33
3	Electrical Conductivity, mS/cm	0.096	0.112	0.318	0.141	0.124	0.084	0.174	0.142
4	Moisture, %	12.3	8.6	5.74	6.99	8.14	7.11	5.98	9.41
5	Total Nitrogen as N, kg/ha	132	91	248	114	81	133	174	79
6	Available Phosphorous a P, kg/ha	35.8	19.7	71.8	42.4	31.9	29.6	51.7	27.3
7	Available Potassium as K, kg/ha	296	244	382	310	334	290	348	372
8	Exchangeable Calcium as Ca,m.eq/100g	21.4	16.7	24.7	22.7	18.1	17.3	22.2	17.7
9	Exchangeable Magnesium as Mg, m.eq/100g	5.41	4.78	8.14	6.03	5.11	4.97	6.24	52
10	Exchangeable Sodium as Na, m.eq/100g	1.18	1.36	2.54	1.09	1.14	1.51	1.37	1.52
11	Organic matter (%)	0.96	0.71	1.02	0.84	0.72	0.92	1.13	0.65
12	Cation Exchange Capacity, m.eq/100g	19.1	15.8	18.1	19.7	16.8	18.1	20.2	16.1
13	Sodium Absorption Ratio	1.02	1.31	1.98	0.91	1.06	1.43	1.15	0.81
14	Texture Classification	Clay	Loam	Loam	Clay	Loam	Clay Loam	Clay	Clay Loam
15	Sand (%)	36.8	34.7	24.8	36.8	36.8	34.7	24.8	33.8
16	Clay (%)	55.6	26.3	25.4	60.2	25.9	36.9	61.1	35.7
17	Silt (%)	5.7	2.6	35.9	13.5	37.3	28.4	14.1	30.5

Table 3-25 Standards of Soil Classification as per ICAR

S.No	Parameters	Acceptable Values
1.	pH	<4.5 Extremely acidic
		4.51-5.50 Very Strongly acidic
		5.51-6.0 Moderately acidic
		6.01-6.50 Slightly acidic
		6.51-7.30 Neutral
		7.31-7.80 slightly alkaline
		7.81-8.50 moderately alkaline
		8.51-9.0 strongly alkaline
		9.01 very strongly alkaline
2	Salinity Electrical Conductivity (mS/cm) (640 ppm=1000 µS/cm)	Upto 1.00 Average
		1.01-2.00 harmful to germination
		2.01-3.00 harmful to crops (sensitive to salts)
3	Organic Carbon (%)	Upto 1.0 : Very less
		0.21-0.4 : less
		0.41-0.5 : medium
		0.51-0.8 : On an average sufficient
		0.81-1.00: Sufficient
		>1.0 more than sufficient
4	Nitrogen (Kg/ha)	Upto 50 very less
		51-100 less
		101-150 good
		151-300 better
		>300 sufficient
5	Phosphorus (Kg/ha)	Upto 15 Very less
		16-30 less
		31-50 medium
		51-65 on an average sufficient
		66-80 sufficient
		>80 more than sufficient
6	Potassium (Kg/ha)	0-120 very less
		120-180 less
		180-240 medium
		240-300 average
		300-360 better
		>360 more than sufficient

3.21 Soil quality results

Based on the results obtained, it is evident that the soil samples are predominantly silty clay type.

- **pH:** The pH of the soil samples ranged from 6.49 to 7.45 indicating the neutral in nature.
- **Electrical Conductivity:** The electrical conductance of the soil samples varied from 0.084 µS/cm to 0.318 µS/cm based on the Conductivity results it can be concluded that the ionic content of the soil samples is within the limits that does not harm the crops. Bulk densities of the soil samples varied from 1.22 to 1.38 gm/cc.
- **Available Nitrogen:** Available nitrogen in the soil samples varied from 81 kg/ha to 248 kg/ha which is indicating in good quantities in the soil samples. Available

phosphorus in the region varied from 19.7 kg/ha to 71.8 kg/ha revealing the distribution from medium to average sufficient quantities

- **Available Potassium:** Available potassium levels in the samples ranged from 244 Kg/ha to 382 Kg/ha, which is indicating average quantities in the soil samples.
- **Particle Size:** Based on particle sizes of the samples collected from the site, they are mostly falling in Loam – Clay loam category. Sand percent was varying from 24.8 to 36.8%, Silt percent was in the range of 2.6 to 37.3 % and Clay was varying in range of 25.4 to 61.1%.

From the above observations, it was found that the soil in the study area shows moderate fertility and ideal for plant growth. Soil amendment is not required for any plantation purposes.

3.22 Biological Environment

Terrestrial Ecology

3.22.1.1 Objectives

The objectives of ecological study during the study period of EIA study period may be outlined as follows:

- To characterize the environmental components like land, water, flora and fauna;
- To understand their present status;
- To understand carrying capacity of the ecosystem;
- To assess present bio-diversity; and
- To identify susceptible and sensitive areas.

3.22.1.2 Regional Biodiversity

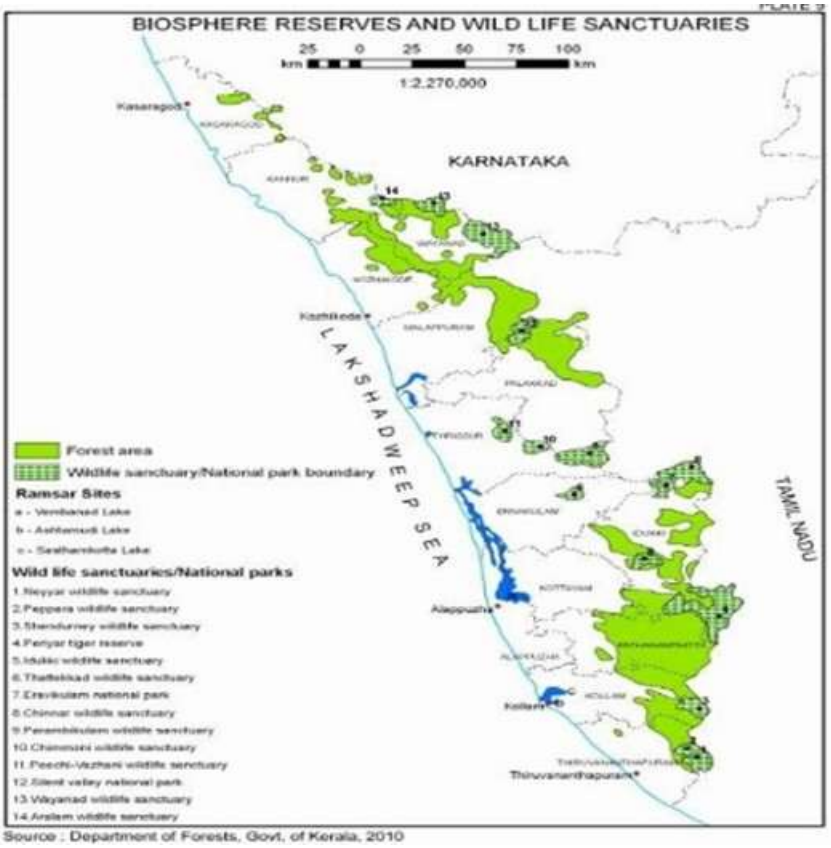
Kerala can be divided into 3 Geographical regions.

- Highlands,
- Midlands and
- Low Lands.

The High lands slope down from the Western Ghats which rise to an average height of 900 m, with a number of peaks well over 1,800m in height. This is the area of major plantations like tea, coffee, rubber, cardamom etc. The midlands lying between the mountains and the lowlands, is made up of undulating hills and valleys. This is an area of intensive cultivations. Cashew, coconut, areca nut, cassava (tapioca), banana, rice, ginger, pepper, sugarcane and vegetables of different varieties are grown in this area.

Kerala forest fall in two biogeographic provinces, viz Western Ghats and the Western Coast, and are rich in biodiversity and vital for environmental protection and considered to be a repository of rare and endangered flora and fauna. The pressure on India's forests is very high because of high population. The rapid growth in the economy of the country in the last one decade has put additional demands on forest for infrastructure development. Forest plays an important role in the country's ecological stability and economic development. Even though the land area of Kerala is only 1.2 percent of India, the forest cover is 2.30 percent of the national average. The geographical area recorded as forests by the state Forest Department shows that during 1993-2001, there is not much of a change or reduction in the extent of forests. However, during 2003, there is a slight increase, which is a positive trend, i.e. an area of 47 km^2 was added during the year and the coverage has almost attained 29 percent. However, this also includes about 75,000 Ha of plantations of different species, the dominant ones being teak and eucalypts, which impoverishes the biodiversity and reduces the quality of the ecosystem. The classification of forest area in Kerala in the context of land utilization

shows that 64 percent of the area is under dense forests and 19 percent of the area is under plantations, while 17 percent of the area is given to other agencies (KFD, 2004). The Forest map of Kerala is shown in Figure 3-28.



Source : Department of Forests, Govt. of Kerala, 2010

Figure 3-27 Forest map of Kerala

The state's rich biodiversity and the natural resources are facing a serious threat from the growing human encroachments, cattle grazing, collection of fire wood, Man-Animal conflict, poaching, illicit felling, mass tourism and pilgrimage etc. and also from various developmental activities. Biodiversity conservation has been structured covering the ecosystem diversity, species diversity and genetic diversity. Species diversity has been structured separately for plants and animals. Wild plant diversity has been structured on the lines of red-listed plants, endemic plants, medicinal plants, Wild relatives of cultivated plants, allied species of cultivated species and others.

Wild animal diversity has been structured on the lines of red listed animals, endemic animals, flagship species, keystone species, pollinators and others. Domesticated species diversity has been structured on the lines of cultivated plants and domesticated animals.

The environmental sensitive map covering 10 km radius from the project site is shown in Figure – 3-29.

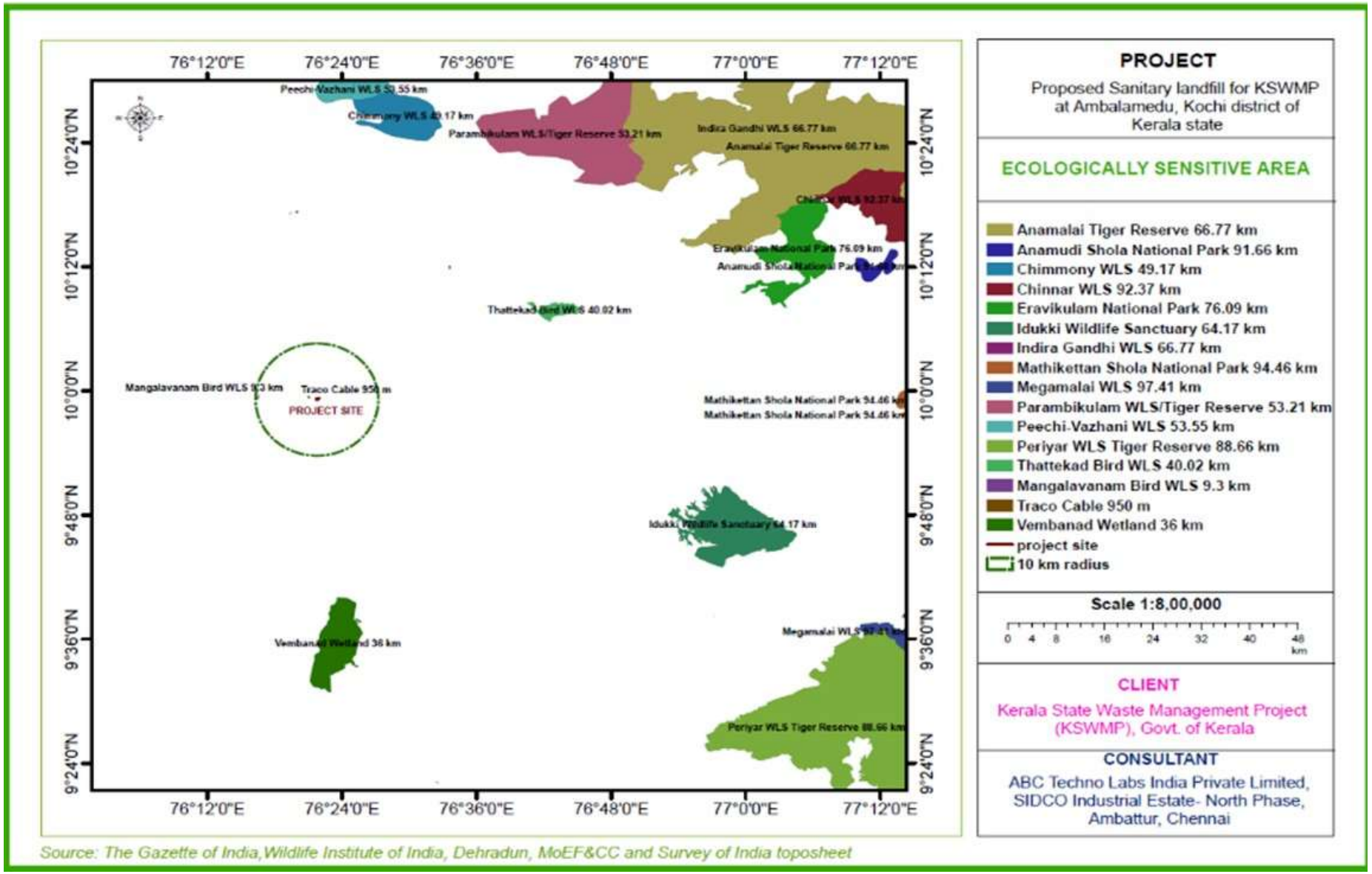


Figure 3-28Environmental Sensitive Map of project site

3.22.2 Biogeographic Zone, Province and Forest Type

This study has been carried out during January 2024 of study period for the purpose of providing an independent and comprehensive baseline assessment of the flora, terrestrial vertebrate and associated habitat values of the site and within 10 km radius area around the study area and a subsequent assessment of potential ecological impacts. The study area falls under Western Ghats category as far as the Indian biogeographical zones *(Rodger, Panwar, Mathur 2000)* are concerned. Under the biogeographical provinces, the study area falls under the category of ***5A-Western Ghats- Malabar Plains.***

The field investigation and satellite imagery data shows, that the study area is a mixture of forest land, agricultural and get irrigated by the canals. The dry tropical vegetation is observed within the study area. The experimental finding of the spring season shows the dominance of grasses like *Cynodon dactylon, Dinebra retroflexa.* From the primary observations, the tree species recorded in the forest were *Cocos nucifera, Artocarpus heterophyllus, Azadirachta indica, Acacia nilotica, Acacia catechu, Bambusa vulgaris, Ficus religiosa, Prosopis juliflora, Melia azedarach* etc. The Bio-geographic provinces of India is shown in Figure 3-29.

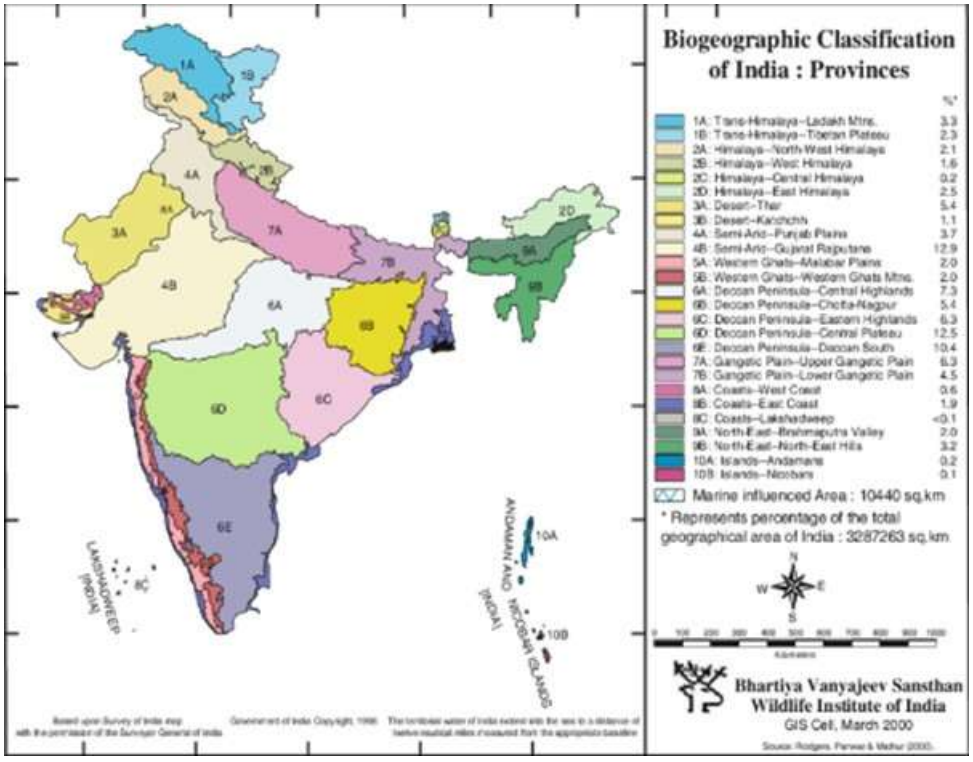


Figure 3-29 map showing the bio-geographic provinces of India

The detailed ecological assessment of the study area has been carried out with the following objectives:

- To establish the present status of ecological conditions surrounding the project location;
- To study the existing anthropogenic stresses on the prevailing ecosystem.
- To identify and predict the likely impacts on the local ecosystem from the proposed activities;
- To list out floral species, terrestrial vertebrate and aquatic flora and fauna present within the study area, and significance status under The Wildlife (Protection) Act, 1972;
- To define ecological/conservation status of each species as per IUCN categories (Red Data List).

- To formulate migratory measures and a sustainable Environmental Management Plan (EMP) basing upon the likely impacts.

During survey, following aspects were considered for ecological studies:

- Assessment of present status of flora and fauna;
- Identification of rare and endangered species of plants and animals (if any);
- Identification of ecologically sensitive areas within the study area;
- Assessment of migratory route of wildlife (if any); and
- Assessment of Aquatic Ecology with specific reference to aquatic birds and fishery resources.

3.22.2.1 Methodology

A desktop review (published documents etc.) was conducted to determine the forest area through satellite imagery, vegetation type *(Champion and Seth, 1962),* floral and faunal assemblage in the study area. Terrestrial investigations for flora and fauna records were collected by random field survey and a checklist was prepared. During field survey, discussions with the local people were carried-out to collect information related to local biodiversity in and around the villages. The ecological status of the study area has been assessed based on the following methodology:

- Primary field surveys to establish primary baseline of the study area;
- Compilation of secondary information available in published literatures/ forest working plans etc.
- Site Verification and finalization in consultation with Project proponent, local inhabitants.

A. Floral Study

The assessment of the flora of the study area is done by an extensive field survey of the area of 10 Km radius.

- Plants species were identified based on their specific diagnostics characters of family, genus and species using available floral, other related literature.
- Besides the identification of plant species, information was collected on the vernacular names and uses of plants made by local inhabitants.
- Qualitative analysis of vegetation is made by two different methods such as floristic (by simple studying various genera and species of various plant groups i.e. herbs, shrubs, trees, etc).

B. Faunal Study

Ground surveys are carried out by trekking the study area for identification of important animal groups such as birds, mammals and reptiles for sampling of animals through the following methods.

- For sampling birds/ avifauna ‘point sampling’ along the fixed transects (foot trails) were done to record all the species of birds with the help of binoculars; field guides and photography for more than 1 hour on each transect (n=4).
- For sampling mammals, ‘direct count on open width (20 m) transect’ were used on the same transects. Besides, information on recent sightings/records of mammals by the locals are also collected from the study areas.
- ‘Reptiles’ mainly lizards were sampled by ‘direct count on open width transects’.
- Secondary information collected from local villagers within 10km radius, published government data etc.

List of the endangered and endemic species as per the schedule of The Wildlife Protection Act, 1972

Emphasis is given to identify avifauna and mammals to determine the presence and absence of Schedule-1 species, listed in The Wildlife Protection Act 1972, as well as in Red List of IUCN. Various methods used for study animals are as follows:

A. Point Survey Method: Observations were made at each site for 15-20 min duration.

B. Road Side Counts: The observer travelled by motor vehicles from site to site and all sightings were recorded.

3.22.2.2 Floristic Composition Within the Study Area

The ecology and diversity survey was conducted in 10 km radius of the study area. It is observed that whereever high density of human settlements are noted have moderate ranges of plantations. Most of the vegetation are natural vegetation observed within the study area. During study area assessment several floral species were encountered within the 10 km radius area.

The project area covering 10 km radial distance reveal the presence of FACT Forest located at 2 km towards East &, Mangalavanam Bird Sanctuary located at 9.3 km towards West and the lat. & log. of the same is 9º69''17.67' N & 76º21''7.93' E respectively.

However, the vegetation within the study area is moderately dense, with the existence of some invasive species as per the survey conducted within 10 km radius of the study area. The results of survey exhibited dense vegetation with the existence of 179 terrestrial flora. In addition coconut, Neem and Acacia trees are abundant widely distributed away from the study area.

The following species were encountered from the study area during the field visits as given in Table 3-26.

Table 3-26 Floristic diversity in the study area

S. No.	Scientific Name	Common Name	Family	IUCN Conservation Status
Tree				
1	*Azadirachta indica*	Vembu	Meliaceae	Not assessed
2	*Acacia catechu*	Karungali	Mimosaceae	Not assessed
3	*Ficus religiosa*	Arayal	Moraceae	Not assessed
4	*Melia azedarach*	Malaivembu	Meliaceae	Least Concern
5	*Aglaia perviridis*	Cheruchokla	Meliaceae	Vulnerable
6	*Ailanthus excelsa*	Perumaram	Simaroubaceae	Not assessed
7	*Alangium salviifolium*	Alangi	Alangiaceae	Least Concern
8	*Baccaurea courtallensis*	Moottilpuli	Euphorbiaceae	Not assessed
9	*Acacia leucophloea*	Vellvale maram	Mimosaceae	Not assessed
10	*Tectona grandis*	Tekku	Verbenaceae	Not assessed
11	*Acacia nilotica*	Karuvale maram	Mimosaceae	Not assessed
12	*Ficus benghalensis*	Peraal	Moraceae	Not assessed
13	*Mesua ferrea*	Churuli	Calophyllaceae	Not assessed
14	*Aegle marmelos*	Vilvam	Rutaceae	Not assessed
15	*Hydnocarpus pentandrus*	Marotti	Achariaceae	Not assessed
16	*Ficus hispida*	Erumanakku	Fabaceae	Least Concern
17	*Thespesia populnea*	Poovarasu	Malvaceae	Not assessed
18	*Albizia lebbeck*	Vagai	Fabaceae	Not assessed
19	*Butea monosperma*	Parasa	Fabaceae	Not assessed
20	*Artocarpus heterophyllus*	Unu	Moraceae	Not assessed
21	*Artocarpus hirsutus*	Anjili	Moraceae	Least Concern
22	*Bambusa vulgaris*	Moongil	Poaceae	Not assessed

S. No.	Scientific Name	Common Name	Family	IUCN Conservation Status
23	*Dalbergia sissoo*	Ette	Fabaceae	Not assessed
24	*Cocos nucifera*	Tennai	Arecaceae	Not assessed
25	*Holigarna arnottiana*	Charu	Anacardiaceae	Least Concern
26	*Cassia fistula*	Kakke maram	Caesalpiniaceae	Least Concern
27	*Coccinia grandis*	Kovai palam	Cucurbitaceae	Not assessed
28	*Alstonia venenata*	Sinnappalai	Apocynaceae	Not assessed
29	*Musa paradise*	Vaazha	Musaceae	Not assessed
30	*Aporosa acuminata*	Vettil	Euphorbiaceae	Not assessed
31	*Alstonia scholaris*	Daivappala	Apocynaceae	Least Concern
32	*Borassus flabellifer*	Nonkuppanai	Arecaceae	Endangered
33	*Adenanthera pavonina*	Manchadi	Fabaceae	Not assessed
34	*Canarium strictum*	Sambirani chedi	Burseraceae	Not assessed
35	*Canthium diococcum*	Payira maram	Rubiaceae	Not assessed
36	*Phyllanthus emblica*	Nelli	Euphorbiaceae	Least Concern
37	*Lannea coromandelica*	Uthi	Anacardiaceae	Not assessed
38	*Pongamia pinnata*	Pungam	Fabaceae	Least Concern
39	*Prosopis juliflora*	Vaelikaruvai	Fabaceae	Not assessed
40	*Psidium guajava*	Perakka	Myrtaceace	Not assessed
41	*Rubus ellipticus*	Mullippazham	Rosaceae	Least Concern
42	*Macaranga peltata*	Vatta	Euphorbiaceae	Not assessed
43	*Acacia auriculiformis*	Acacia	Fabaceae	Least Concern
44	*Cinnamomum camphora*	Pachkarpooram	Lauraceae	Not assessed
45	*Eucalyptus sp*	Karpura marum	Myrtaceae	Not assessed
46	*Commiphora caudata*	Kiluvai	Burseraceae	Not assessed
47	*Delonix regia*	Cemmayir-konrai	Fabaceae	Least Concern
48	*Elaeocarpus serratus*	Karakka	Elaeocarpaceae	Not assessed
49	*Erythrina variegata*	Mullumurungai	Fabaceae	Least Concern
50	*Glycosmis pentaphylla*	Kulu Pannal	Rutaceae	Least Concern
51	*Madhuca longifolia*	Illuppa	Sapotaceae	Not assessed
52	*Calotropis gigantea*	Erukku	Apocynaceae	Not assessed
53	*Mangifera indica*	Mavin mara	Anacardiaceae	Data Deficient
54	*Moringa oleifera*	Murungai	Moringaceae	Least Concern
55	*Terminalia chebula*	Kadukkai	Combritaceae	Not assessed
56	*Bridelia retusa*	Mulluvenga	Phyllanthaceae	Not assessed
57	*Wrightia tinctoria*	Palai	Apocynaceae	Least Concern
58	*Annona squamosa*	Manilanilam	Annonaceae	Not assessed
59	*Areca catechu*	Atakka	Arecaceae	Not assessed
60	*Sapindus emarginatus*	Pucha	Sapindaceae	Not assessed
61	*Samanea saman*	Chakkarakkaymaram	Fabaceae	Least Concern
62	*Syzygium cumini*	Naval	Myrtaceae	Not assessed
63	*Tamarindus indica*	Puli	Caesalpiniacae	Not assessed
64	*Terminalia catappa*	Nattuvadumai	Combretaceae	Not assessed
65	*Emblica officinalis*	Nellimaram	Euphorbiaceae	Not assessed
66	*Terminalia arjuna*	Marutu	Combritaceae	Not assessed
67	*Terminalia paniculata*	Vellamaruth	Combritaceae	Not assessed
Shrubs				
1	*Datura metel*	Ummattangani	Solanaceae	Not assessed
2	*Argemone mexicana*	Brahmadanti	Papaveraceae	Not assessed
3	*Calotropis gigantea*	Erukku	Apocynaceae	Not assessed
4	*Lantana camara*	Vadaikkutti	Verbenaceae	Not assessed
5	*Atalantia monophylla*	Kattuelumichai	Rutaceae	Not assessed
6	*Begonia malabarica*	Rattha choori	Begoniaceae	Not assessed
7	*Breynia vitis-idaea*	Chuvanna-niruri	Phyllanthaceae	Least Concern

S. No.	Scientific Name	Common Name	Family	IUCN Conservation Status
8	*Euphorbia geniculata*	Chithirapala	Euphorbiaceae	Not assessed
9	*Cassia auriculata*	Aavaarampoo	Caesalpiniaceae	Not assessed
10	*Melastoma malabathricum*	Kadali	Melastomataceae	Not assessed
11	*Sida cordifolia*	Anakurunthoti	Malvaceae	Not assessed
12	*Mimosa diplotricha*	Mimosa diplotricha	Fabaceae	Not assessed
13	*Clerodendrum infortunatum*	Elumichi	Lamiaceae	Not assessed
14	*Jatropha gossypifolia*	Valampuri edampuri	Euphorbiaceae	Not assessed
15	*Leea indica*	Chorianthali	Vitaceae	Least Concern
16	*Canthium rheedei*	Cherukara	Rubiaceae	Least Concern
17	*Agave tomentosa*	Aanakaitha	Agavaceae	Not assessed
18	*Pavetta indica*	Maravalli	Rubiaceae	Not assessed
19	*Rauvolfia serpentine*	Vellaippavattai	Apocynaceae	Not assessed
20	*Ixora coccinea*	Thetti	Rubiaceae	Not assessed
21	*Urena lobata*	Kandankathiri	Malvaceae	Least Concern
22	*Vitex negundo*	Notchi	Verbenaceae	Least Concern
23	*Commelina benghalensis*	Kanavazhai	Commelinaceae	Least Concern
Herbs				
1	*Plumbago zeylanica*	Chittiramoolam	Plumbaginaceae	Not assessed
2	*Abutilon indicum*	Thuththi	Malvaceae	Not assessed
3	*Acalypha indica*	Kuppaimeni	Euphorbiaceae	Not assessed
4	*Acanthospermum hispidum*	Musumusu	Asteraceae	Not assessed
5	*Cynodon dactylon*	Arugu	Poaceae	Not assessed
6	*Aerva lanata*	Poolai poo	Amaranthaceae	Not assessed
7	*Ageratum conyzoides*	Aappakkoti	Asteraceae	Not assessed
8	*Alpinia galangal*	Perratthei	Zingiberaceae	Not assessed
9	*Euphorbia tirucalli*	Cakkalavi	Euphorbiaceae	Least Concern
10	*Cassia occidentalis*	Karintakara	Caesalpiniaceae	Not assessed
11	*Cassia tora*	Sakramardakam	Caesalpiniaceae	Not assessed
12	*Dinebra retroflexa*	Viper grass	Poaceae	Not assessed
13	*Cleome viscosa*	Karpooravalli	Cleomaceae	Not assessed
14	*Coleus aromaticus*	Kancatam	Lamiaceae	Not assessed
15	*Catharanthus roseus*	Vallarai	Apocynaceae	Not assessed
16	*Cleome gynandra*	Ellukku sakkalathi	Cleomaceae	Not assessed
17	*Chloris barbata*	Kamyunist Alai	Poaceae	Not assessed
18	*Aloe vera*	Sotru katrallai	Liliaceae	Not assessed
19	*Amorphophallus paeniifolius*	Kattukarunai	Araceae	Not assessed
20	*Andrographis paniculata*	Neelavembu	Acanthaceae	Not assessed
21	*Anisomeles malabarica*	Peymiratti	Lamiaceae	Not assessed
22	*Chromolaena odorata*	Karumpoondu	Astraceae	Not assessed
23	*Digera muricata*	Kattucheera	Amaranthaceae	Not assessed
24	*Emilia sonchifolia*	Vellarugu	Asteraceae	Not assessed
25	*Croton bonplandianum*	Manjal	Euphorbiaceae	Not assessed
26	*Curcuma aromatic*	Nilapanai	Zingiberaceae	Not assessed
27	*Curculio orchids*	Vallukkai	Hypoxidaceae	Not assessed
28	*Cyanotis axillaris*	Elumichai pul	Commelinaceae	Least Concern
29	*Cymbopogon citratus*	Arugam pull	Poaceae	Not assessed
30	*Cyperus rotundus*	Orilai	Cyperaceae	Least Concern
31	*Echinops echinatus*	Karisalankanni	Asteraceae	Not assessed
32	*Eclipta prostrate*	Kaelvaragu	Asteraceae	Not assessed
33	*Euphorbia hirta*	Vishnukiranthi	Euphorbiaceae	Not assessed
34	*Hemidesmus indicus*	Orithalthamarai	Asclipadaceae	Not assessed
35	*Hybanthus enneaspermus*	Voyal chullai	Violaceae	Vulnerable

S. No.	Scientific Name	Common Name	Family	IUCN Conservation Status
36	*Hygrophylla auriculata*	Karunchsatachi	Acanthaceae	Not assessed
37	*Hyptis suaveolens*	Nattapoochedi	Lamiaceae	Not assessed
38	*Ipomoea eriocarpa*	Theanthumpai	Convolvulaceae	Not assessed
39	*Mimosa pudica*	Thottavadi	Fabaceae	Least Concern
40	*Ocimum americanum*	Nallathulasi	Lamiaceae	Not assessed
41	*Ocimum sanctum*	Karut tulasi	Lamiaceae	Not assessed
42	*Pilea microphylla*	Kizhaanelli	Urticaceae	Not assessed
43	*Physalis minima*	Karpooravalli	Solanaceae	Vulnerable
44	*Ruellia tuberosa*	Sanam	Acanthaceae	Not assessed
45	*Scoparia dulcis*	Ellu	Scrophulariaceae	Not assessed
46	*Sida acuta*	Kurunthotti	Malvaceae	Not assessed
47	*Synedrella nodiflora*	Kozhunji	Asteraceae	Not assessed
48	*Tephrosia purpurea*	Kanchori	Fabaceae	Least Concern
49	*Tribulus terrestris*	Vettukkaya puntu	Zygophyllaceae	Least Concern
50	*Tridax procumbens*	Vettukkaaya-thalai	Asteraceae	Not assessed
51	*Typha angustifolia*	Aattudarbha	Typhaceae	Least Concern
52	*Vernonia cinerea*	Mukuttipoondu	Asteraceae	Not assessed
53	*Vigna radiate*	Pasipayaru	Fabaceae	Not assessed
54	*Withania somnifera*	Amukkaramkizangu	Solanaceae	Not assessed
Climbers				
1	*Abrus precatorius*	Kundu mani	Fabaceae	Not assessed
2	*Acacia sinuate*	Seeyakkai	Fabaceae	Not assessed
3	*Ampelocissus tomentosa*	Kattukodi mundiri	Vitaceae	Not assessed
4	*Cyclea peltata*	Padaikilangu	Menispermaceae	Not assessed
5	*Cyperus difformis*	Karimuttan	Cyperaceae	Least Concern
6	*Asparagus racemosus*	Thanneervittan	Asparagaceae	Not assessed
7	*Antigonon leptopus*	Kodi roja	Polygonaceae	Not assessed
8	*Mikania micrantha*	Dhritarashtra-pacha	Asteraceae	Not assessed
9	*Mukia maderaspatana*	Mosumosukkai	Cucurbitaceae	Not assessed
10	*Passiflora foetida*	Chirranchantiya	Passifloraceae	Not assessed
11	*Aristolochia bracteolate*	Aaduthinnapalai	Aristolochiaceae	Not assessed
12	*Aristolochia indica*	Aaduthinnapalai	Aristolochiaceae	Not assessed
13	*Basella rubra*	Kodippasali	Basellaceae	Not assessed
14	*Cardiospermum canasense*	Mudakathan	Sapindaceae	Not assessed
15	*Cardiospermum halicacabum*	Uzhinja	Sapindaceae	Least Concern
16	*Cissus quadrangularis*	Pirandai	Vitaceae	Not assessed
17	*Cucurbita moschata*	Poosani	Cucurbitaceae	Not assessed
18	*Ipomoea pes-tigridis*	Pulichuvatu	Convolvulaceae	Not assessed
19	*Ipomea staphylina*	Onan kodi	Convolvulaceae	Not assessed
20	*Cuscuta chinensis*	Manjapulluruvi	Convolvulaceae	Not assessed
21	*Cuscuta reflexa*	Akasavalli	Convolvulaceae	Not assessed
22	*Dioscorea oppositifolia*	Kavvala kodi	Dioscoreaceae	Not assessed
23	*Dioscorea pentaphylla*	Kaattuvalli	Dioscoreaceae	Not assessed
24	*Solena amplexicaulis*	Pulivanchi	Curcurbitaceae	Not assessed
25	*Tylophora indica*	Mekachettu	Asclipedaceae	Not assessed
26	*Waltheria americana*	Sengalipundu	Sterculiaceae	Not assessed
27	*Gloriosa superba*	Kanuvalikodi	Liliaceae	Least Concern
28	*Cayratia pedata*	Chorivalli	Vitaceae	Not assessed
29	*Centrosema pubescens*	Kattupayar	Fabaceae	Not assessed
30	*Pergularia daemia*	Vaeliparuththi	Asclepiadaceae	Least Concern
31	*Piper betle*	Vetrilai	Piperaceae	Not assessed
32	*Piper nigrum*	Kurumilagu	Piperaceae	Not assessed

S. No.	Scientific Name	Common Name	Family	IUCN Conservation Status
33	*Ziziphus oenoplia*	Cheruthudali	Rhamnaceae	Not assessed
Epiphytes				
1	*Loranthus flacata*	Ittikkanni	Loranthaceae	Not assessed
2	*Viscum album*	Pulluruvi	Santalaceae	Not assessed

The detailed study revealed dominance of *Cocos nucifera, Artocarpus heterophyllus, Azadirachta indica, Acacia nilotica, Acacia catechu, Bambusa vulgaris, Ficus religiosa, Prosopis juliflora, Melia azedarach*. Total 67 species of trees found in the study area along with 23 shrub species and 54 herb species. From the result, it is observed that the predominant species are *Cocos nucifera, Azadirachta indica, Acacia nilotica, Acacia catechu, Bambusa vulgaris, Ficus religiosa, Prosopis juliflora, Melia azedarach* among tree species and *Lantana camara, Datura metel, Argemone mexicana, Calotropis procera, Agave tomentosa* found to be the predominant species among shrub. Among the herbaceous species *Cynodon dactylon, Mimosa pudica, Chromolaena odorata, Sida acuta, Digera muricata etc* found to be abundant. The sitribution of floral community is shown in Figure 3-30.

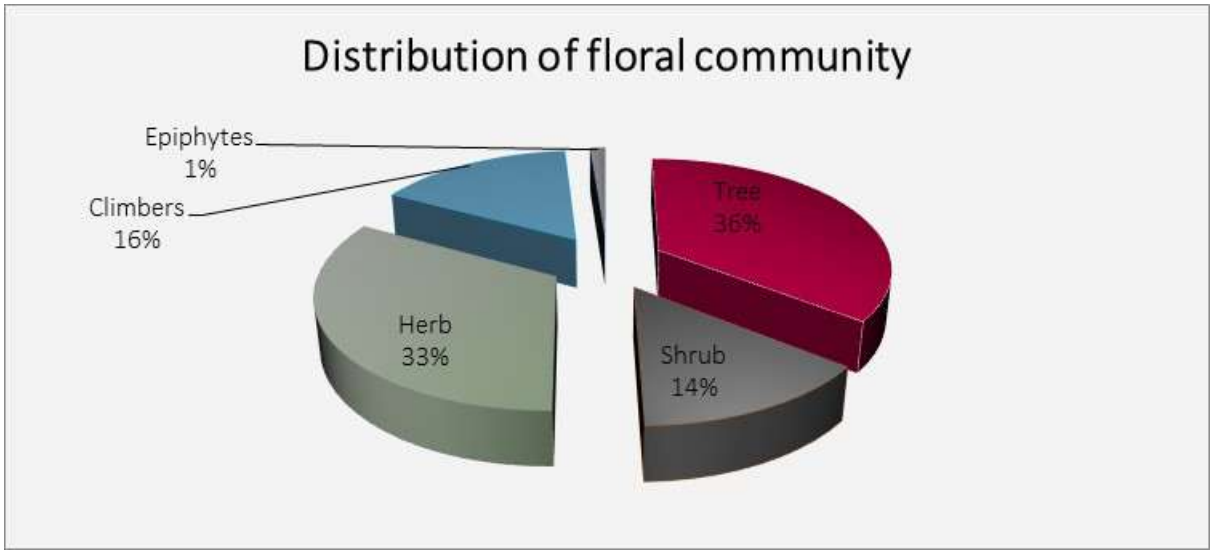


Figure 3-30 Distribution of Floral community

3.22.2.3 Economically important flora of the study area

Agricultural crops: Coconut palms, paddy, tapioca, pepper, pineapple and pulses. The coconut palm dominates the garden crops. Among the condiments and spices grow in the district the areca nut is the most important. A large variety of fruit trees are also grown by the local people.

Medicinal plant species: The nearby area is also endowed with the several medicinal plants which are commonly available in the shrub forest and waste lands. The common medicinal plants of the region are Azadirachta indica (Neem), etc.

Rare and endangered floral species: As per IUCN red list Borassus flabellifer categorized as endangered species. During the vegetation survey in the study area no other species found to be endangered or threatened under IUCN (International Union for Conservation of Nature and Natural resources) guidelines.

3.22.2.4 Faunal Communities

Both direct (sighting) and indirect (evidences) observations methods were used to survey the faunal species around the study area. Additionally reference of relevant literatures (published/ unpublished) and dialogues with local villagers were also carried

out to consolidate the presence of faunal distribution in the area (Smith 1933-43, Ali and Ripley 1983, Daniel 1983, Prater 1993, Murthy and Chandrasekhar 1988).

Mammals: No wild mammalian species was directly sighted during the field survey. Dialogue with local villagers around the study area confirms presence of some wild animal in that area. Palm–Squirrel, Spotted Deer, Wild Boar, Indian Grey Mongoose, Common Langur, Common Mouse, Small India Civet, Jackal, Indian Hare, Wild dog, etc were reported during primary survey.

Avifauna: Since birds are considered to be the indicators for monitoring and understanding human impacts on ecological systems (Lawton, 1996) attempt was made to gather quantitative data on the avifauna by walk through survey within the entire study area and surrounding areas. From the primary survey, a total of 78 species of avifauna were identified and recorded in the study area. The diversity of avifauna from this region was found to be quite high and encouraging.

The list of fauna species found in the study area is mentioned in Table 3-27. The Chameleon, Rat snakes, Snake-eyed lizard are also seen. Variety of butterflies (like Common crow, Southern birdwing, Common tiger, Plain Tiger, Common lime, Blue Mormon, Lime butterfly, South Indian blue oakleaf, Tamil yeoman, Glad-eye bushbrown) is spotted in abundance in the study zone.

Table 3-27 Fauna recorded from the primary survey in the study area and their conservation status

S. No.	Scientific Name	English Name	Schedule of Wildlife Protection Act	IUCN Conservation Status
Mammals				
1	*Funambulus pennantii*	Palm-Squirrel	--	Not assessed
2	*Canis aureus*	Jackal	Appendix III	Least Concern
3	*Axis axis*	Spotted Deer	II	Least Concern
4	*Sus scrofa*	Wild Boar	II	Least Concern
5	*Herpestes edwardsii*	Indian Grey Mongoose	Appendix III	Least Concern
6	*Presbytis entellus*	Common Langur	--	Not assessed
7	*Mus musculus*	Common Mouse	--	Not assessed
8	*Viverricula indica*	Small India civet	Appendix III	Least Concern
9	*Lepus nigricollis*	Indian Hare	II	Least Concern
10	*Rattus rattus*	Black rat	--	Not assessed
11	*Cuon alpinus*	Wild dog	Appendix II	Endangered
12	*Bandicota indica*	Rat	--	Least Concern
13	*Felis catus*	Cat	--	Not assessed
Birds				
1	*Acridotheres tristis*	Common myna	II	Least Concern
2	*Ardeola grayii*	Pond heron	II	Least Concern
3	*Artamus fuscus*	Ashy swallow shrike	II	Least Concern
4	*Athene brama*	Southern Spotted owlet	II	Least Concern
5	*Bubulcus ibis*	Cattle egret	II	Least Concern
6	*Centropus sinensis*	Crow pheasant	II	Least Concern

S. No.	Scientific Name	English Name	Schedule of Wildlife Protection Act	IUCN Conservation Status
7	*Ceryle rudis*	Pied Kingfisher	II	Least Concern
8	*Charadrius dubius*	Little ringed plover	II	Least Concern
9	*Charadrius leschenaultii*	Large sand plover	II	Least Concern
10	*Chlidonias hybrida*	Indian whiskered tern	II	Least Concern
11	*Acrocephalus dumetorum*	Blyth's reed warbler	II	Least Concern
12	*Alcedo atthis*	Small blue kingfisher	II	Least Concern
13	*Amaurornis phoenicurus*	White-breasted waterhen	II	Least Concern
14	*Anas poecilorhyncha*	Indian spot-billed duck	II	Least Concern
15	*Anastomus oscitans*	Asian open billed stork	II	Least Concern
16	*Anthus hodgsoni*	Tree pipit	II	Least Concern
17	*Apus apus*	Common swift	II	Least Concern
18	*Ardea alba*	Large egret	II	Least Concern
19	*Ardea cinerea*	Grey heron	II	Least Concern
20	*Ardea intermedia*	Intermediate egret	II	Least Concern
21	*Ardea purpurea*	Purple heron	II	Least Concern
22	*Columba livia*	Blue rock pigeon	--	Least Concern
23	*Cuculus canorus*	Cuckoo	II	Least Concern
24	*Cuculus micropterus*	Indian cuckoo	II	Least Concern
25	*Dendrocitta leucogastra*	Southern tree pie	II	Least Concern
26	*Elanus caeruleus*	Black-winged Kite	II	Least Concern
27	*Eudynamys scolopaceus*	Indian koel	II	Least Concern
28	*Ficedula albicilla*	Red-throated flycatcher	II	Least Concern
29	*Francolinus pondicerianus*	Grey Francolin	II	Least Concern
30	*Gallinula chloropus*	Common Moorhen	II	Least Concern
31	*Dicaeum agile*	Thick-billed flowerpecker	II	Least Concern
32	*Dicrurus adsimilis*	Fork-tailed drongo	II	Least Concern
33	*Coracias benghalensis*	South Indian roller	II	Least Concern
34	*Corvus macrorhynchos*	Indian jungle crow	II	Least Concern
35	*Corvus splendens*	House crow	--	Least Concern
36	*Dicrurus macrocercus*	Black drongo	II	Least Concern
37	*Dryocopus javensis*	Great black woodpecker	II	Least Concern
38	*Ducula aenea*	Green imperial pigeon	II	Least Concern

S. No.	Scientific Name	English Name	Schedule of Wildlife Protection Act	IUCN Conservation Status
39	*Egretta garzetta*	Little egret	II	Least Concern
40	*Egretta intermedia*	Intermediate egret	II	Least Concern
41	*Nectarinia minima*	Small sunbird	II	Least Concern
42	*Nectarinia zeylonica*	Indian Purple rumped sunbird	II	Least Concern
43	*Milvus migrans*	Common pariah kite	II	Least Concern
44	*Oriolus chinensis*	Black naped oriole	II	Least Concern
45	*Hirundo rustica*	Common eastern swallow	II	Least Concern
46	*Hydrophasianus chirurgus*	Pheasant-tailed Jacana	II	Least Concern
47	*Lanius cristatus*	Brown shrike	II	Least Concern
48	*Lanius schach*	Long-tailed Shrike	II	Least Concern
49	*Megalaima zeylanica*	Brown-headed barbet	II	Least Concern
50	*Merops orientalis*	Small green bee-eater	II	Least Concern
51	*Tringa ochropus*	Green sandpiper	II	Least Concern
52	*Gallus sonneratii*	Grey jungle fowl	Appendix II	Least Concern
53	*Monticola solitarius*	Blue rock thrush	II	Least Concern
54	*Nectarinia asiatica*	Purple sunbird	II	Least Concern
55	*Nectarinia lotenia*	Loten's sunbird	II	Least Concern
56	*Turdoides caudatus*	Common babbler	II	Least Concern
57	*Turdoides striatus*	Jungle Babbler	II	Least Concern
58	*Vanellus indicus*	Red-wattled lapwing	II	Least Concern
59	*Pycnonotus cafer*	Red-vented bulbul	II	Least Concern
60	*Saxicoloides fulicata*	Indian robin	II	Least Concern
61	*Nycticorax nycticorax*	Night heron	II	Least Concern
62	*Halcyon smyrnensis*	White-breasted kingfisher	II	Least Concern
63	*Streptopelia chinensis*	Spotted dove	II	Least Concern
64	*Surniculus lugubris*	Drongo Cuckoo	II	Least Concern
65	*Tachybaptus ruficollis*	Little grebe	II	Least Concern
66	*Oriolus oriolus*	Golden oriole	II	Least Concern
67	*Orthotomus sutorius*	Tailor bird	II	Least Concern
68	*Parus major*	Great Tit	II	Least Concern
69	*Pellorneum ruficeps*	Spotted babbler	II	Least Concern
70	*Perdicula asiatica*	Jungle bush quail	II	Least Concern
71	*Phalacrocorax niger*	Little cormorant	II	Least Concern
72	*Pitta brachyura*	Indian pitta	II	Least Concern
73	*Ploceus philippinus*	Baya weaver bird	II	Least Concern
74	*Pluvialis squatarola*	Grey plover	II	Least Concern
75	*Psittacula krameri*	Rose-ringed parakeet	II	Least Concern
76	*Tephrodornis pondicerianus*	Common wood shrike	II	Least Concern
77	*Tringa glareola*	Spotted sandpiper	II	Least Concern

S. No.	Scientific Name	English Name	Schedule of Wildlife Protection Act	IUCN Conservation Status
78	*Tringa hypoleucos*	Common sandpiper	II	Least Concern
Reptiles & Amphibians				
1	*Ahaetulla nasuta*	Green whip snake	--	Least Concern
2	*Boiga dightoni*	Pirmad Cat Snake	--	Not assessed
3	*Naja naja*	Cobra	Appendix II	Least Concern
4	*Bungarus caeruleus*	Common Krait	--	Not assessed
5	*Macropisthodon plumbicolor*	Green keel back	--	Not assessed
6	*Calotes rouxii*	Roux's forest lizard	--	Least Concern
7	*Calotes versicolor*	Common Garden Lizard	--	Least Concern
8	*Draco dussumieri*	Southern flying lizard	II	Least Concern
9	*Hemidactylus flaviviridis*	House Gecko	--	Not assessed
10	*Ophisops leschenaultii*	Snake-eyed lizard	--	Not assessed
11	*Duttaphrynus melanostictus*	Common toads	--	Least Concern
12	*Bufo melanostictus*	Toad	--	Least Concern
Butterflies				
1	*Euploea core*	Common crow	--	Least Concern
2	*Troides minos*	Southern birdwing	--	Least Concern
3	*Danaus genutia*	Common tiger	--	Not assessed
4	*Danaus chrysippus*	Plain Tiger	--	Not assessed
5	*Papilio demoleus*	Common lime	--	Not assessed
6	*Papilio polymnestor*	Blue Mormon	--	Least Concern
7	*Papilio demoleus*	Lime butterfly	--	Least Concern
8	*Kallima horsfieldii*	South Indian blue oakleaf	--	Not assessed
9	*Cirrochroa thais*	Tamil yeoman	--	Not assessed
10	*Mycalesis patnia*	Glad-eye bushbrown	--	Not assessed

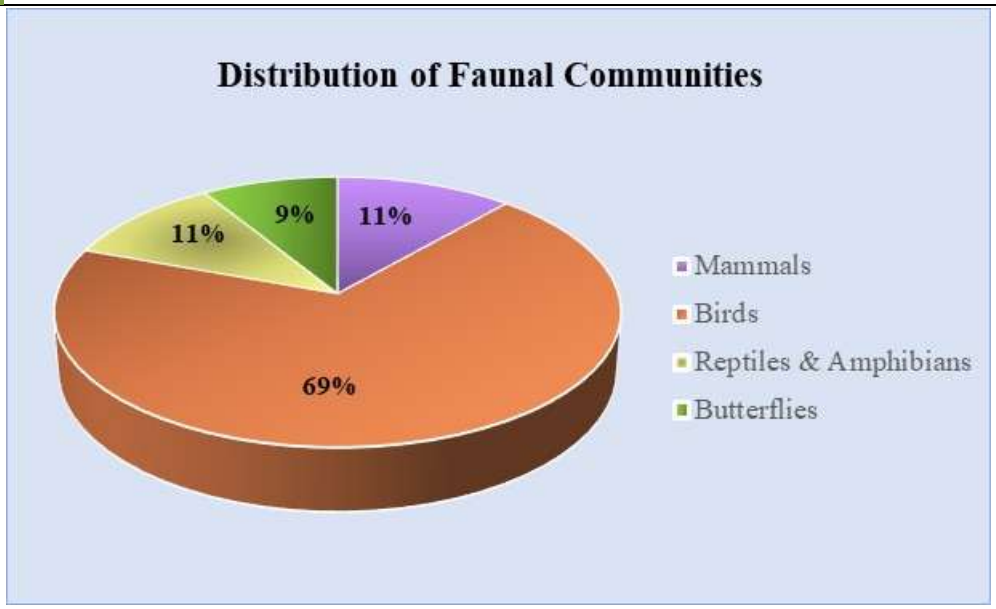


Figure 3-31 Distribution of Faunal Communities

Livestock like cattle, buffalo, goat, poultry, duck and pig are reared for dairy products, meat, egg and for agriculture purpose. Majority of cattle and buffalo are of local variety. Backyard poultry farms are mostly common in this area; however, some commercial poultry farms are also recorded in the study area.

The study area is marked with moderate population of flora and fauna. With reference to the Wildlife Protection Act 1972 (Last Updated 1-4-2023) total number of wildlife tabulated in this study can be characterized as given in the Table 3-28.

Table 3-28 Characterization of fauna in the study area

(As Per W.P Act, 1972; Last Updated 1-4-2023)

S. No.	Schedule of Wildlife Protection Act 1972	No. of species	Remark
1	Schedule I	0	-
2	Schedule II	79	-
3	Appendix I	0	-
4	Appendix II	3	-
5	Appendix III	2	-

The detailed interpretation of flora and fauna identified within 10 km radius of the project site are tabulated in Table 3-29.

Table 3-29 Description of Flora and Fauna

S. No.	Type of Species	Scientific Name	Common Name
Flora			
1	Endangered species	*Borassus flabellifer*	Karimpana
2	Threatened species	None	None
3	Near Threatened species	None	None
4	Vulnerable species	*Aglaia perviridis*	Cheruchokla
		Hybanthus enneaspermus	Voyal chullai
		Physalis minima	Karpooravalli
Fauna			
1	Endangered species	*Cuon alpinus*	Wild dog
2	Threatened species	None	None

S. No.	Type of Species	Scientific Name	Common Name
3	Near Threatened species	None	None
4	Vulnerable species	None	None
5	Migratory Corridors & Flight Paths	No corridors & flight paths	-
6	Breeding & Spawning grounds	None	-

A comprehensive Central Legislation namely Wild Life (Protection) Act was enforced in 1972 to provide protection to wild animals. Schedule-I of this act contains the list of rare and endangered species, which are completely protected throughout the country. The list of wild animals and their conservation status as per Wild Life Act (1972) (Last Updated 1-4-2023) are presented in Table 3-28 species recorded/reported from study area, out of which 79 species belongs to schedule II, 3 species belongs to Appendix II and 2 species belongs to Appendix III of Wildlife protection Act, 1972 (Last Updated 1-4-2023).

3.23 Marine Environmental

3.23.1 Sea bed and marine water quality

Sea Bed Sediment and Water samples were collected from 3 locations within 10 km radius of the project site and securely sealed for further analysis. The location of the sediment and water sample are collected from intertidal zone and the details are given in following Table 3-30.

Table 3-30 Marine Seabed and Water sampling location

Location Code	Geographical location		Distance from the project site (Km)	Water Depth
	Latitude	Longitude		
Marine Seabed Sediment				
MS 1	13°13'19.05"N	80°19'44.76"E	9.71	-
MS 2	13° 9'13.64"N	80°18'21.63"E	9.53	-
MS 3	13° 3'4.11"N	80°17'6.71"E	9.35	-
Marine Seawater				
MW 1	13°12'32.11"N	80°21'11.22"E	9.71	Surface
MW 2	13° 8'43.08"N	80°20'47.86"E	9.53	Surface
MW 3	13° 3'50.12"N	80°20'15.96"E	9.35	Surface

3.23.2 Observations – Seabed Sediments

The collected marine sediment samples were analyzed and results of sediment analysis are given in Table 3-29.

- pH: The pH value of all marine sediment samples ranges from 7.68 to 7.97.
- Texture: Texture silty clay for all the samples.
- Total Organic Carbon: Total Organic Carbon content in marine sediment samples ranges from 3.11 to 3.99 %.
- Phosphorus: Phosphorus content in marine sediment samples ranges from 216 to 309 mg/kg.
- Iron: Iron content in marine sediment samples ranges from 687 to 915 mg/kg.
- Zinc: Zinc content in marine sediment samples ranges from 80 to 119 mg/kg.
- Manganese: Manganese content in marine sediment samples ranges from 102 to 148 mg/kg.
- Lead: Lead content in marine sediment samples ranges from 7.14 to 10.7 mg/kg

- Chromium (Cr): Chromium content in marine sediment samples ranges from 16.6 to 23.7 mg/kg
- Copper (Cu): Copper content in marine sediment samples ranges from 29.6 to 32.8 mg/kg.

Cadmium, Nickel, Mercury, Selenium, Total Arsenic, Total Petroleum Hydrocarbon in all IT sediment samples were found Below Detection Limit (BDL).

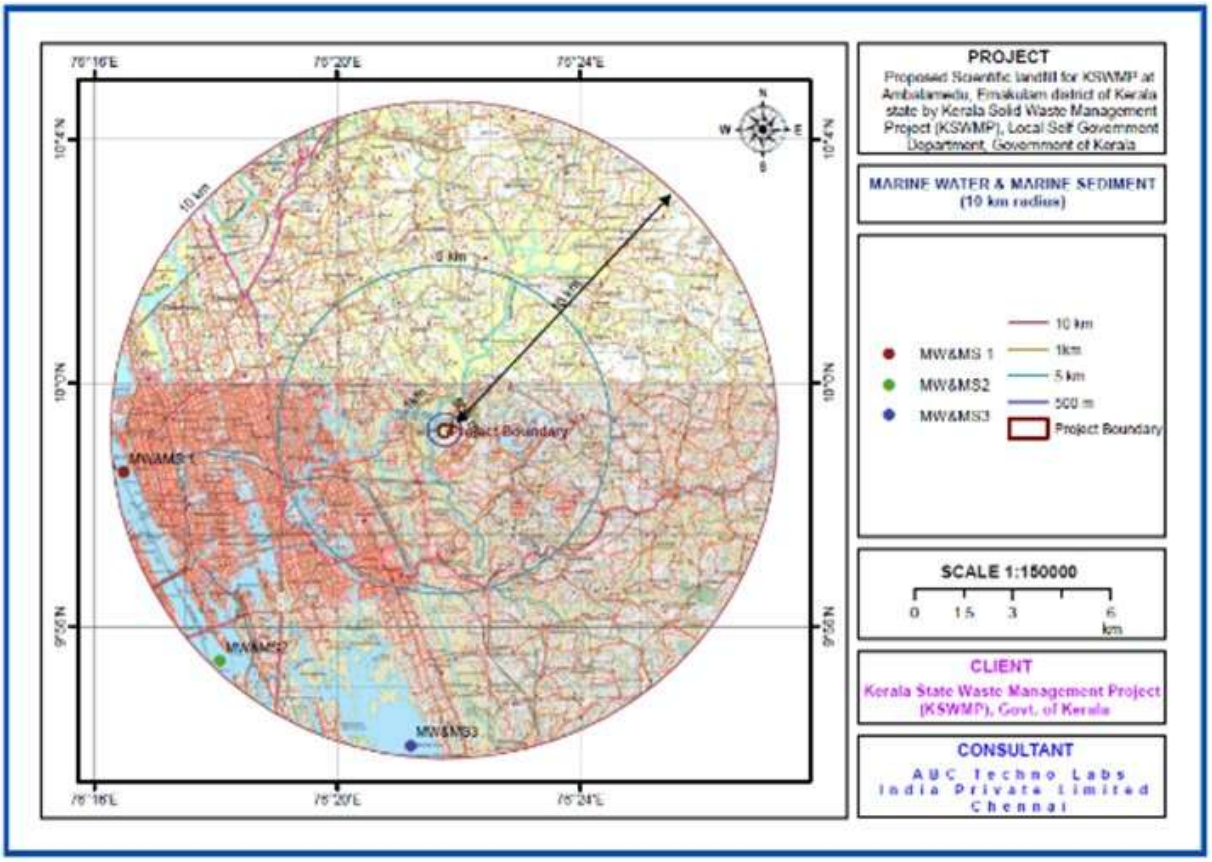


Figure 3-32 Marine sediment and water locations

3.23.2.1 Observations – Seawater

The collected marine water samples were analysed and results of marine water analysis are given in Table 3-31 & Table 3-32 respectively.

Physical Parameters`

- **Salinity:** Salinity in marine water samples ranges from 18.6 ppt to 26.9 ppt.
- **Turbidity:** The turbidity of marine water samples was found in the range 2.1 to 2.7 NTU.
- **pH:** The pH value of all marine water samples ranges from 7.63 to 7.97.
- **Total Suspended Solids:** TSS in marine water samples ranges from 3 to 4 mg/l.

Chemical Parameters

- **Nitrite:** Nitrite content in marine water samples ranges from 0.03 mg/l to 0.08 mg/l.
- **Nitrate:** Nitrate content in marine water samples ranges from 2.7 mg/l to 4.9 mg/l.
- **Phosphate:** Phosphate content in marine water samples ranges from 0.11 mg/l to 0.29 mg/l.
- **Iron:** The iron content in all marine water sample found to be BDL (<0.05) mg/l.
- **Zinc:** Zinc content in all marine water samples found to be 0.11 mg/l to 0.17 mg/l.
- **Dissolved Oxygen (DO):** The DO level of the marine samples found to be in the range between 6.4 mg/l to 6.8 mg/l.

- **Bio-chemical Oxygen Demand (BOD):** The BOD level of the marine samples found to be <2 mg/l.

Other Parameters

Manganese, Lead, Cadmium, Nickel, Chromium, Copper, Mercury, Selenium, Total Arsenic, Cyanide, Total Petroleum Hydrocarbon in all Marine water samples were found below detection limit.

3.23.2.2 Results

The results of the bed sediments are tabulated in Table 3-31.

Table 3-31 Marine Sediment Quality Results

Sl. No	Parameters	Unit	MS1	MS2	MS3
1	pH	-	7.97	7.68	7.94
2	Texture	%	Silty Clay	Silty Clay	Silty Clay
3	Total Organic Carbon as C	%	3.11	3.78	3.99
4	Phosphorous as P	mg/kg	266	216	309
5	Iron as Fe	mg/kg	915	687	748
6	Zinc as Zn	mg/kg	112	80	119
7	Manganese as Mn	mg/kg	132	102	148
8	Lead as Pb	mg/kg	10.7	8.66	7.14
9	Cadmium as Cd	mg/kg	BDL(<2)	BDL(<2)	BDL(<2)
10	Chromium as Cr	mg/kg	21.6	16.6	23.7
11	Nickel as Ni	mg/kg	BDL(<2)	BDL(<2)	BDL(<2)
12	Copper as Cu	mg/kg	32.8	41.1	29.6
13	Mercury as Hg	mg/kg	BDL(<1)	BDL(<1)	BDL(<1)
14	Selenium as Se	mg/kg	BDL(<2)	BDL(<2)	BDL(<2)
15	Total Arsenic as As	mg/kg	BDL(<2)	BDL(<2)	BDL(<2)
16	Total Petroleum Hydrocarbon	mg/kg	BDL (<0.05)	BDL (<0.05)	BDL (<0.05)

Table 3-32 Marine water quality results

S. No	Parameters	Unit	MW1	MW2	MW3
1	Temperature	°C	26.7	27.9	26.1
2	Salinity	ppt	26.9	22.7	18.6
3	pH	-	7.85	7.97	7.63
4	Total Suspended Solids	mg/l	4	4	3
5	Turbidity	NTU	2.7	2.4	2.1
6	Dissolve Oxygen	mg/l	6.8	6.4	6.5
7	Bio-Chemical Oxygen Demand	mg/l	<2	<2	<2
8	Nitrite as NO2	mg/l	0.05	0.03	0.08
9	Nitrate as NO3	mg/l	3.9	2.7	4.9
10	Phosphate as PO4	mg/l	0.11	0.21	0.29
11	Total Nitrogen as N	mg/l	5	8	9
12	Iron as Fe	mg/l	BDL (<0.05)	BDL(<0.05)	BDL(<0.05)
13	Zinc as Zn	mg/l	0.11	0.17	0.16
14	Manganese as Mn	mg/l	BDL(<0.02)	BDL(<0.02)	BDL(<0.02)
15	Lead as Pb	mg/l	BDL(<0.01)	BDL(<0.01)	BDL(<0.01)
16	Cadmium as Cd	mg/l	BDL(<0.01)	BDL(<0.01)	BDL(<0.01)
17	Nickel as Ni	mg/l	BDL (<0.02)	BDL (<0.02)	BDL (<0.02)
18	Chromium as Cr	mg/l	BDL(<0.03)	BDL(<0.03)	BDL(<0.03)
19	Copper as Cu	mg/l	BDL(<0.03)	BDL(<0.03)	BDL(<0.03)
20	Mercury as Hg	mg/l	BDL(<0.001)	BDL(<0.001)	BDL(<0.001)
21	Selenium as Se	mg/l	BDL(<0.01)	BDL(<0.01)	BDL(<0.01)
22	Total Arsenic as As	mg/l	BDL(<0.01)	BDL(<0.01)	BDL(<0.01)
23	Cyanide as CN	mg/l	BDL(<0.02)	BDL(<0.02)	BDL(<0.02)
24	Total Petroleum Hydrocarbon	mg/l	BDL(<0.001)	BDL(<0.001)	BDL(<0.001)

4 Anticipated Environmental Impacts and Mitigation Measures

4.1 General

The purpose of this chapter is to predict the potential environmental impacts that could result from construction and operation of the proposed Scientific Landfill at Ambalamedu. Both beneficial (positive) and potentially adverse (negative) impacts are considered in this analysis. The impacts due to off normal operations and environmental disaster scenarios are also considered and detailed in Chapter 07. In this chapter, various impacts during the construction and operation of the SLF and their mitigation measures envisaged along with the design have been discussed.

Impact prediction is a way of mapping the environmental consequences along the phases of activities of the proposed landfill site. The impact assessment will broadly cover the following information and components:

- Assessment of physical effects for all phases including location, design, construction, operation and possible accidents
- Prediction of impacts of the various facilities envisaged for scientific landfill site due to pollutants during construction and operation
- Estimation by type and quantity of expected contaminants and emissions (air, water, noise, solid wastes) resulting from the operation of the proposed SLF site.
- Assessment of any significant irreversible impacts.
- Impacts and mitigation measures during construction
- Impacts and mitigation measures during operation

The anticipated environmental impacts & mitigations of the proposed landfill site are discussed below under the following categories, the details regarding siting and design are already dealt in Chapter 2.

- Impacts and mitigation measures during construction
- Impacts and mitigation measures during operation
- Impacts and mitigation measures during Closure & Post Closure phase

4.2 Impact and Mitigation Measures during Construction Phase

This is the first phase of activity of the project and involves:

- KSEB line EHT shifting
- Site works for SLF consists of preconstruction activities like site clearing, labour camps, construction of access road, levelling and raising the ground level to above the flood level
- Construction of LFG collection system, Construction of the bottom liner system, leachate collection, LT pond and drainage system
- Construction of peripheral arrangements (dykes, internal roads, others not on raised ground & etc) offices workshop, Waste, waste water, sludge collection, storage, treatment, disposal arrangements etc.
- Green belt

As the project site admeasuring about 25 acres is allotted by KINFRA to KSWMP and the land is barren and it requires shifting of HT lines, levelling and laying of approach road. Site clearing activities like removal of bushes, transplantation and levelling are expected. Hence, the impacts on air, water, noise and soil within close proximity of the project site is expected. The direct and indirect impacts due to construction activities are discussed in the following sections.

4.2.1 KSEB line EHT shifting

As stated in Chapter 2 figure 2-30, KSEB EHT lines are crossing the proposed SLF site. It is planned to approach KSEB for shifting the lines away from the proposed SLF site.

Initially, KSEB will carry out the preliminary survey followed by Detailed profile survey, Tentative Tower Locations, Conduct Geotechnical Investigation. Based on the survey the detailed design report will be prepared and approval will be taken. The design consists of sag analysis, foundation of towers etc. and detailed cost estimate. On remitting the cost by KSWMP to KSEB and after obtaining WB clearance on ESIA the work will be started . The contractors engaged by KSEB will decommissioning the exiting line on completion of new line profile with tower erection. During construction it is expected that vegetation clearing & habitat loss, impact on marshy areas, soil & water contamination, air and noise pollution. In order to mitigate the above impacts suitable measures are to be adopted and they are as follows;

4.2.1.1 Vegetation Clearing and Habitat Loss

As the EHT Line is proposed to be shifted in the same vicinity and no additional impact to the baseline and no loss of bio diversity expected. Deforestation is not required in the shifting and realignment as there is no forest. Compensation for tree cutting shall be required to offset the ecological losses.

4.2.1.2 Impact on Marshy Areas

As the new alignment passes through marshy land the benthic organisms may get affected for a small area and generally they will recolonize again as the work is for shorter duration. There is no crossing of river or stream and hence no altering of natural flow and thereby no potential disruption to aquatic habitats and ecosystem. Excavation on compact soil and affect marshy land. Soil protection measures shall be developed for restoring of soil structure.

4.2.1.3 Soil and Water Contamination

Construction activities, including the use of heavy machinery and chemical treatments having spillage of fuels and lubricants are not expected at the site as its storage/repaired shop is planned at designated places near the working area. Berms or dikes around excavation areas shall be provided to prevent oil spills and run off carrying debris from spreading. The construction will be carried during non-monsoon season thereby runoff contamination from the construction site will be avoided.

4.2.1.4 Noise and Air Pollution

Storage or stocking of materials result only in localized dust emission effect. Noise reducing apparatus such as mufflers, silencers and acoustic screens shall be provided. Ambient air quality monitoring and noise monitoring shall be conducted during demolition and excavation works to conform the standards applicable to industrial area.

4.2.1.5 Electromagnetic Field (EMF) Concerns

Although scientifically inconclusive, prolonged exposure to EMFs generated by EHT lines is often perceived as a potential environmental issue, particularly for flora and fauna in the area. Whereas, the realignment is in the near vicinity of the existing line, there is no incremental potential EMF effect on flora and fauna in the area.

4.2.1.6 Healthy and safe work environment

All good construction practice and compliance with OSHA norms shall be ensured. OHS Policy will be developed and followed. The works and operations will follow National/International Good Practice Guidance including WB EHS in line with KSWMP ESMF, OHS measures are addressed in detail in Section 4.2.5.

4.2.1.7 C & D waste generation

C & D waste generated shall be utilized for reused for construction purpose of SLF.

4.2.1.8 E waste generation

Electronic waste are not expected as the work is related to EHT shifting. If any E waste like PCBs shall be collected and utilized as per the E waste management Rules 2022.

4.2.1.9 Recyclables recovery and its utilization

Recyclables such as plastic shall be collected and utilized as per Plastic waste management Rules 2022.

4.2.1.10 Impact on other industries in the area

No negative environmental impacts are expected for the nearby industries due to the activity of line shifting and realignment. Alternate arrangement for power supply shall be made by KSEB on consultation with the industries.

4.2.2 Site clearing and levelling

The site is presently occupied with patchy vegetation, which need to be removed in order to develop the proposed landfill. It is plan to transplant the existing tree to the proposed green belt around the site as explained in section 2.19.1.

As the site is mildly undulated, cutting and filling is expected for the project which will impact the environmental matrices like air, noise, soil and ecological environment of the site. The entire construction period (for both KSWMP & GoK phases) is expected to be prolonged for 28 months. Hence, it can be stated that the impacts if any, will be short term impact and the remedial measures likely to be taken at the time of construction are discussed in subsequent paragraphs. It is estimated that the land is to be filled by 3.65m height (refer Figure 2-14) to place the SLF above HFL which is measured about 1.65m, from the natural ground level of the SLF site with borrowed soil material from the identified mines or from the location identified for excavating the soil. The estimated quantity of filling material required for the project is about 7.0 Lakh m^3 plus 3 lakh m^3 for preloading. It is planned to be filled in a span of twelve months of time duration. The filling is planned to be carried out during the non-peak hours to avoid traffic congestion. The expected trips per day is about 100-105 nos. of trips.

The borrow material will be collected from the area identified for earth filling and should have proper EC for the proposed sand mining to meet the quantity of 7.0 lakh m^3 plus 3 lakh m^3 for preloading. KSWMP shall ensure the availability of EC before placing the order to contractor. The borrow material will be stage wise compacted using compactors thereby subsidence and displacement during construction are avoided. Labour camps are not planned for the site, the required no. of labour will be drawn from the nearby urban area and they will be staying from their own residence. The other construction raw materials are sand, cement, steel and aggregate requirements are approximately 283 tonnes, 65 tonnes, 1440 tonnes (coarse & fine aggregates) respectively. The material will be procured from nearest authorized agencies.

To minimize the impact, the filling activity will be carried out with all due care in order to avoid any discharge of soil or silt to nearby surface water bodies. The scientific landfill site will be prepared in such a way so as to avoid surface discharge of soil or silt (run off). Suitable surface drains along with settling tank are planned to be provided to avoid siltation. Moreover, it is planned to start the filling operation after monsoon which will help in reducing fugitive dust generation as well as siltation.

The internal access roads (7m wide) for the landfill site of about 1306m in length is also planned. In order to avoid fugitive dust generation and spillages from the trucks, the trucks will be covered by tarpaulins and by controlling the speed of vehicles along with

wetting of roads. The generation of fugitive dust during filling period is dealt in the impact of air quality section.

Form the borehole data of the core zone it is observed that the occurrence is encountered below 3.8m from ground level. The thickness of the soil burden is observed from 0-14m. in view of this it can concluded rock outcrops is observed and thereby rock blasting is not required. Hence further mitigation measures are not warranted.

The GAIL pipeline is passing through the site. The SLF facilities are planned minimum of 5m away from the pipeline. As per the GAIL guidelines 1.5m earth cushion is provided. Further the earth cushion will be given with 0.5m to prevent any damages to the pipeline[6].

4.2.3 Construction of LFG collection system, bottom liner system, leachate collection, LT pond and drainage system

During construction of LFG lines, the quality of materials such as HDPE geomembranes and pipes to ensure the LFG collection system is durable, leak-proof, and resistant to degradation over time. During installation, proper sealing of gas collection wells shall be ensured for vents, and pipes to prevent leaks. Integrity testing like pressure testing or vacuum testing of the pipes and liner system to verify that no gas can escape into the surrounding environment. Construction of vertical and horizontal gas collection pipes to efficiently collect and remove gas from the landfill are to be ensured. The pipes should be spaced correctly to cover the entire landfill area and designed to withstand the pressure of the landfill gas. The excavation activities shall be carefully managed to avoid disturbance of areas where gas migration could occur, and carefully manage excavation activities. the same practice will be followed for bottom liner, leachate collection system and LT pond.

4.2.4 Impact on physiography and drainage

Since, Ambalamedu Landfill is going to receive inert which will contain a very little amount of organic content, the chances of landfill gas generation are very low. As such it has been suggested to have a passive gas venting wells placed at every 2500 sqm intervals to remove the landfill gas. The details of passive vents are shown in Figure 2-28.

As described in Chapter - 3, under geology and hydrogeology, the landfill area falls under semipermeable zone. The study area is mainly governed by simple dendritic/trellis drainage system. The surface run-off water from the project site is naturally diverted into surface water drainage system which is already existing on towards Chithrapuzha river. The SLF is located near Chithrapuzha river and sloppy towards west area with height ranging from 23 in west to 37 in east AMSL and away from any potential flooding water bodies. Further, the SLF site is increased by 5.3m above HFL which is having sufficient safe ground level. Hence, flooding of the area is not anticipated.

The drainage density of project site is 0.6 km/sq.km and the top soil layer is unsaturated with low infiltration capacity of lateritic soil. From the drainage map Figure 3-11 it is concluded that ephemeral drains which are located around the site not affected. It is also evident from the drainage map that, chitrapuzha river is located nearer to the site and facilitate the drainage system.

The existing ground slope with respect to project site is towards west which facilitates the run-off into Chithrapuzha river and the overflow of rainwater harvesting pond will be diverted to natural drainage system. The storm water drainage system will have recharging pit and excess water will be allowed into the natural drain.

[6]Petroleum and Natural Gas Regulatory Board Notification dated 11.11.2020

It is proposed to construct surface storm water drainage network along the Toe of the SLF. The maximum intensity of the rainfall accounted to design the storm water drain is about 223 mm/hr. The minimum width 1200mm and height is 1100mm is considered for SLF site which is sufficient to mitigate the storm water runoff.

The outlet locations of the storm water channel were maintained inline with topographical ground slopes with silt traps. It is expected that the increase in built-up area leads to higher run-off. To mitigate that the storm water drains are planned in such a way to collect the surface run-off and diverted to rainwater harvesting pond/river. Rain water harvesting is also provided to contain the flow which is dealt in subsequent sections.

4.2.4.1 Seismic design

The proposed SLF civil constructions are designed inline with seismic requirement i.e. to meet the standards of moderate seismic zone. Hence, impact w.r.t seismic is not anticipated.

4.2.4.2 Estimation of change in peak flood discharges in pre and post construction scenarios for project site

To estimate the run-off in pre and post construction scenarios for the site a value of 0.4 and 0.9 run-off coefficients are considered respectively. The annual average rainfall of Kochi district for the past thirty years (IMD data) is computed to be 2,884 mm. Table 4.1 shows the estimated run-off volume for pre and post construction scenarios for project site. The annual average run-off volume increases from 1,16,493.76 m^3 to 1,76,347.58 m^3, showing an increase of 59,853.89 m^3 of run-off about 33.9% in post construction scenario of SLF.

Table 4-1 Estimated run-off volume for pre and post construction scenarios for project site

I Pre construction						
Sl. No	**Description**	**Run-off coefficient**	**Total area in m^2**			**Run-off volume (m^3/yr)**
I Pre-construction						
1	Total area	0.4	1,01,123			1,16,493.76
II Post construction						
Sl.No	**Area Type**	**Area in sqm**	**Normal Rainfall in m/hr**	**Runoff co-efficient**	**Total runoff available in m^3/annum**	**Runoff at hourly Rain Fall Intensity (50 Year frequency in India) of 50 mm/hour. 15 minutes of rainfall intensity is 12.5mm**
1	Roof Area	1860	2.88	0.9	4,821.12	20.93
2	Open area	99,263	2.88	0.6	1,71,526.46	744.47
	Total	101123			1,76,347.58	765.4

Pre-construction run-off considering the vacant site is estimated to be about 1,16,493.76m^3 / annum, whereas the post construction run off is estimated to be about 1,76,347.58m^3/annum. Excess runoff due to proposed construction of SLF site is estimated to be 59,853.89m^3/annum which is to be planned for rainwater harvesting and recharging.

From the above table, it can be concluded that there is an increase in surface run–off due to construction of scientific landfill. The increase runoff will be directed to rainwater storage pond, after sufficient storage, the excess runoff (i.e., post-construction stage quantity) will be diverted to natural drainage system which is having sufficient carrying

capacity. The harvested water will be used for SLF purposes like washing, wetting of grounds etc.

4.3 Erosion and sediment control

4.3.1 Impacts

The SLF project involves in land disturbance as the land is mildly undulated and disturbance is limited to 25 acres. Hence, soil erosion if any is limited to 25 acres of land. A minor amount of erosion may occur due to filling activities during twelve months of filling period. Soil removed by erosion may become airborne and create dust problem or be carried by water into natural waterways and pollute them.

4.3.2 Mitigation measures

The following mitigation measures will be adopted to minimise erosion:

- Areas to avoid and reduce erosion in two phases to minimize land disturbance during planning and design stage
- Area of filling is to be earmarked in advance by planning the work program
- Keep vehicles to well-defined parking area and construction material will be stored under covered area
- Construct the cleared areas immediately
- Construct silt traps at all possible drains and periodic removal of silt
- Construct temporary garland drain along the periphery of the area earmarked for filling to divert the run-off

4.4 Dust control

To ensure that there is no health risk or damage to amenity due to dust emission, many measures are adopted to reduce dust problems are the same as those taken to minimize erosion and sediment run-off. Additional measures are:

- Implementing a dust prevention strategy like wind curtains all around the site-developed at the project planning stage
- Implementing dust suppression measures, such as wetting of exposed areas twice a day
- Wheel washing will be one activity prior to departure from the construction site to reduce the mud and dirt.
- All haul trucks will be covered with tarpaulin sheets to prevent fugitive dust emissions during transportation of materials
- Construction works will be regulated during the high wind days.

4.5 Contaminated storm-water

4.5.1 Impacts

Soil/construction material eroded during construction can wash away and contaminate the storm-water emanating from the construction site. If contaminated storm-water enters into drainage line or storm-water drainage system, it will eventually discharge/seep into an adjacent waterway/groundwater aquifer and pollute the same.

4.5.2 Mitigation measures

The construction planning will be done in such a way earthwork filling for raising the sticky land will be done during non-monsoon season and all loose material will be removed on day-to-day basis. so that there are no chances of soil/silt flowing through with run-off and clogging the storm water system.

- Phase wise construction is planned in order to avoid the dust & fugitives

- During construction phase, strict administrative measures will be enforced to store all materials such as aggregate, sand, bricks in earmarked zones. Material like cement will be stored under covered sheds
- Minimize the generation of contaminated storm-water by restricting the construction site to the required limit for day-to-day basis
- Minimize the quantity of uncontaminated storm-water entering cleared areas
- Establish cut-off or intercept drains to redirect storm-water away from cleared areas and slopes to stable (vegetated) areas or effective treatment installations
- Reduce water velocities by providing mild slopes in the drains
- All the internal roads will have surface drain with the width of 1200mm and depth of 1100mm about 1306m length will be provided which will collected the surface water according to terrain height. The SLF area of drainage is considered into two parts i.e northern half and southern half
- The proposed Storm Water Drain (SWD) will have minimum required slopes to direct rainwater into nearby nala and river by gravity flow. The interception and diversion Hume pipes of 1.2m diameter is proposed at every 100m distance all around the perimeter towards north and north-west side of the SLF footprint area.

4.6 Influx of labours

The construction of any development activities is undertaken by segregating the total project into various independent packages. In the tender specification for various packages, the requirements related to environmental aspects and applicable mitigation measures to be adopted in the package are specified. The inspection/monitoring of the same are built-in within the quality assurance procedures/plans of the package. The supply of manpower for different packages, is contractor's/sub-contractor's responsibility including providing residential facilities for those personnel's being brought from outside. The contractor's labourer will be accommodated by the contractor in the surrounding villages. During construction of SLF site, labour camps are not envisaged inside the SLF site.

4.6.1 Impacts and mitigation measures

It has been envisaged that during construction phase maximum of 200 persons may be temporarily deployed. For prediction of impact of manpower influx, the peak construction phase has been considered. Out of the total 200 construction man-power, 10% will be engineers, supervisors, skilled & semiskilled manpower and 90% will be labours. The break-up of manpower during peak construction stage is given in Table 4-2.

Table 4-2 Break-up of manpower during peak construction stage

Sl. No.	Type of construction manpower	Number
1	Engineers, Supervisors, Skilled & Semi-skilled	180
2	Labors	20
	Total	**200**

4.7 Tree transplantation

The present patchy vegetation cover of the site is dominated by voluntarily grown trees including primary colonisers and thickets of wild growth constituted by shrubs, seedlings of trees and weeds. The proposed site for SLF at Ambalamedu will involve clearing of trees, both planted and naturally or voluntarily grown, and thickets of bushes from the entrance towards the SLF site. Enumeration of trees of 40 cm Girth at Breast Height (GBH) and above in the project site was carried out. Coconut and Areca are the majority among the tree species. Vegetation part coming under the proposed SLF area will be removed and transplanted. Nevertheless, the loss of trees will be compensated through eco-development in the form of planned greenery with maximum width of 10m within the SLF study area.

4.8 Greenbelt

The loss will be compensated in the form of proposed green belt to tune of about 13,155 sq.m around the SLF site. In addition to this, foot prints of proper SLF of about 70,000 sq. m will be covered by grass land at the final stage of closing of SLF.

4.9 Air Quality

4.9.1 Impacts

The air environment may be described in terms of parameters of ambient air quality such as concentration of Particulate Matter (PM_{10}) representing suspended particulates which are less than 10-micron size which easily get into our respiratory tracts. Further the Particulate Matter ($PM_{2.5}$) denotes that fraction of finer particulates which are deposited in our lungs and cause respiratory diseases and also affect metabolism.

During the construction phase, the major pollutant of concern will be particulate matter (PM_{10} and $PM_{2.5}$). The potential dust sources associated during construction phase will be as follows:

- Excavation activities, site clearing activities and site levelling/raising
- Operation of construction equipment's, machinery and vehicular movement
- Back filling of project development area by inert good-earth
- Unloading of construction materials
- Civil works at site
- Construction material handling
- Operation of diesel driven equipment and machinery
- Haulage of materials
- Dumping and stacking of construction material and debris cause generation of fugitive dust particulates over the proposed area and in the neighbourhood
- Movement of vehicles causes both emission of exhaust gases and also wheel laden fugitive dust particulates
- Wind erosion from stockpiled material
- Operation of DG sets

The fugitive particulate load generated daily depends upon the duration of construction activities which may be said to be temporary lasting for a few (twelve) months. After the completion of this phase all of the sources stated above will be ceased and there by generation of dust is avoided.

4.9.2 Mitigation Measures

- Water sprinkling will be done for dust suppression to all inactive disturbed surface areas on regular basis especially during dry and windy days
- Wheel washing will be one activity prior to departure from the construction site to reduce the mud and dirt. The wastewater will either reused after settling of silt or disposed for green belt
- The vehicle speeds on unpaved roads will be restricted to 15 – 20 kmph
- Limited vehicular movement will be permitted on disturbed soils
- Contractors will be required to maintain valid Pollution Under Control (PUC)certificates and Bharat IV compliance certified vehicles will be used at site and to retain proper maintenance records for their fleet
- All haul trucks will be covered with tarpaulin sheets to prevent fugitive dust emissions during transportation of filling materials
- Temporary chain link fence with fine shade cloth will be provided in area involving heavy dust generation
- Undertake periodic maintenance of construction equipment to minimize exhaust emissions

- Ensure machinery is turned off when not in use
- Proper housekeeping of the area to be maintained to remove dirt/debris from the site on daily basis
- DG set with dual burner will be envisaged to control the air pollution

B Gaseous Pollutants

4.9.3 Impact

The gaseous pollutants namely CO, and NOx and smoke released due to construction vehicular exhausts are noxious in nature. As said earlier, the construction phase is temporary and ceases after a few months. As such the load of gaseous pollutants generated will be for a short duration of time.

4.9.4 Mitigation Measures

The impact on air quality would be temporary and restricted to the construction phase. The impact is generally confined to the project area and is expected to be negligible outside the SLF site boundaries. The overall impact is assessed to be moderate, however with the implementation of mitigation measures the impact can be contained with minor residual impacts.

In order to estimate emissions associated with the construction mainly due to filling, following factors are considered.

- The peak daily number of material delivery trips associated with construction which increases the ground level concentration
- The total number of material delivery trips associated with construction of each project component

The types of vehicle likely to be deployed for construction is shown in Table 4-3.

Table 4-3 Types, number of equipment and vehicles expected during construction

Sl. No.	Type of vehicle	Numbers plying per day	Type of impact plying
1	Trucks	100	In the region
2	Cars/Jeeps	20	In the region
3	Air compressors	500 Cubic Foot per Minute (CFM)	Construction site only
4	Front end loader JCB	1	Construction site only
5	Tractor mounted water tanker & sprinkler for dust control	5000 litres capacity 2 numbers	Construction site only
6	Redimix/transit truck 6 m^3 capacity	1	Construction site only
7	Dozer	2	Construction site only
8	Excavator	1	Construction site only
9	Two wheeler	15	In the region

Dispersion Modelling

Prediction of impacts on air environment has been carried out by employing a mathematical model. In the present case, AERMOD view dispersion model has been used based on steady state Gaussian plume dispersion is used for predicting the ground level concentrations. The computation is dealt with Suspended Particulate Matter only as there is no change in generation of other pollutants. The options used for short-term computations are,

- The plume rise is estimated by Briggs formulae
- Buoyancy induced dispersion is used to describe the increasing plume dispersion during the ascension phase of the dust
- Calms processing routine is used by default
- Wind profile exponents are used by default, 'Irwin'
- Flat & elevated terrain is used for computations
- It is assumed that the pollutants do not undergo any physio-chemical transformations and that there is no pollutant removal by dry deposition;
- Washout by rain is not considered; and
- Cartesian co-ordinate system has been used for computations

The emission factors applied in the analysis were calculated based on the Upward Flux Method for estimation of fugitive emissions and based on the Bharat Stage-IV standards of vehicle at optimum operating conditions in Haul Roads of length 1km. For the modelling purposes, the Sulphur dioxide has not been considered since the vehicle's SOx emission is almost nil due to introduction of BS-IV norms for the oil companies. Estimated emissions from various vehicles used during construction are given in Table 4-4.

Table 4-4 Estimated emission from various vehicles used during construction

Sl. No.	Parameter	Emission rate (g/s)
1	Particulate Matter	1.302×10^{-5}
2	Oxides of Nitrogen	1.9×10^{-6}
3	Carbon monoxide	1×10^{-6}

The above parameters have been used in the AERMOD and isopleths are drawn for both construction and operation phase is shown in Figure 4-2,4-3 and 4-4 for PM, NOx and CO respectively. The wind rose for the study period is shown as Figure 4-1 to predict the direction of flow of pollutants.

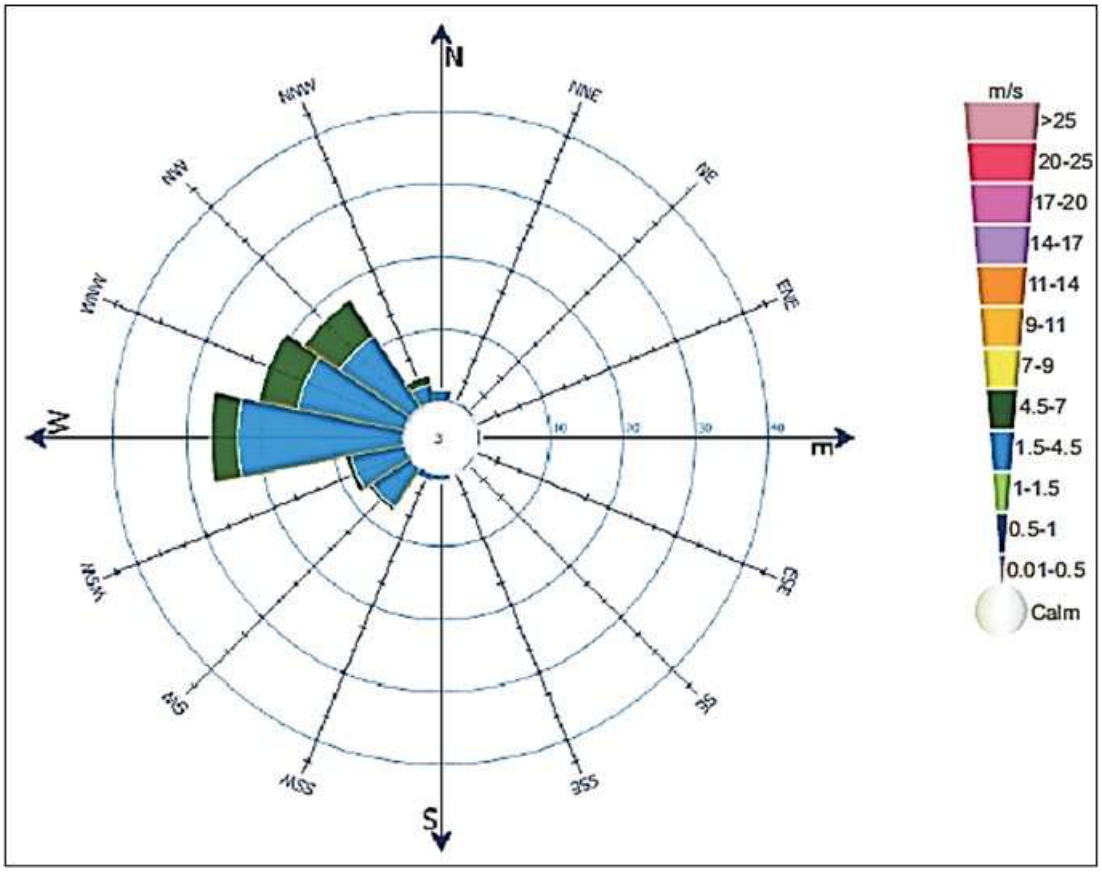


Figure 4-1 Annual Windrose for proposed area

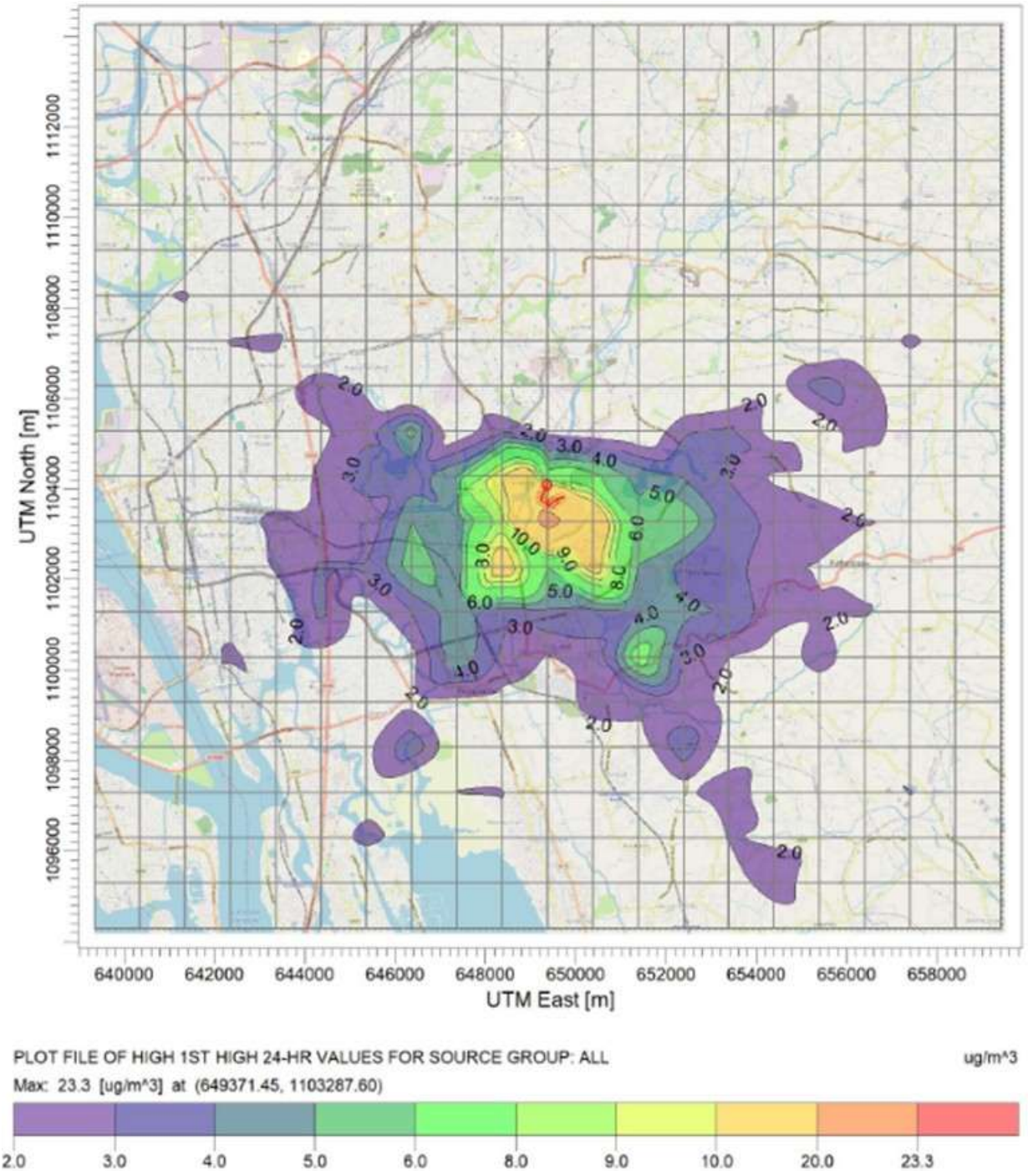


Figure 4-2 Predicted GLCs – PM – Construction Phase

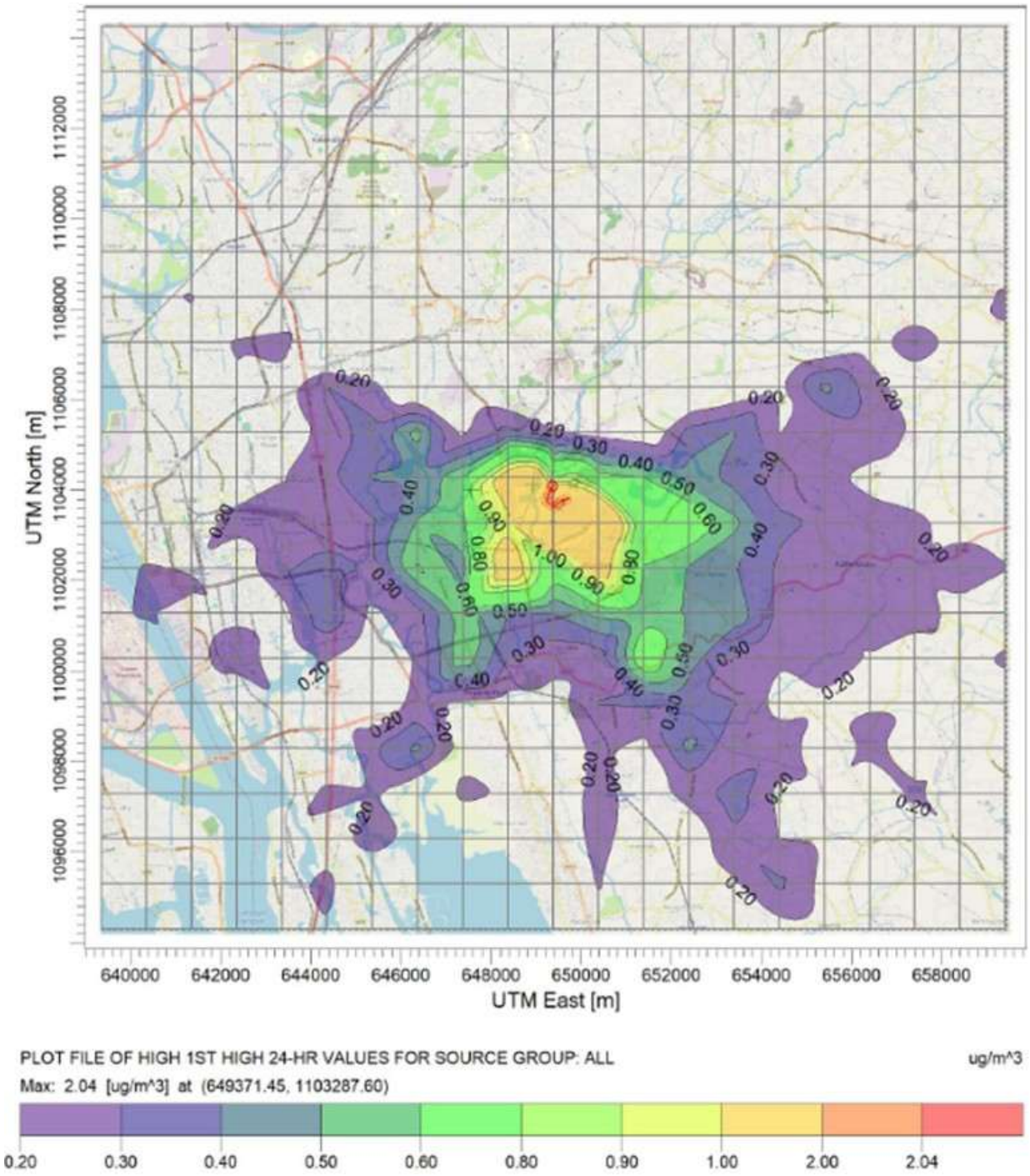


Figure 4-3 Predicted GLCs – NOx – Construction Phases

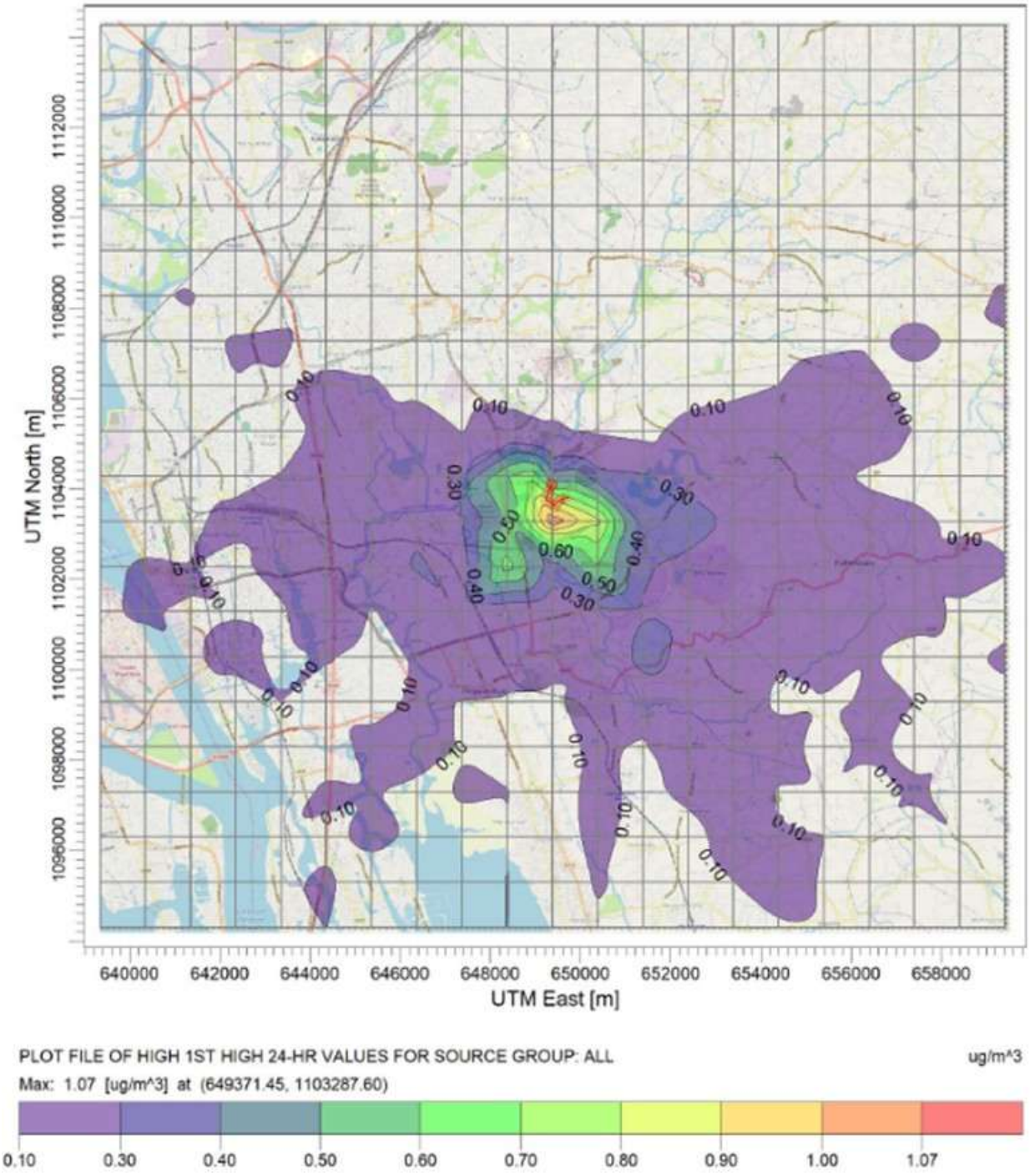


Figure 4-4 Predicted GLCs – CO – Construction Phases

From the above air quality modelling isopleths, it is evident that the GLC increases substantially more during the construction phase than in the operation phase. The reason may be due to the transportation of borrowed earth amounting to about 7.0 lakh m^3 plus 3 lakh m^3 for preloading from a multiple source of borrow soil for site levelling, construction of embankment & its associated activities. In our case, the transportation of material in haul road (unpaved approached road) was considered for a distance of 1km from the SLF site on the FACT Road. This can be reduced to some extent if paved road is considered. The maximum GLC observed during the construction phase corresponds to 23.3 µg/m^3, 2.04 µg/m^3, & 1.07 µg/m^3 for parameters PM, NOx & CO respectively. The incremental concentrations at the baseline monitoring locations are enumerated in the Table 4-5.

Table 4-5 Resultant concentration due to proposed activity during construction stage

Pollutant	Monitoring Station	Concentration (µg/m³)			
		Max. Baseline	Incremental	Resultant	Permissible Limit (µg/m³)
Particulate Matter	AAQ 1	48	13	61	100
	AAQ 2	51	8.03	59.03	
	AAQ 3	62	7.87	69.87	
	AAQ 4	51	2.92	53.92	
	AAQ 5	57	2.09	59.09	
	AAQ 6	64	1.41	65.41	
	AAQ 7	56	0.16	56.16	
	AAQ 8	58	0.26	58.26	
Oxides of Nitrogen	AAQ 1	14.7	1.37	16.07	80
	AAQ 2	17.2	0.85	18.05	
	AAQ 3	19.4	0.95	20.35	
	AAQ 4	16.7	0.28	16.98	
	AAQ 5	18.1	0.26	18.36	
	AAQ 6	22.9	0.21	23.11	
	AAQ 7	17.2	0.02	17.22	
	AAQ 8	19.4	0.03	19.43	
Carbon monoxide	AAQ 1	0.1	0.72	0.82	2
	AAQ 2	0.17	0.45	0.62	
	AAQ 3	0.28	0.5	0.78	
	AAQ 4	0.1	0.15	0.25	
	AAQ 5	0.26	0.14	0.4	
	AAQ 6	0.31	0.11	0.42	
	AAQ 7	0.27	0.01	0.28	
	AAQ 8	0.29	0.01	0.3	

Mitigation measures

The following mitigation measures are suggested:

- Proper and prior planning, sequencing and scheduling of all major construction activities will be done, and timely availability of infrastructure supports needed for construction will be ensured to shorten the construction period in turn to reduce pollution
- Construction materials will be stored in covered go-down or enclosed spaces to prevent the windblown fugitive emissions
- Wet suppression and wind speed reduction barriers will be used to control open dust sources at construction sites
- Stringent construction material handling/overhauling procedures will be followed.
- Truck carrying soil, sand, stone dust, and stone will be duly covered to avoid spilling and fugitive emissions
- Adequate dust suppression measures such as regular water sprinkling at vulnerable areas of construction sites will be undertaken to control fugitive dust during material handling and hauling activities in dry seasons
- The construction material delivering vehicles will be covered in order to reduce spillages
- It will be ensured that all construction equipment and vehicles are in good working condition, properly tuned and regularly maintained to keep emission within the permissible limits
- Safety equipment for the workers like dust mask will be provided

- All the vehicles will be certified for pollution control under check
- Periodic health checkup for the workers shall be done.




Monitoring of air quality at regular intervals will be conducted during construction phase inline with the requirements of SPCB

4.10 Surface water

4.10.1 Impacts

The impacts on surface water quality during construction phase mainly arise due to site clearing and ground level raising etc. A levelling and filling activities normally increase the level of suspended solids in the surface water run-off.

4.10.2 Mitigation measures

The mitigation measures are:

- Quality of construction wastewater generated from the construction site will be controlled through the drainage system with sediment traps (silting basin as water intercepting ditch) for arresting the silt/sediment load before its disposal
- All the washable construction material will be stored under sheds or enclosed space by fencing it with brick or earth in order to prevent spillage into the drainage network, so that the same does not find its way into the surface water run-off
- The sediment traps and storm water drainage network will be periodically cleaned and especially before monsoon season
- Majority of the water generated will be utilized for dust suppression and plantation within the site premises
- The sediments removed from the traps will be used for road shoulders
- The vehicle maintenance/washing area will be maintained with proper drainage system having oil trap mechanism to avoid contamination of surface and ground water by oil/lubricants
- Used oil will be disposed through the Authorized dealers
- Silt settlement tanks will be provided with suitable retention time

4.11 Ground water

4.11.1 Impacts

The ground water will not be extracted for construction work. The construction water is estimated about 35,000 litre which is sourced from private water tankers. Therefore, it is most unlikely that construction phase will bring any significant modification in the ground water regime of the area. Therefore, the construction phase of the proposed SLF site will have insignificant impact on the ground water.

4.11.2 Mitigation measures

As the construction mainly structure related work major impact on ground water regime is not anticipated.

4.12 Noise levels

4.12.1 Impact and Mitigation Measures

Major sources of noise during the construction phase are immovable machineries within the site, general construction activities and from movements of vehicles servicing the site. Noise on construction site results from machinery used for excavation, levelling and from fixed machineries such as compressors, concrete mixers and dumpers. The damage caused by noise is a function of type as well as loudness.

During construction, noise is generated from different sources. With increasing distance from the source, the noise level decreases due to wave divergence. Additional decrease also occurs due to atmospheric effects and interaction with objects in the transmission paths. Based on the above principle a noise model has been developed in house, which has been used to predict the noise. It is predicted that the noise levels in the surrounding environment due to above said noise sources at a distance of 100m will be 78.4 dB(A) and at 500m will be 69.7 dB(A). It is also predicted that the noise levels from these sources at 1500m distance will be 64.0 dB(A). Therefore, background noise levels in the nearest settlements which is located at a distance of about 500m will not be receiving the impact. The above prediction is for worst scenario case like during construction if all the construction equipment is working together which is not likely to occur. Further, the above prediction is without any attenuation factors like green belt, wind curtains etc. It is expected that mitigation measures it will be limited to ambient level.

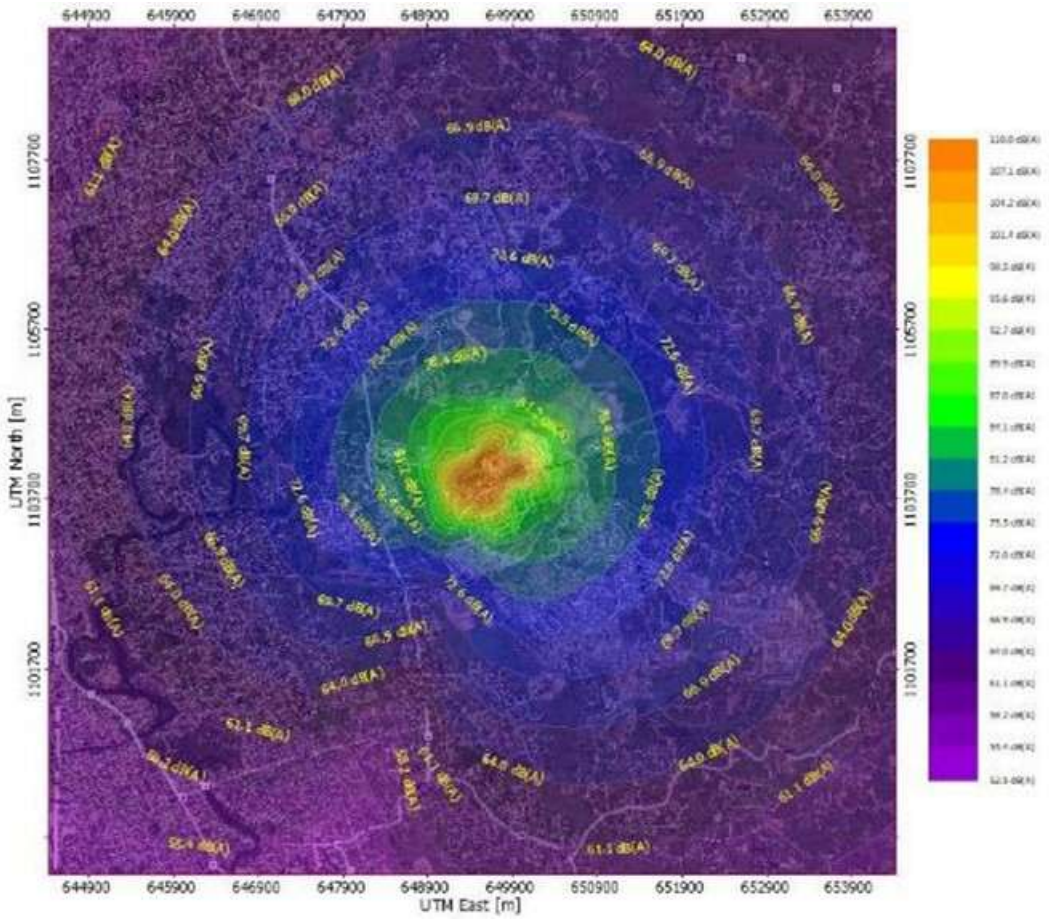


Figure 4-5 Noise level contours for the construction phase

4.13 Impacts and Mitigation Measures During Operation

The operational activities of the project are likely to have some stress on the environment as mentioned below

- Conventional pollutants generation from the SLF is not anticipated. A meagre amount of landfill gas is expected and will have gas vents
- Domestic effluent generation is very less as the operation phase manpower is only 85 nos.
- Inert material transport to SLF and layering/compacting will be causing some impact on air quality
- Leachate generation may cause ground water pollution
- Surface water contamination due to run-off from the SLF

The environmental parameters likely to be affected are quality of air, ground water, and soil/land due to release of pollutants from SLF.

4.13.1 Impact of conventional pollutant

4.13.1.1 Air environment

From the upcoming SLF, air pollutants like PM_{10}, $PM_{2.5}$, SOx and NO_X will not be generated during the operation period of 25 years as there is no process or point source of emission is involved. The expected air pollutants are methane and nonmethane hydrocarbons. These pollutants are expected to be released through passive gas vents provided at every 2,500 m^2 from the 300mm diameter gas collection layer provided below the SLF.

In Chapter 3, the existing air quality status has been reviewed. It was observed that the maximum of all C_{98} pollutant concentrations in the study area for PM_{10}, $PM_{2.5}$, SO_x and NOx are 58, 27, 5.4 and 19.4 µg/m^3 respectively. These concentrations are due to the emissions emitted into the atmosphere from the existing industrial activities in the area, road transport as well as due to urban activity in the study area.

Based on the above, the emissions have been anticipated due to the proposed SLF project as given in Table 4-6.

Table 4-6 Types, number of equipment and vehicles expected during operation phase

Sl. No.	Type of vehicle	Numbers plying per day	Type of impact plying
1	Trucks	4	In the region
2	Cars/Jeeps	25	In the region
3	Front end loader JCB	2	Construction site only
4	Tractor mounted water tanker & sprinkler for dust control	5000 litres capacity 1 numbers	Construction site only
5	Dozer	2	Construction site only
6	Two wheeler	50	In the region
7	Three wheeler	5	In the region

The dispersion modelling is done in a similar way to the operation phase also, emission factors applied in the analysis were calculated based on the Upward Flux Method for estimation of Fugitive Emissions and based on the Bharat Stage-IV standards of vehicle at optimum operating conditions in Haul Roads of length 1km. For the modelling purposes, the Sulphur dioxide has not been considered since the vehicle's SO2 emission is almost nil since the introduction of BS-IV. Estimated emissions from various vehicles used during construction are given in Table 3-7.

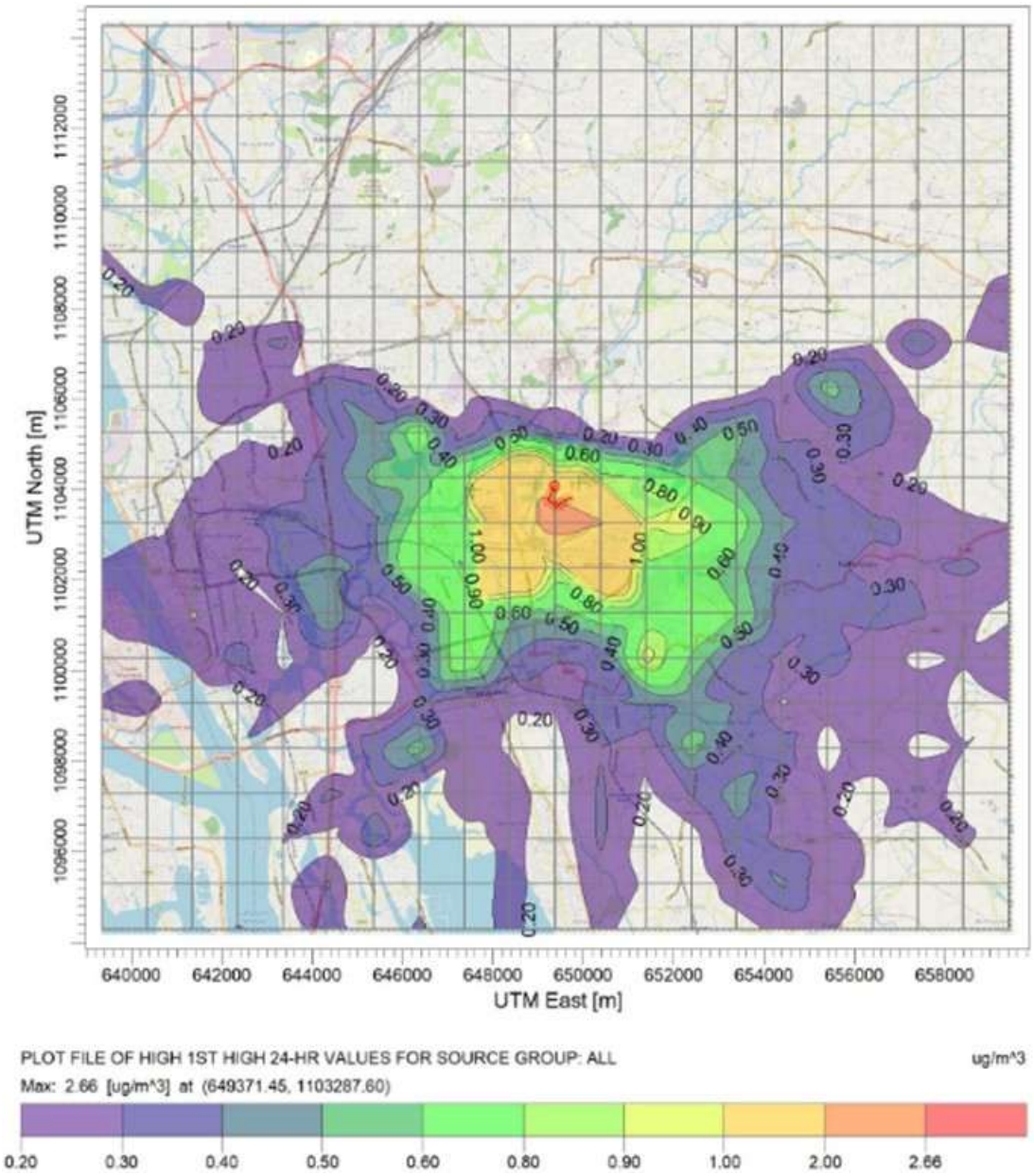


Figure 4-6 Predicted GLCs – PM – Operation Phases

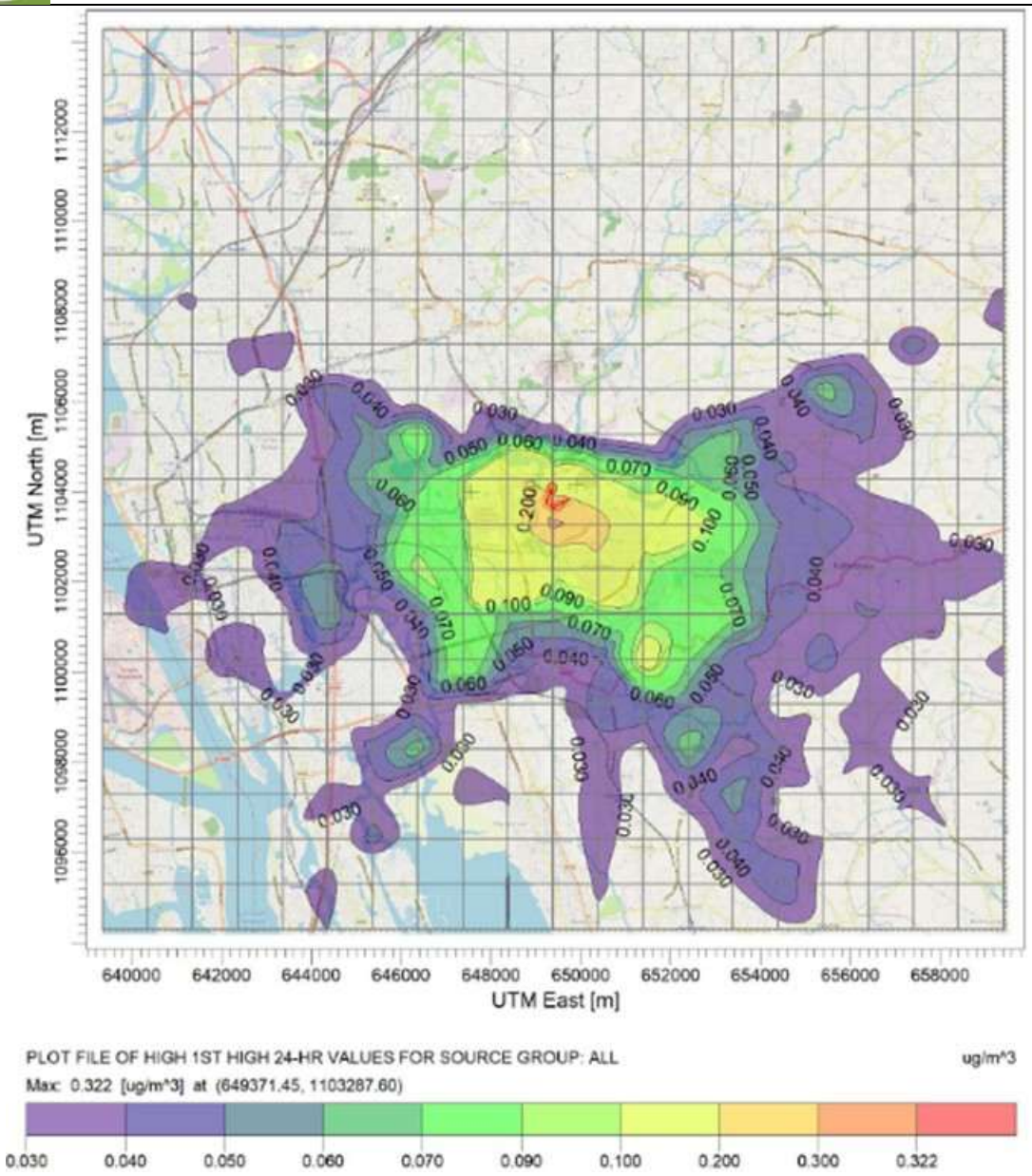


Figure 4-7 Predicted GLCs – NOx –Operation Phases

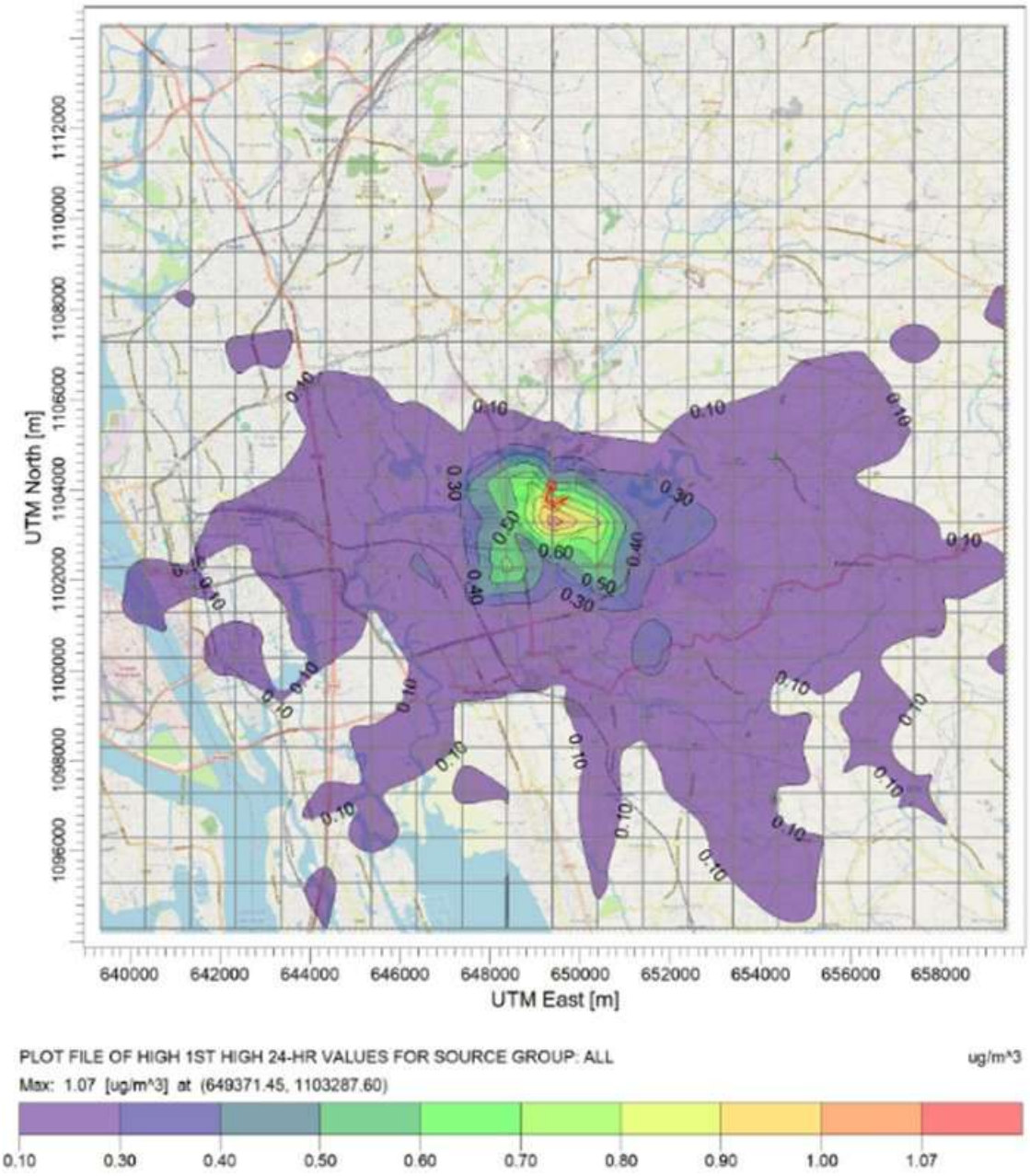


Figure 4-8 Predicted GLCs – CO –Operation Phases

Table 4-7 Estimated emission from various vehicles used during operation

Sl. No.	Parameter	Emission rate (g/s)
1	Particulate Matter	$2.48x10^{-6}$
2	Oxides of Nitrogen	$3x10^{-7}$
3	Carbon monoxide	$1x10^{-6}$

Air quality modelling isopleths has been shown in Figure 4-2, 4-3 & 4-4 for PM, CO & Nox respectively. From the result, it is evident that the GLC increases substantially more during the construction phase than in the operation phase due to reduced vehicle operations. In our case, the transportation in Haul Road was considered for 1km from the SLF site to the Fact Road. The maximum GLC observed during the operation phase for parameters PM, NOx & CO 2.66 µg/m^3, 0.322 µg/m^3, & 1.07 µg/m^3 respectively. The incremental concentrations at the baseline monitoring locations are enumerated in the Table 4-8.

Table 4-8 Resultant concentration due to proposed activities during operation stage

Pollutant	Monitoring Station	Concentration (µg/m^3)			Permissible Limit (µg/m^3)
		Baseline	Incremental	Resultant	
Particulate Matter	AAQ 1	48	1.79	49.79	100
	AAQ 2	51	1.11	52.11	
	AAQ 3	62	1.24	63.24	
	AAQ 4	51	0.36	51.36	
	AAQ 5	57	0.35	57.35	
	AAQ 6	64	0.28	64.28	
	AAQ 7	56	0.02	56.02	
	AAQ 8	58	0.03	58.03	
Oxides of Nitrogen	AAQ 1	14.7	0.22	14.92	80
	AAQ 2	17.2	0.13	17.33	
	AAQ 3	19.4	0.15	19.55	
	AAQ 4	16.7	0.04	16.74	
	AAQ 5	18.1	0.04	18.14	
	AAQ 6	22.9	0.03	22.93	
	AAQ 7	17.2	0	17.2	
	AAQ 8	19.4	0	19.4	
Carbon monoxide mg/m^3	AAQ 1	0.1	0.72	0.82	2
	AAQ 2	0.17	0.45	0.62	
	AAQ 3	0.28	0.5	0.78	
	AAQ 4	0.1	0.15	0.25	
	AAQ 5	0.26	0.14	0.4	
	AAQ 6	0.31	0.11	0.42	
	AAQ 7	0.27	0.01	0.28	
	AAQ 8	0.29	0.01	0.3	

4.14 Methane Calculation

For estimation of emission concentrations from SLF following methodology has been followed:

At solid waste disposal sites the degradable organic carbon in waste is decomposed by bacteria under anaerobic conditions into methane (CH_4) and other compounds[7].

[7] Source: IPCC guidelines

However, the proposed site is identified disposal of inerts which is segregated from municipal solid waste which may contain a small amount of organic carbon. The available organic carbon in the inert may pose the problem of generating methane at the inert disposal site. In order to collect the methane from the anaerobic degradation of organic material from the SLF horizontal and vertical vent pipes are planned

Both passive venting and gas collection under suction pressure are methods for handling the gas. There is very little organic content in rejects are going into the SLF, the chances of landfill gas generation are about very low. As such it has been planned to have a passive gas venting wells placed at every 2500 sqm intervals to evacuate the landfill gas. It is planned to quantify the methane emanated from SLF based on the available methods.

The IPCC guidelines enumerates two methods for estimation CH_4 emissions from solid waste disposal. The IPCC default method is a simple mass balance calculation which estimates the amount of CH_4 emitted from the landfill site assuming that all CH_4 is released the same year the waste is disposed off. The other method outlined in the IPCC guidelines is the First Order Decay (FOD) method. The FOD method takes the time factors of the degradation process into account, and gives annual emission estimates that reflect the degradation process, which can take years, even decades. The estimates on annual emissions produced by Mass Balance Calculation is considered as suitable for SLF as it gives result based on the mass balance which will reflect the worst-case scenario. This worst-case scenario is generally considered for predicting the environmental contributions.

The default method is based on the main equation 1

Methane Emissions (t/yr) = (MSW_T x MSW_F x MCF x DOC x DOC_F x F x 16/12-R x (1-OX)

Where,

MSW_T: total MSW generated (t/yr)
MSW_F: fraction of MSW disposed to solid waste disposal sites
MCF: methane correction factor (fraction)
DOC: degradable organic carbon (fraction) (kg C/ kg SW)
DOC_F: fraction DOC dissimilated
F: fraction of CH_4 in landfill gas (IPCC default is 0.5)
16/12: conversion of C to CH_4
R: recovered CH_4 (t/yr)
OX: oxidation factor (fraction – IPCC default is 0)
The method assumes that all the potential CH_4 emissions are released during the same year when the waste is disposed off. The method is simple and emission calculations require only input of a limited set of parameters, for which the IPCC Guidelines provide default values, where country-specific quantities and data are not available. The IPCC Guidelines introduce various specific default values and recommendations, (particularly for use in countries with lack of SW statistics):

MSW_T: A selection of national specific MSW generation (in kg/capita/day) figures are provided, but information appropriate for many low- and medium-income countries and regions is missing

MSW_F: A selection of national specific MSW disposal figures (in kg/capita/day) are provided (to be used instead of MSW_T)

MCF: Three default values ranging from 1.0 to 0.4 are included, depending on the site management and with 0.6 as general default value

DOC: A selection of national values for DOC in MSW are provided, although a more limited selection than for MSW_T and MSW_F. In addition, an equation is provided together with default values related to MSW fractions to estimate country specific figures based on national MSW composition.

DOC_F: Tabasaran's[1] (1981) theoretical equation $DOC_F = 0.014T + 0.28$, where T = temperature is used to determine the value.

F: 0.5 is the IPCC default value

OX: 0 is the IPCC default value
Parameters considered for SLF to substitutes in the Equation (1)
Total Inert waste generated (MSW_T) = Not considered as SLF quantity is known
Fraction of MSW disposed to solid waste disposal site = 50,005 t/yr (MSW_F)
Methane Correction factor = 0.6
Degradable organic carbon = 0.77
Fraction DOC dissimilated = 0.5
16/12 conversion of C to CH_4 = 1.3
Recovered R = 0
Oxidation factor OX = 0

Methane Emission (t/yr) @ of 137 TPD of inert = 50,005 x 1 x 0.31 x 0.77 x 0.5 x 1.3 x 1
= 7,758.52 ~ 7,759 t/yr

Methane Emission (t/yr) @ of 229 TPD of inert = 83,585 x 1 x 0.31 x 0.77 x 0.5 x 1.3 x 1
= 12,968.6 ~ 12,970 t/yr

Average methane generation tonnes per year = (7759 + 12970) / 2 = 10,364.5 t/yr

Average methane generation tonnes per sec = 0.000328 t/s

Average Methane generation gram per sec = 3.28 x10-11g/s

Average methane generation in terms m^3/s = 3.28 x 10-9 x 0.657 = 2.15 x 10^{-9}

Average H_2S generation is 30% of total methane = 2.15 x 10^{-9} x 0.30 = 0.645 x 10^{-9} m^3/s

As the generation is very meagre the SLF is safe and does not warrant for further analysis.

4.15 Carbon Footprint Analysis

Carbon footprint technique is an environmental indicator is being used to understand the climate change impact of individuals, communities, nations, or any specific activity. The carbon footprint for companies or organisations is to assess GHG emissions resulting from human activities, both directly or indirectly, such as the burning of fuel, electricity consumption and waste management, and transport, by showing the amount of GHG emissions in unit of Carbon dioxide equivalent (CO_2e). Carbon footprint estimation is helpful for the efficient management of GHG emissions and the evaluation of measures to reduce them.

4.15.1 Methodology

The methodology of the study includes the following steps,

- To fix the boundary for carbon footprint study.
- To analyse the sources which produce the GHG from the site.
- To collect the data from the sources of GHG emissions.

- To identify the suitable method for calculating the carbon footprint.
- To quantify the GHG emissions from each source.
- To account the plantations around in the site.
- To control and find the remediation for CO_2e emission.

4.15.2 Setting an Operational Boundary

In this study, a top-down methodological approach, Environmentally Extended Input-output (EEIO) modelling is used for the calculation of the Carbon Footprints (CF) for proposed SLF. The quantification is done based on Input - Output Analysis. While EEIO modelling works very well to provide a complete overview on the contributions of the total carbon footprint. Collate the data and the accuracy of the footprint relies on collating consumption data for all the emission sources within the established boundary.

Environmentally Extended Input – Output Analysis (EEIO)

EEIO modelling works effectively in providing good quality, timely estimates of reliable accuracy compared to a more detailed, time consuming, LCAs. While EEIO modelling works very well to provide a complete overview on the contributions of the total carbon footprint.

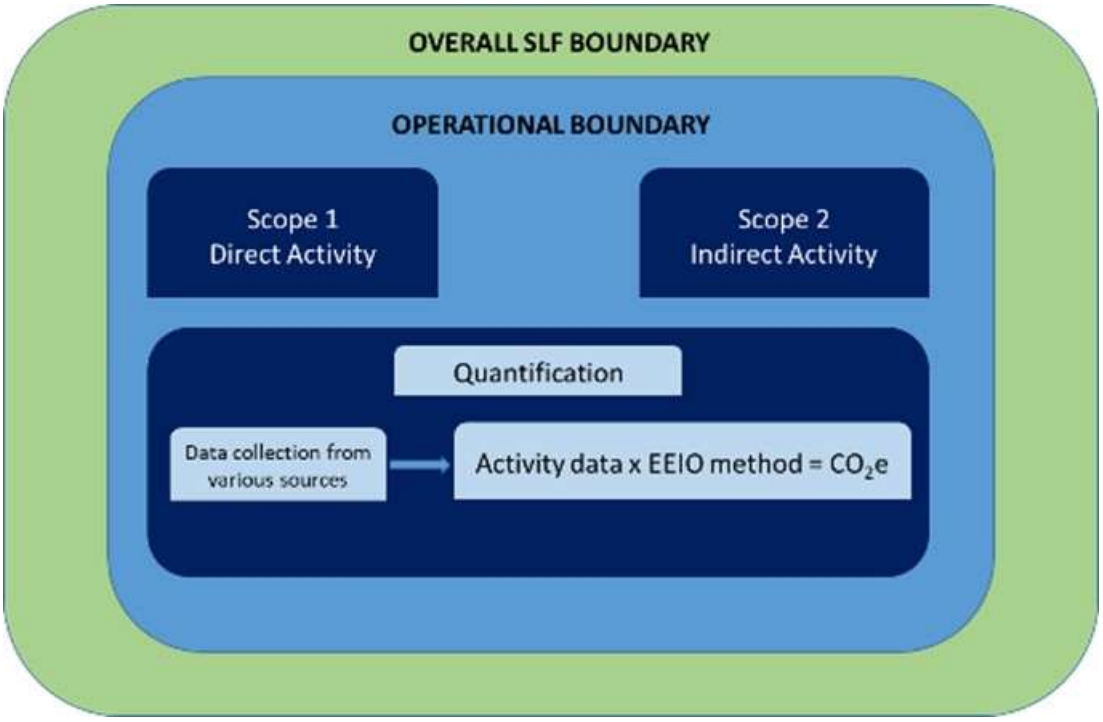


Figure 4-9 Assessment flow for CFP

4.15.3 Quantification of GHG Emissions

The quantification is done by standard method as per the assessment standard ISO 14064

i. Energy Consumption (EC)

As per the design consideration, the total power consumption for the proposed SLF will be 88.52 kWh. While calculating the CFP for energy consumption, it is considered for both original power grid and combination of original power & Renewable energy grid. Since, the emission factor (EF) varies both type of power sources, the quantity might also be varying. The below calculation shows both the scenarios.

EC (kg CO_2) = (kg/year) * EF

Scenario 1	EC	=	(kg/year) * EF
Operating Margin		=	294555 kWh/year * 0.97
		=	285718.35 kWh/year
		=	285.71 tCO_2e/year
Scenario 2	EC	=	(kg/year) * EF
Combination power		=	294555 kWh/year * 0.71
		=	209134.05 kWh/year
		=	209.134 tCO_2e/year

From the calculation, it can be inferred that power consumption by renewable energy sources reduces the carbon emission. The integration of natural energy sources can continue to provide sustainable electricity as well as leading towards zero carbon emission in the energy consumption sector. However, the energy consumption is an indirect activity comes under Scope 2 of CFP i.e. the emissions which are a consequence of SLF activity but are owned by another entity. Electricity consumption is the largest contribution of emission, and since it is purchased and was considered as an indirect source of emission the alternative measures can be taken to reduce the GHG.

ii. Fuel Consumption (FC)

The major fuel consumption is from (petrol & diesel) by vehicular movement. Since the proposed project is a SLF site, the continuous vehicular movement can be expected during construction and operation phase. The construction phase involves filling of borrowed soil through tippers and it is scheduled for 12 months. After completion of ground improvement, the operation phase takes place for 14 years. The RCVs carrying inert waste, personal vehicles of workers and officials (both 2 wheelers & 4 wheelers), DG set are included as major fuel consumption. The quantification is shown below.

During Construction phase Total – 125.35 tCO2e/year	**2 Wheelers (Petrol)**	FC	=	(kg/year) * EF
			=	15 * 2.27
			=	34.05 kgCO_2e/day
			=	12.42 tCO_2e/year
	4-Wheeler (Petrol)	FC	=	(kg/year) * EF
			=	20 * 2.27
			=	45.4 kgCO_2e/day
			=	16.571 tCO_2e/year
	4-Wheeler (Diesel)	FC	=	(kg/year) * EF
			=	100 * 2.64
			=	264 kgCO_2e/day
			=	96.36 tCO_2e/year

During Operation phase Total – 74.47 tCO2e/year	**2 Wheelers (Petrol)**	FC	=	(kg/year) * EF
			=	50 * 2.27
			=	113.5 $kgCO_2e$/day
			=	41.42 tCO_2e/year
	4-Wheeler (Petrol)	FC	=	(kg/year) * EF
			=	5 * 2.27
			=	11.35 $kgCO_2e$/day
			=	4.142 tCO_2e/year
	4-Wheeler (Diesel)	FC	=	(kg/year) * EF
			=	30 * 2.64
			=	79.2 $kgCO_2e$/day
			=	28.908 tCO_2e/year

From the above quantification, the total emission during construction phase will be ~ 125 tCO_2e/year. However, this emission will be restricted only during the construction phase but not during the operation phase. And the expected emission during operation phase will be ~75 tCO_2e/year. By initiating appropriate mitigation measures such as using BS VI vehicles, unleaded petrol / diesel, or CNG fuelled generators may help in reducing carbon emissions, as it falls under Scope 1 – Direct activity.

iii. Domestic wastewater

Wastewater generation from domestic and toilet flushing activities were quantified as per IPCC guidelines, 2006. The total manpower requirement is 85 during operation phase. The quantification is made accordingly. The wastewater generation will be

TOW = P x BOD x 0.001 x I x 365

P = 85, Population in a year

BOD = 34, Country specific per capita BOD in a year, g/person/day

0.001 = Conversion of g BOD to kg BOD

I = 0.06, Correction factor of BOD

Since the waste water is treated in Bio septic tank, there may be some external factors which influence the emission of GHG from the waste water before and after treatment/ for this reason the emission was quantified by the formula.

Total Organic Waste = 63.291 tCO_2e/year

iv. Solid waste Generation

Solid waste generated from parking, toilets, greenbelt area etc are collected everyday which contains garden waste, paper waste, napkins, food waste. The total population during operation is 85. Waste generation is 85*0.02 = 1.7 kg/d, 620.5 kg/year, 0.62 t/yr.

CH_4 emission	=	Total waste generated (t/yr) * Fraction landfilled * Fraction DOC in waste * Fraction dissimilated DOC * 0.5 g C as CH4 * theoretical ratio (16/12)

N_2O emission	=	(Mass of total Waste * Emission Factor) * 10^{-3}
CO_2 emission	=	Mass of total waste (t/yr) * Fraction of C content in waste * Fraction of fossil C in waste * EF * theoretical ratio (44/12)

From the above formula, the total emission from solid waste would be **0.673 tCO2e/year**. The solid waste generated from various sources as mentioned above will be collected and disposed off by Municipality/Corporation where the wastes are collected on a daily or alternative basis. Hence, the waste is also considered as Scope 2 – Indirect activity.

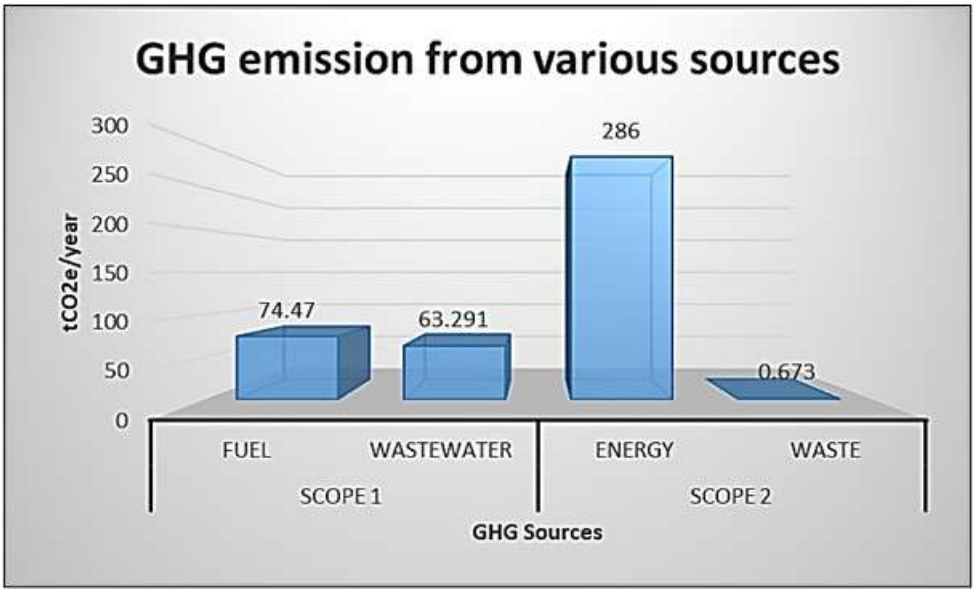
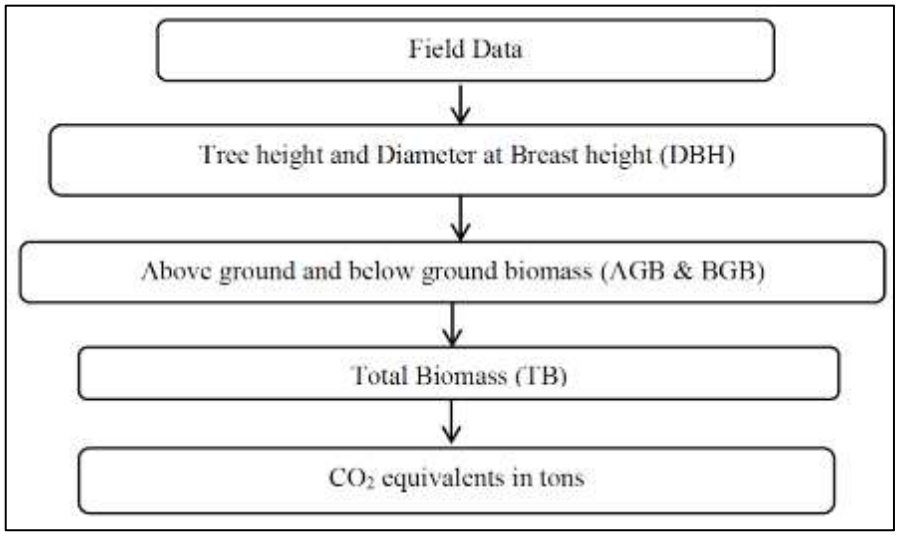


Figure 4-10 GHG emission comparison of Scope 1 & 2

4.15.4 Carbon Sequestration

The natural process involved in the carbon capture and long-term storage of atmospheric CO_2 or other forms of carbon to mitigate global warming by trees. To neutralize the GHG emission, greenbelt development is the great way to initiate. Trees can act as excellent carbon pools that capture and store atmospheric CO_2 through a natural process known as photosynthesis. The ability of trees to capture and store carbon varies from species to species and a healthy habitat of mixed species is likely to store a greater volume of carbon over the long term as it also promotes soil health and thus increases the amount of carbon stored in the soil as well. The carbon sequestration by trees is quantified can be observed by kgC/tree. From the total SLF land area, about 15% (15,175 sq.m.) of land is allocated for greenbelt development during operation which is for 14 years. A planting density of 2,500 trees per hectare is a standard spacing for broad leaved or dense leaved, where trees are typically spaced 2.5 meters apart. Accordingly, 3750 trees may be planted in the allotted greenbelt area during operation phase.



Source: *https://www.mdpi.com/2673-4931/3/1/52*

Figure 4-11 Methodology flow chart for quantification of carbon sequestration of trees

It is assumed to be planted about 3750 nos. of trees in and around the periphery of the project site. The quantification is also based on age of tree, breadth of leaves, canopy of tree etc. The primary data are collected as per flow chart shown in fig 4-6. The total carbon content can be estimated from any tree species are 50% of total biomass, i.e.

Carbon content = 0.5 x Total biomass

The CO_2 equivalent is then calculated using the below given equations

CO_2 (eq) = (Carbon content x 44) / 12

The bigger the tree, the greater the sequestration. The theoretical assumptions of total sequestration are made for different age of trees like 5, 10 & 15 years. The graphical representation is shown below.

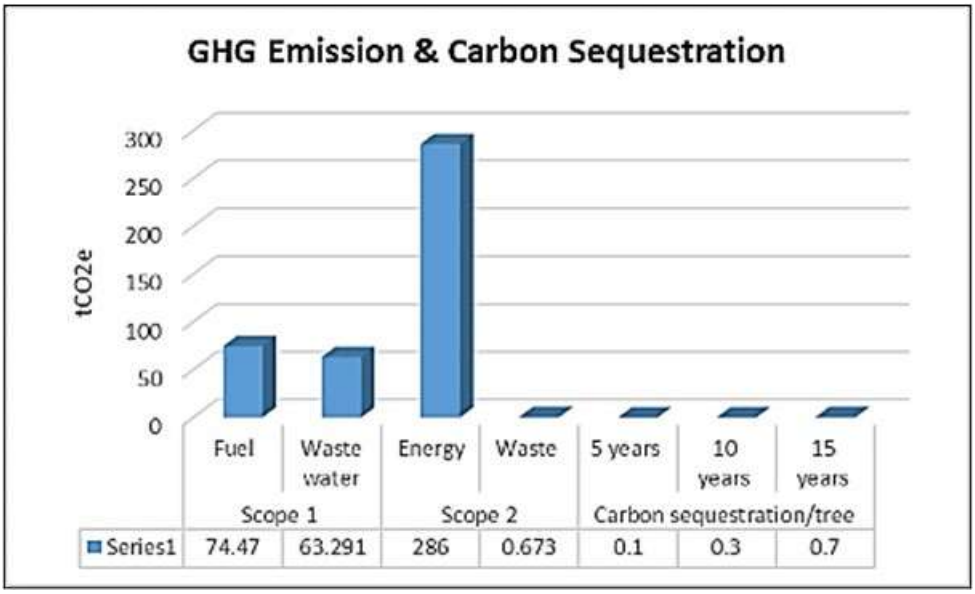


Figure 4-12 Graph comparison showing GHG emission & sequestration per tree

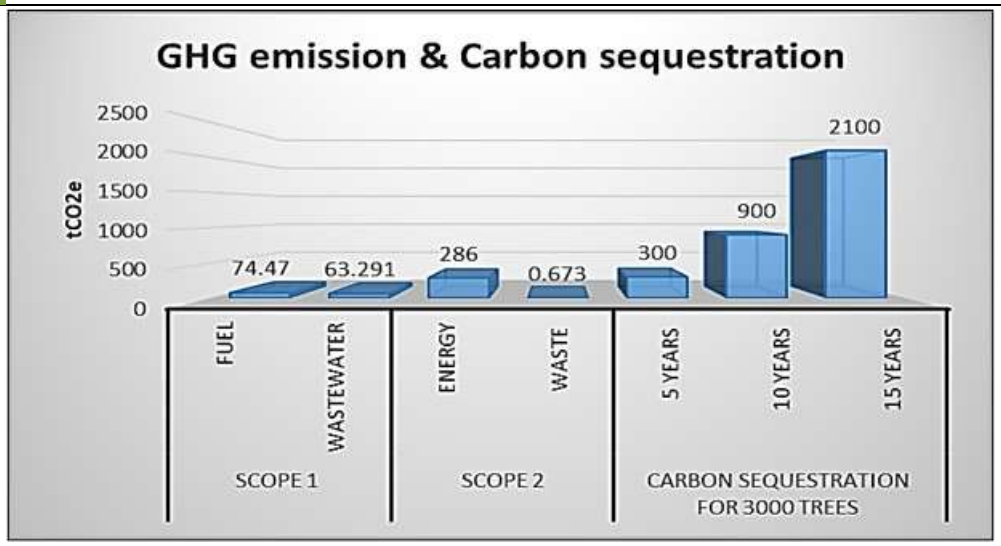


Figure 4-13 GHG emission & carbon sequestration for 3000 trees

The Figure 4-10 shows that the maximum emission from electricity consumption is about 286 tCO2e/year and the minimum emission from waste generation 0.67 tCO2e/year. To find the carbon neutrality in the study area the carbon sequestration quantification was done on theoretical basis. The graph makes it clear that 3000 trees' carbon absorption may offset the site's greenhouse gas emissions. Every year, the amount of carbon absorbed by the greenbelt that will be planted on the planned project site will increase. The graph additionally indicates the carbon absorption over the intervals of 5, 10, and 15 years.

Though, the electricity consumption is the largest contribution of emission, it is considered as indirect source of emission. The energy from renewable source can reflect in reduction in GHG emission as well as cost effective. Similarly, the solid waste generated are collected and disposed off by Municipal Corporation is also can be neglected. The used water are drained and pumped to the SLF owned LTP, there they are treated and recycled and pumped back for the gardening purpose. Therefore, the emission from waste water is also reduced. The second largest emission of GHG was from fuel consumption by vehicles, they can be neutralized by the available plantations around the campus and need mitigation measures.

From the study it can be concluded that, the proposed scientific landfill (SLF) for inert waste management in Ambalamedu at Kerala, covering an area of 25 acres with a life span of 14 years and 15 years of post-closure maintenance, demonstrates a sustainable approach to waste management. During its operational phase, the project achieves a net positive environmental impact, with carbon sequestration by 3,000 trees exceeding greenhouse gas (GHG) emissions.

4.16 Noise Environment

The proposed project related activities will lead to minimum generation of noise due to vehicular movement that may have minor impact on the surrounding communities in terms of minor increase in background noise levels. The potential impacts on noise level may arise out of the following:

4.16.1 Noise from Vehicle /Traffic

Vehicle movement for transportation of inert materials, dozer and compacter for consolidation at landfill site and work force to the site will cause minor noise generation as the frequency of vehicular movement a few times in a day. Initially, it is expected 4 trucks per day with 40 ton capacity each will be deployed to SLF site to dispose the inert waste collected from various waste collection stations. Similarly, 1 dozer will be

operating at SLF to compact the inert material. The operation of dozer at SLF site will be maximum of 2 hours in a day.

4.16.2 Noise from DG Set

Noise generated from DG sets will have a permanent effect to the workers working in the nearby vicinity of SLF.

4.16.2.1 Impacts

The machinery envisaged for SLF operation is a source of noise. Generally, this noise is generated due to continuous operation of vehicle movement, Dozer and DG sets. The noise levels likely to be generated by these sources are presented in Table 4-9 It is all likely that equipment manufacturers are to adhere the noise norms in design stage which may further reduce the noise levels. Most of the machines will be working intermittently during operation of the proposed facilities. However, these machines would be housed in acoustic enclosures in such a way that they would not be contributing any additional noise levels in the surrounding environment.

Table 4-9 Main sources of noise from different equipment & their noise levels

Sl. No.	Location of source/Equipment	Distance from noise source (m)	No. of Equipment's	Noise level in dB (A)
1	Trucks (compactor)	2	4	85
2	Dozer	2	2	100
3	DG Set	2	1	85
4	Landfill compactors	2	2	90
5	Water tanker (5KL capacity)	2	1	80
6	Tippers	2	2	80
7	Front end loader with back - hoe	2	2	80

During operation phase, noise is generated from the above sources only. Hence, with increasing distance from the source the noise level decreases due to wave divergence. Additional decrease also occurs due to atmospheric effects and interaction with objects in the transmission paths. In view of this, the propagation modelling considered for operation and the predicted noise level at source during operation is 100 dB(A).

The results of the noise modelling reveal that the maximum noise level will be 100 dB(A) at project site due to the SLF activity. The noise level at 100m, 500m and 1500m is predicted to the level of 75, 40 and 25 dB(A) respectively. The results are predicted without any attenuation factors. It is expected with attenuation factors as given in mitigation measures will reduce the noise level to the extent possible/within the permissible norms. The noise contours are shown in Figure 4-14.

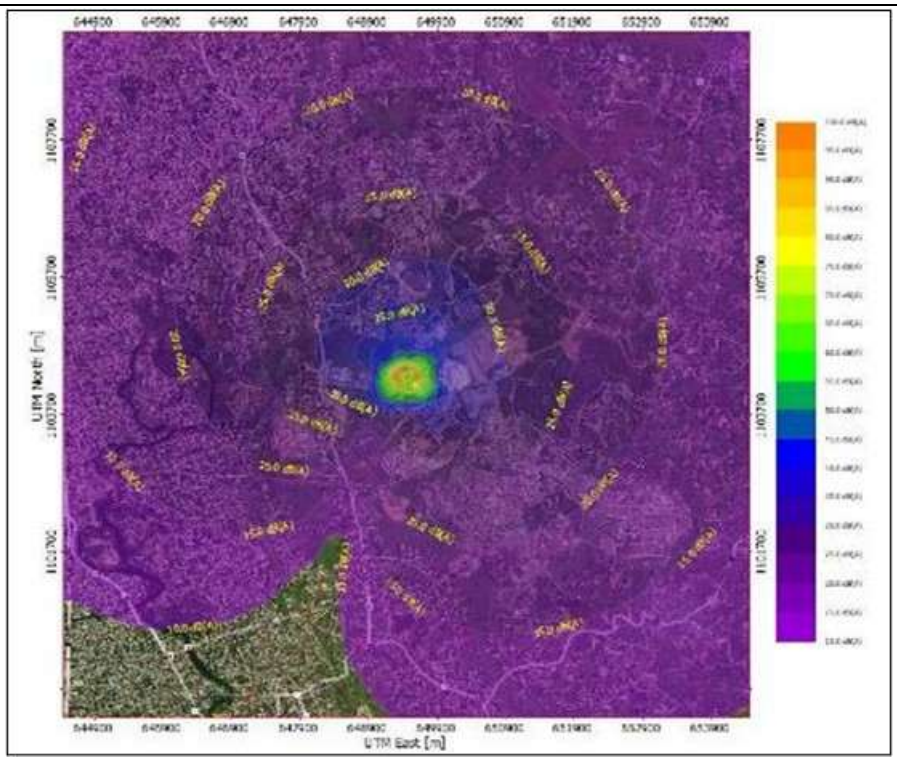


Figure 4-14 Noise contours

4.16.2.2 Mitigation measures

- The following mitigation in order to avoid any permanent noise source to the people working inside the SLF site
- Acoustic enclosures on dozer and DG set in the site is provided for noise attenuation
- Workers will be provided with suitable personal protective equipment (PPE) such as earmuffs, earplugs etc.,
- Green belt will be developed to reduce noise
- Vehicle trips to be minimized to the extent possible by maximizing the truck capacity
- Dozer and DG set will be maintained in good working order
- Implement good working practices to minimize noise and reduce its impacts on human health (earmuffs, safe distances, and enclosures)
- Noise to be monitored in ambient air within the SLF premises
- Limits for maximum permissible noise will be incorporated in the technical specifications for the machines (fans, motors & compressors)
- The silencers and mufflers of the individual machines would be checked regularly

4.17 Impact due to Traffic

4.17.1 Impact due to transportation of soil & inert waste

The project site is well connected with road, rail & airways. The project site is located along the bank of Chitrapuzha River with setbacks to meet the SLF criteria of 100m. The site can be accessed by SH 41 (3.5 km – N) & NH 85 (3 km – SSW) which is connecting the Cochin port and Cochin International Airport. The nearest railway station is Tripunittura located in the SSW direction at a distance of about 4 km. The Cochin International Airport in the NNE direction at a distance of 18 km, Naval Airstrip is at a distance of 10.10 km in the SWS direction. The nearest city is Ernakulam at a distance of 4 km to the west. The connectivity map of the project site covering 10 km radius is shown in Figure 2-4. The approach road will be developed during the construction phase of the site.

4.17.2 Existing traffic count

Traffic survey was carried out at the selected locations at NH - 85 & SH - 41 by manual vehicle counting method for different types of vehicles near propose site. The counting was done for 24 hours. The traffic survey monitoring was performed to predict the future traffic growth and the load on the approach road and surroundings due to the proposed project.

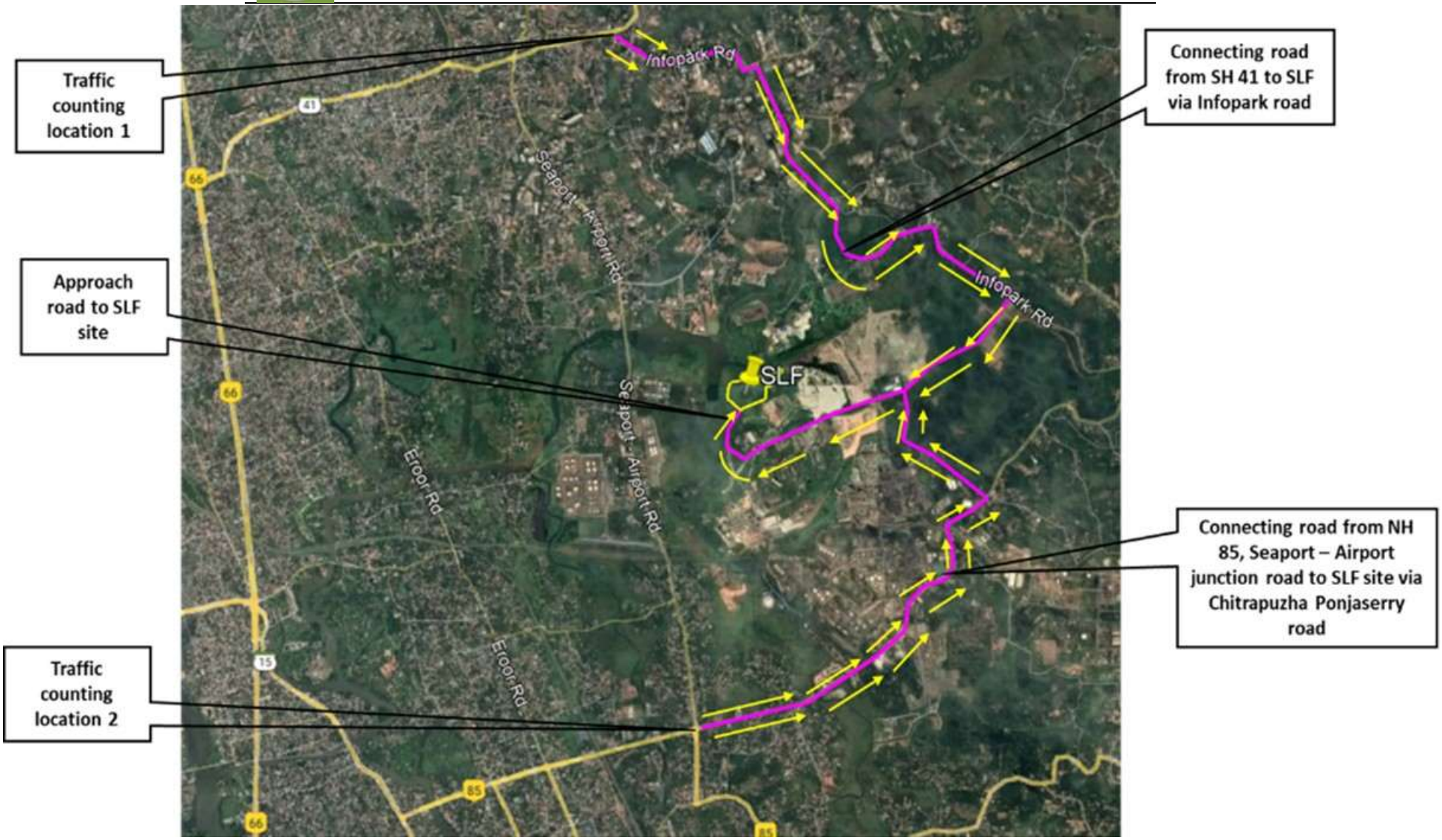


Figure 4-15 Image showing approach road connecting from National & State Highways

From the above image, it can be noted that the transportation of soil during construction phase (12 months) and inert waste during operation phase (14 years) carried from various sources are narrowed to two roads. One is from NH 85 – Seaport Airport road junction leads to Chitrapuzha Ponjaserry road with a distance of 5.55 km to proposed site, another is from SH 41 leads to Infopark road with the distance of 9.5 km. Both the roads are finally connecting to FACT road which leads to approach road towards SLF site.

4.17.3 Methodology

Passenger Car Units (PCU) count was carried out to determine the traffic demand and expected congestion near roads of proposed high rise development. Indian road congress (IRC) and National Highway Authority of India has laid down the PCU equivalent for different types of vehicles operating in urban areas. The recommended passenger car equivalent for urban areas is given in table below.

Table 4-10 Recommended PCU values for different types of vehicles in urban roads

Sl. No.	Vehicle Type	Passenger car unit (PCU) factor
1	Motor cycle/ scooter	0.5
2	Passenger car/van	1
3	Truck	3
4	Bus	3
5	Trailer	4.5

Based on the PCU equivalent the capacity and the volume of roads would be compared with IRC 106 guidelines. PCU units moving through the roads near the proposed site were estimated as:

PCU unit = No. of vehicles × PCE of that particular vehicles

4.17.4 Existing traffic scenario near project site

Measurements of traffic density were carried out continuously for 24 hours by visual observation and counting of vehicles under five categories, viz., Motor cycle/scooter, Passenger car/ van/ auto rickshaw, tractors, trucks, bus. Total numbers of vehicles per hour under the five categories were determined. The details of the traffic volume count have been provided in Table 4-11 and 4-12 for traffic count survey at SH-41 and NH-85 – Seaport Airport road junction respectively.

Table 4-11 Traffic count survey from SH 41

Sl. No.	Time	Type of Vehicle					Total Vehicles
		Motor cycle/ scooter	Passenger car/van	Truck	Bus	Trailer	
1.	6:01 to 7:00 am	14	12	4	4	0	34
2.	7:01 to 8:00 am	17	10	5	4	0	36
3.	8:01 to 9:00 am	32	15	6	5	0	58
4.	9:01 to 10:00 am	34	21	4	4	2	65
5.	10:01 to 11:00 am	38	22	5	5	2	72
6.	11:01 to 12:00 pm	42	18	6	5	3	74
7.	12:01 to 01:00 pm	45	19	4	4	2	74

Sl. No.	Time	Type of Vehicle					Total Vehicles
		Motor cycle/ scooter	Passenger car/van	Truck	Bus	Trailer	
8.	01:01 to 02:00 pm	52	20	5	5	4	86
9.	2:01 to 03.00 pm	49	30	6	9	4	98
10.	03:01 to 4:00 pm	26	18	5	7	1	55
11.	4:01 to 5:00 pm	32	18	4	5	2	57
12.	5:01 to 6:00 pm	30	19	5	8	2	57
13.	6:01 to 7:00 pm	39	20	4	6	2	71
14	7:01 to 8:00 pm	34	20	5	7	2	68
15	8:01 to 9:00 pm	34	20	5	7	2	68
16	9:01 to 10:00 pm	34	12	0	0	0	46
17	10:01 to 11:00 pm	19	0	0	0	0	19
18	11:01 to 12:00 pm	14	0	0	0	0	14
19	12:01 to 01:00 am	10	0	0	0	0	10
20	01:01 to 02:00 am	8	0	0	0	0	8
21	2:01 to 03.00 am	6	0	0	0	0	6
22	03:01 to 4:00 am	5	0	0	0	0	5
23	4:01 to 5:00 am	12	14	6	2	0	34
24	5:01 to 6:00 am	14	12	6	3	0	35
Grand total		**640**	**320**	**85**	**91**	**28**	**1164**

Table 4-12 Traffic count survey from NH 85 – Seaport Airport road junction

Sl. No.	Time	Type of Vehicle					Total Vehicles
		Motor cycle/ scooter	Passenger car/van	Truck	Bus	Trailer	
1.	6:01 to 7:00 am	18	16	9	5	3	51
2.	7:01 to 8:00 am	21	14	10	5	0	50
3.	8:01 to 9:00 am	36	19	11	7	0	73
4.	9:01 to 10:00 am	38	25	8	6	2	79
5.	10:01 to 11:00 am	42	26	9	8	2	87
6.	11:01 to 12:00 pm	46	22	11	5	3	87
7.	12:01 to 01:00 pm	49	23	8	4	2	86
8.	01:01 to 02:00 pm	56	24	9	6	4	99
9.	2:01 to 03.00 pm	53	34	11	9	4	111
10.	03:01 to 4:00 pm	30	22	10	7	1	70
11.	4:01 to 5:00 pm	36	23	9	5	2	75
12.	5:01 to 6:00 pm	34	24	11	8	2	79
13.	6:01 to 7:00 pm	43	24	7	6	2	82
14	7:01 to 8:00 pm	38	25	5	7	2	77
15	8:01 to 9:00 pm	38	22	6	5	2	73
16	9:01 to 10:00 pm	38	16	9	8	5	76
17	10:01 to 11:00 pm	23	4	7	6	2	42
18	11:01 to 12:00 pm	18	7	3	5	2	35
19	12:01 to 01:00 am	14	5	8	5	8	40
20	01:01 to 02:00 am	12	3	10	6	6	37
21	2:01 to 03.00 am	10	8	11	7	8	44
22	03:01 to 4:00 am	9	2	5	8	5	29

23	4:01 to 5:00 am	16	18	10	2	5	51
24	5:01 to 6:00 am	18	15	13	3	6	55
Grand total		**736**	**421**	**210**	**143**	**78**	**1588**

The table 4-13 gives the detail of PCU on SH – 41 and Level of Service capacity as per IRC: 64 – 1990 is given in Table 4-14. The existing traffic and LOS is shown in table 4-15. From the result it is evident that SH-41 LOS is excellent. Similarly, for NH-85, he Table 4-16, 4-17 gives the detail of PCU and LOS respectively.

Table 4-13 No. of vehicles w.r.t. PCU from SH 41

Sl. No.	Vehicle Type	No. of Vehicles/ day	Passenger car unit(PCU) factor	Total no. of Vehicles(PCU)/day
1.	Motor cycle/scooter	640	0.5	320
2.	Passenger car/van	320	1	320
3.	Truck	85	3	255
4.	Bus	91	3	273
5.	Trailer	28	4.5	126
	Total	**1164**	**12**	**1294**

Table 4-14 Level of Service capacity as per IRC: 64 – 1990

V/C	LOS (Level of Service)	Performance
0.0 – 0.2	A	Excellent
0.2 – 0.4	B	Very good
0.4 – 0.6	C	Good/Average/Fair
0.6 – 0.8	D	Poor
0.8 – 1.0	E	Very poor

Table 4-15 Existing Traffic & LOS

Name of Road	V (Volume in PCU/day)	C (Capacity in PCU/day)	Existing V/C	LOS
SH 41	1294	15,000	0.0862	A (Excellent)

Table 4-16 No. of vehicles w.r.t. PCU from NH 85 – Seaport Airport road junction

Sl. No.	Vehicle Type	No. of Vehicles/ day	Passenger car unit(PCU) factor	Total no. of Vehicles(PCU)/day
1.	Motor cycle/scooter	736	0.5	368
2.	Passenger car/van	421	1	421
3.	Truck	210	3	630
4.	Bus	143	3	429
5.	Trailer	78	4.5	351
	Total	**1588**	**12**	**2199**

Table 4-17 Existing Traffic Scenario & LOS

Name of Road	V (Volume in PCU/day)	C (Capacity in PCU/day)	Existing V/C	LOS
NH 85 – Seaport Airport road junction	2199	15,000	0.1466	A (Excellent)

From the current traffic scenario study, the LOS of both counting locations were found to be EXCELLENT. In order to predict the future traffic, the expected traffic in terms of number of vehicles produced below:

Table 4-18 Increase in traffic due to proposed project

Sl. No.	Name of material to be transported by road	Quantity of material required	Average carrying capacity	No. Of trips/day(filled)
Construction phase				
1.	6W / 8W Tippers (Soil)	7.0 lakh m^3 + 3 lakh m^3	30 T	52
Operation phase				
1.	RCV (Inert waste)	310 MTA	11 T	16

Increase in PCU/day (no. of trips x PCU factor) = 16 x 3 = 48 (during operation)

Increase in PCU/day (no. of trips x PCU factor) = 52 x 3 = 156 (during construction)

Table 4-19 Expected Traffic scenario and LOS after proposed project during operation

Name of Road	V (Volume in PCU/day)	C (Capacity in PCU/day)	Expected V/C ratio	LOS
SH 41	1294 + 24 = 1318	15,000	0.0878	A (Excellent)
NH 85 – Seaport Airport road junction	2199 + 24 = 2223	15,000	0.1482	

Table 4-20 Expected Traffic scenario and LOS after proposed project during construction

Name of Road	V (Volume in PCU/day)	C (Capacity in PCU/day)	Expected V/C ratio	LOS
SH 41	1294 + 78 = 1372	15,000	0.091	A (Excellent)
NH 85 – Seaport Airport road junction	2199 + 78 = 2277	15,000	0.1518	

The LOS value is “EXCELLENT” for both counting locations (L1 & L2); hence, the additional load on the carrying capacity of the concern roads is not likely to have any change in the LOS value. Thus, it can be concluded that the present road network is good enough to bear the increased traffic load.

The number of trips will be less after construction phase since the soil filling takes place only for 12 months. The traffic flow during construction period the PCU values are arrived and the details are shown in Table 4-20. Although we have the maximum number of trips for road adequacy study is accounted and there is LOS change is observed considered. The LOS value is still EXCELLENT for the SH 41 and NH 85 – Seaport Airport Road junction.

4.17.5 Anticipated Impacts

- Increase in traffic density will lead to air pollution
- Movement of vehicles will cause noise pollution
- No direct impact envisaged on the flora and fauna of the area
- Increased traffic may cause accidental incidences and public health problems

4.17.6 Mitigation measures

- Trolleys will be preferred as compared to trucks/tractors
- Vehicles with PUC Certificate will be hired
- Regular maintenance of vehicles will be done to ensure smooth running of vehicle
- Vehicles will be covered with a tarpaulin & not over loaded
- Vehicular emissions will be kept under control and regularly monitored
- Un-necessary use of horn shall be avoided
- Roads will be maintained in good condition to reduce noise due to traffic
- Greenbelt of appropriate quality & width will be maintained
- To avoid accidents the speed of vehicles will be low near habitation areas

4.18 Water Environment

The total water requirement during operation phase is estimated about 3 KLD which will be sourced from Kerala Water Authority (KWA). On Operation, the SLF wastewater generation from leachate is estimated to be about 300 KLD which will be treated in Leachate Treatment Plant (LTP) having capacity of 400 KLD. The entire treated water of 300 KLD planned to be used for industry which requires the water in the nearby areas as per the designated use of the treated water.

4.18.1 Impacts

The source of wastewater generation from the project is as follows:

- Leachate
- Surface run-off

Disposal of wastewater generated may also affect the surface water quality if they left untreated.

4.18.2 Mitigation Measures

The mitigation measures proposed to minimize the impact on the water environment due to the wastewater generation during the operation phase are detailed below,

It is proposed to lay the base clay layer of 0.9m thickness with clay layer of 0.3m thickness and Geo Clay Liner in order to reduce the dependence on good soil from borrow pit and reduce environment impact. After construction of the SLF, base subgrade of 300mm is made of compacted clay layer, the base liners such as Geo Clay Liner (GCL) (GCL 7 mm thickness with kf ≤5 x 10^{-9} cm per second (cm/s)) will be installed as

bottom lining above 300mm clay layer. Above GCL, HDPE Geomembrane of 1.5 mm thick will be installed, the geomembrane layer is employed to avoid leachate seepage. Above HDPE layer, the Geotextile of 800 GSM (GT-800 GSM) will be laid as per SWM Manual 2016 as the landfill height is more than 20 meters. It will act as protective layer for the HDPE Geomembrane and the GT-800 GSM act as a cushion which will prevent piercing of the HDPE Geomembrane liner due to drainage gravels. Above GT 800 GSM, a 300mm thick layer of gravel or aggregates (size 20–25mm) will be provided as leachate drainage media/layer so that any leachate produced from waste/rejects/inert will be collected in a leachate collecting system. To collect the leachate and drain it to a leachate pond, the header and lateral HDPE pipes will be placed in the leachate drainage media/layer. The Geotextile of 400 GSM (GT-400 GSM) is provided as filtration and separation layer above the leachate drainage media/layer. It prevents clogging of leachate drainage media/layer and perforated leachate pipe line. Further, a protective layer 200 mm of soil or soil bags is proposed to protect GT-400 GSM from rejects/ Inert and landfill vehicular movement. Leachate pond of sufficient capacity will be provided to store leachate, from which it will be removed for treatment in the Leachate Treatment Plant (LTP) which is having the capacity of 400 KLD is shown in Figure 2-22.

The properties and amount of the leachate determine the sort of treatment facilities to be adopted. The concentration of biodegradable and non-biodegradable organic material, certain hazardous elements, ammonia and nitrate ions, sulphides, odorous chemicals, and suspended solids may typically need to be reduced (before to release). The typical inlet and outlet parameters considered for leachate treatment are mentioned as per SWM Rules, 2016 is given in the Table 2-21 & 2-22.

4.18.2.1 Primary treatment

(i) Screening

The screening chamber is provided to arrest the floating materials from the leachate. The screen compartment is made of MS perforated material. The arrested material needs to be disposed off as per regulatory requirements. The bar screen chamber of 2.5 KL capacity is proposed for the project.

(ii) Equalization

The primary function of an equalization tank is to regulate and equalize the inflow of leachate, ensuring a consistent flow rate for downstream treatment processes. It also helps to achieve a more uniform composition, optimizing the efficiency of subsequent treatment steps. Additionally, the tank provides a buffer storage capacity to handle variations in leachate quantity and quality. Thus, shock loading in the treatment plant can be prevented. The equalization tanks of 400 KL capacity (2 tanks of 200 KL capacity) are proposed for the project.

(iii) Neutralization

The pH of leachate plays crucial role in the further treatment process. Hence, the equalized effluent needs to be neutralized further with acid/alkali in the neutralization tank. The 10 KL neutralization tank is proposed for the project.

(iv) Primary Flocculation

After neutralization the overflow goes to flash mixer followed by flocculator where coagulants and flocculants will be added. Flocculator is a mixer where we dose polymer to increase the size and weight of flocs. It consists of agitator to mix polymer with raw water. The 3.5 KL capacity of flash mixer and flocculator is proposed for the project.

After mixing the coagulants in the flocculator the flow goes to primary clariflocculator to remove suspended solids in the effluent. The clarified water will be collected in

intermittent collection tank and then fed to two stage anaerobic reactor. The 70 KL of primary clarifier and 70 KL of intermittent collection tank is proposed for the project.

4.18.2.2 Secondary treatment

(i) Anaerobic digester

The anaerobic digester's where BOD/COD reduction can be achieved by virtue of anaerobic microbial activities. The reactor is equipped with PVC corrugated media of specific block dimensions. These are provided as the inert support media for bio-film attachment and growth and completely covered. Two anaerobic reactors of 2750 KL capacity are proposed for the project.

(ii) Moving Bed Bio Reactor (MBBR)

The overflow from anaerobic reactors goes to two stage Moving Bed Bio Reactors (MBBR) where further BOD/COD reduction can be achieved by virtue of aerobic microbial activities. The reactor some portion filled up with small carrier elements. The bio film develops on the elements, which move along with leachate in the reactor. The movement within the reactor is generated by providing aeration with the help of air diffusers placed at the bottom of the reactor. The thin bio film on the elements enables the bacteria to act upon the biodegradable mater in the effluent and reduce the BOD/COD content. Two MBBR tanks of 900 KL capacity are proposed for the project.

(iii) Secondary Flocculator

The bio-solids formed in the biological process in MBBR will be separated in the downstream secondary clarifier and reactive clarifier of proposed capacity of 70 KL tank.

(iv) Sludge Handling

The sludge generated in the reactors and settled in the primary, secondary clarifier and reactive clarifier will be pumped sludge thickener. The thickened sludge will be collected in sludge collection tanks, and further to screw press for de-watering, and drying.and finally sent to the nearest TSDF's as per hazardous Rules.The flow of screw press for feed pump (2 nos.) and dewatering sludge (1 no.) of capacity 6 cum/hr is proposed for the project. The expected quantity of sludge is about 6 kg/hr will be disposed in the drying bed provided along with LTP. The size of drying bed is 4m x 5m. The Sludge will be tested for Hazardous material by conducting (Toxicity Characteristic Leaching Procedure) TCLP test accordingly it will be disposed.

4.18.2.3 Tertiary Treatment

(i) Chlorination

Chlorine is powerful oxidizing agent and widely used for functions such as, disinfecting water, colour reduction, for microorganism's control, taste and odour removal and destruction of organic matter. The process of chlorination is provided as first step of disinfection for the leachate treatment plant. The chlorination contact tank of 70 KL capacity is proposed. The chlorine concentration level is maintained below 0.01 mg/l to avoid harm to aquatic life.

(ii) Multigrade Sand Filter

Filtration is a process that consists of solid liquid mixture through a porous material which retains the solid and allows the clear liquid to pass through. The porous media can be any filtering media like different grades of pebbles and quartz sand etc. The clear liquid is called filtrate. Backwashing with air scouring facility provided. The Multigrade sand filter capacity flow of 20 cum/hr is proposed for the project.

(iii) Activated Carbon Filter (ACF)

The leachate from the Multigrade sand filter will undergo additional filtration treatment in the ACF to remove colour and aroma. ACF possesses activated carbon, one of the most popular media for impurity absorption. Depending on the incoming impurity load, the activated carbon media's finite capacity of absorption will exhaust itself after lengthy use. The filter is operated by a manual valve. To eliminating adherent particles on the filter media, filter backwashing is done once per day. The ACF flow capacity of 20 cum/hr is proposed for the project.

(iv) Ultrafiltration (UF)

The filtered effluent will be collected in the storage tank (UF feed tank) and fed to Ultra filtration membranes through Micron filter. It will be collected in storage tank for further treatment. This system is dead end filtration system. There are no rejects. Rejects only consider by fast and back flushing. The ultra-filtration membranes are with small pore size (0.01 microns) and used to remove the suspended solids, bacteria, colloids, proteins, and carbohydrates. Generally, the observed System recovery is approximately 90%. The 120 KL UF feed tank is proposed for the project.

(v) Reverse Osmosis (RO)

The Ultra-Filtration product water will be collected in the storage tank (RO feed tank) and feed to RO system through the cartridge filter pH, antioxidant, and Anti scaling dosing system then leachate is pumped by high pressure pump to the reverse osmosis system. The RO membrane has small pore sizes (0.0001) which do not allow ions to higher sizes to pass through. The feed stream is split into two streams one is the permeate (product) which is low TDS and other is the reject containing all the rejected salts.

Two stage RO process is proposed for the project as shown in process flow diagram below. First stage RO (RO1) feed tank of capacity 120 KL is proposed whereas second stage RO (RO2) feed tank will be reject tank of RO1 of capacity 60 KL. The product of RO1 & RO2 will be collected in combined tank of capacity 150 KL which can be reused for gardening purpose or other industrial needs. The 80 KLD RO reject will be further treated using Multiple Effect Evaporator (MEE) system using coal-based boiler as steam and distillate to be treated in Agitated Thin Film Dryer (ATFD) process. The powder salt remaining from the ATFD process will be sent to TSDF for disposal. The MEE is proposed having 4 effect forced circulation system, ATFD will be of 10 m2, boiler of 2 Tonnes capacity and cooling tower of 500 TR.

The sludge and sediments settled at the bottom of tertiary treatment unit shall be disposed in the Hazardous waste landfill as and when required. The RO product can be reused at the facility and excess can be discharged into the surface water body ensuring the quality of the same meets the discharge standard given by SWM rules 2016. The monitoring of the same is required to ensure the legislation compliances before discharging the same in environment. The process flow and capacity proposed of each unit depends up on the quality of the leachate influent which can be further modified based on detail characterization of the leachate. The general process flow diagram for LTP is shown in below Figure 2-22. The sludge generated in the reactors and settled in the primary, secondary clarifier and reactive clarifier will be pumped sludge thickener. The thickened sludge will be collected in sludge collection tanks and further to screw press for de-watering. The dried sludge will then be disposed off suitably as per KSPCB norms. The flow of screw press for feed pump (2 nos.) and dewatering sludge (1 no.) of capacity 6 cum/hr is proposed for the project. The expected quantity of sludge is about 6 kg/hr will be disposed in the drying bed provided along with LTP. The size of drying

bed is 4m x 5m. The Sludge will be tested for Hazardous material by conducting (Toxicity Characteristic Leaching Procedure) TCLP test accordingly it will be disposed.

About 2.55 KLD of sewage will be generated and the same will be drained to LTP for proper treatment. In addition, the efficient rainwater management plan is also adopted for entire SLF area according to the topography. Groundwater recharge, storm water management also considered as mitigation measures. To check the status of clay layers 7 nos. of piezometers will be installed around the SLF. The depth of the piezometers will be about 10m.

4.19 Land environment

The total land area likely to be occupied by the SLF is estimated as 1,01,123 Sq.m (25 Acres). Out of which the SLF footprint is estimated to be 73,615 Sq.m. The existing land use pattern will be altered due to disposal of inert waste. The existing buil-up area is reported 70% which will remain as it is, as the proposed SLF is 25 acres which is very meagre. However, the existing land use pattern as shown in the LU/LC map would not be altered.

4.19.1 Impacts

Disposal of inert on the land will affect the soil quality if mitigation measures are not provided. In the proposed SLF the soil is protected through various bottom linear system as per SWM rules, 2016. It is expected that SLF management and good housekeeping will be practiced and that problems arising from the improper disposal of inert waste will therefore be avoided. So, the impact on the soil will be insignificant as an organized inert waste collection and disposal practices are followed.

4.19.2 Mitigation Measures

- During Operation, approx. 1.7 kg per day solid waste will be collected, segregated and disposed into the SLF area
- Hazardous waste is not expected from the disposal of inert. However, a meagre quantity of oil is expected from DG set which will be disposed through authorized vendors
- Once the waste has been filled to the designated capacity in the sanitary landfill, it will be capped to prevent rain water ingress. To minimise storm water infiltration in the landfill body and to allow storm water drainage, a surface sealing system must be built following the final completion of each landfill portion.
- The closure cap liner system for the scientific landfill closure, will consist of the four layers as represented in the Figure 2-28.

4.20 Soil Environment

Soil contamination is not expected as SLF is provided with suitable liners and storm water drains as shown in Figure 2-19 & 2-24 respectively which will have settling tank. The SLF will be in operation with phase wise and there is no source of emission which is laden with dust and expected to be deposited to the downwind direction. Hence deterioration of soil is not expected from SLF.

4.20.1 Impacts on Utility line

The major utility lines (GAIL Gas Pipeline, and EHT Lines) are passing very closely with the proposed landfill footprint area. The Electrical High-Tension Lines (EHT) of KSEB are passing through the SLF footprint area of the proposed land parcel resulting in lower volumetric capacity. There are five high-tension lines of 110 kVA at the site, three lines out of these five lines are crossing from the proposed land parcel. These needed to be re-aligned shifting of EHT line is planned by Kerala State Electricity Board (KSEB).

The GAIL (KKBPL Gas Pipeline) is located adjacent on the eastern side of the proposed land parcel in the proximity to the footprint area of the proposed site. 5m Right of Way will be provided to ensure the safety of existing utilities.

4.20.1.1 Potential impacts

The expected environmental impact associated with re-alignment/shifting of HT line are

- Clearing of ground vegetation/trees
- Geological safety, soil erosion and landslide/sinking & unequal settlement
- Noise and vibration
- Temporary loss of access.

4.20.1.2 Mitigation measures

The work of EHT shifting is undertaken by Kerala State Electricity Board, through its certified contractors. The work is carried out following the Safety Manual published by the Central Electricity Authority, 2011. Some of the rules and regulations to be followed during shifting of HT line as per Government of India are:

- Electricity Act, 2003 – Section 68 (1); Section 164 (B)
- Environmental (protection)Act, 1986
- Batteries (management & Handling) Rules, 2001
- Hazardous waste (management & Handling) Amendment Rules, 2003
- Health & Safety Requirements
- Exposure to Electromagnetic Fields (EMF)
- Right of Way and compensation under Electricity laws
- The Indian Telegraph Act (ITA), 1885

4.21 Biological Environment

4.21.1 Impacts

The impact on terrestrial ecology will be due to construction pahse and operation phase. The mitigation measures for construction phase like ground levelling, surface run-off etc. are short term and the mitigation measures are provided. The long term impacts is during operation of the SLF methane emission which is estimated as low dose. The mitigation measures are as follows.

4.21.2 Mitigation measures

The methane emissions during the operation phase will be restricted within the norms. The greenbelt will be developed as a parallel activity during the construction phase. Development of adequate green belt at and around the site will help in reducing the impacts on the flora and fauna as the plant species will act as air and noise pollution sink. Thus, the impact on the terrestrial ecology of the area would be reduced to some extent during the operational phase of the project.

4.22 Closure of Landfill

4.22.1.1 Impacts

The impact of scientific landfill will be substantial if it not planned properly during the design stage. The identified major impacts are as follows;

- Odour and LF gas generation from the inert
- Storm water contamination due to run off from SLF
- Ground water contamination due to percolation
- Soil and surface water contamination
- Biodiversity Loss
- Health and Safety Impacts

4.22.1.2 Mitigation Measures

The closure profile of SLF KSWMP phase plus GoK Phase (Combined) is planned and proposed based on the available footprint area and required capacity with capping slope of 1:4 and required berm of 3m width at required intervals of height to ensure slope stability, smooth movement of landfill vehicles and post closure maintenance. The figure 2-8 shows the closure profile of combining two phases and the cross section of SLF is Figure 2-9.

After closure, no construction activities of any sort will be permitted without scientific evidence for utilizing the site for any other purposes. The remaining plant area of 27,559 sq.m will be used for next 15 years as a maintenance period.

Once the waste has been filled to the designated capacity in the Scientific landfill, it must be capped/ closed to prevent rainwater ingress. To minimize storm water infiltration in the landfill body and to allow storm water drainage, a surface sealing system must be built following the final completion of each landfill portion. The primary goals of the final cover system are:

The closure cap liner system, for both the open dump site closures and the Scientific landfill closure, will consist of the layers as shown in the Figure 2-25 which is inline with the SWM 2016 Rules.

Further, the proposed capping layer is further optimized, made thinner and practically implementable (Slope Stability) on site to make it sustainable from environmental perspective. The proposed scientific capping liner layers is shown in Figure 2-26.

4.22.1.3 Functions of Closure Cap layers

The details of Compacted Clay Liner, Geosynthetic Clay Liner (GCL), HDPE Geomembrane (GM) (optional), Geo-Composite (GC), Vegetative soil layer, and coir mesh are explained in section 2.23 to 2.28.

4.22.1.4 Storm Water Management

The Closure system is intended to reduce waste infiltration. The top two cover layers, topsoil and drainage layer, flow into the peripheral storm water gutter created around the SLF. On the side slopes and at the bottom, the trenches will be trapezoidal channels formed of brick construction. The storm water trenches will drain runoff just from the closure area and open into a neighbouring river. The storm water drains will open at the lowest drain, where the water will be carried to the storm water retention pond and subsequently released into the natural water channel.

The highest runoff will occur when the closure is completed, as the surface area will be at its greatest. The top of the closure will have a 2-5% slope. The top will be separated into numerous parts to ensure that rainwater does not soak into the closure and flows off as quickly as possible. This will aid in minimizing infiltration and, as a result, the generation of leachate. There are drains provided at the bench to let water to flow smoothly into the storm drains positioned at the bottom of the closure. Storm water should be channelled into the nearest river, according on the site characteristics through a retention pond.

4.22.2 Proper Design and Engineering

The pond should be appropriately sized to handle the expected volume of stormwater from the watershed. This includes considering factors like the rainfall intensity, the size of the drainage area, and the pond's storage capacity to facilitate the outflow. Inlets should be designed to prevent debris build-up, and outlets should be designed to regulate the outflow of water to avoid downstream flooding. Proper maintenance of these features is crucial for safe pond operation.

Gentle slopes are important around the pond to prevent sudden drops into deep water, which could be hazardous. Steep or slippery slopes should be avoided to reduce the risk of people or animals falling into the water generally 1:4 is planned. Retention ponds should have emergency overflow systems, such as weirs or spillways, that activate during heavy rain events, allowing excess water to flow safely out of the pond without causing damage.

4.22.3 Access Control and Barriers

To prevent accidental entry, the pond should be surrounded by a secure fence with clear warning signs indicating the potential hazards (e.g., deep water, slippery slopes). Fencing should be high enough to deter entry, and gates should be locked when not in use. The retention will be within the boundary of SLF site. Limit the number of access points to the pond to ensure people don't accidentally wander into unsafe areas. Access should be restricted to authorized personnel only, such as maintenance workers and emergency responders.

4.22.4 Water Quality Monitoring

Regular testing for water quality, including monitoring for contaminants such as bacteria, algae, and heavy metals, is essential for maintaining a healthy ecosystem and ensuring the pond's safety. Algae growth can cause water to become stagnant and unsafe. Implementing control measures like aerators, vegetation management, or natural treatments can reduce this risk. Over time, sediment can accumulate in the pond, affecting water flow and water quality. Regular dredging or sediment management practices are necessary to maintain proper pond function and avoid overflow during heavy rain.

4.22.5 Regular Inspection and Maintenance

Regular inspections should be performed to ensure that the pond is functioning as designed. This includes checking for erosion, sediment build-up, structural integrity of walls, inlet/outlet blockages, and general water quality. Invasive plant species and excessive vegetation can obstruct water flow, degrade water quality, and increase the risk of flooding. Routine management and removal of unwanted vegetation are necessary for the pond's safety and performance. After storms or heavy rainfall, debris like leaves, branches, and trash can clog the inlet and outlet structures. These should be cleared regularly to maintain flow and prevent blockages.

4.22.6 Emergency Preparedness

Implement flood forecasting and warning systems, especially in areas where the retention pond could overflow during extreme weather events. Flood maps and evacuation plans should be in place for communities downstream of the pond. A well-designed emergency spillway that can handle large storm events should be included to avoid overtopping the pond and causing downstream flooding. KSWMP, maintenance crews, and emergency responders should be trained in how to manage the pond during extreme weather events, including quickly clearing debris or managing overflow.

4.22.7 Safety During Maintenance

Workers performing maintenance on or near the pond should use proper PPE, such as life jackets, gloves, boots, and protective clothing, to ensure their safety when interacting with the pond. When maintenance is necessary, ensure that any water-pumping or drainage systems are safe to use and that proper procedures are in place to prevent accidents.

4.22.8 Long-Term Monitoring and Adaptation

Stormwater retention pond designs should allow for adaptation based on changes in local climate patterns, population growth, or land use. Regular assessments help identify potential risks and adjust safety measures accordingly. Keep thorough records of inspections, maintenance, water quality testing, and safety procedures. This helps identify recurring issues and supports future improvements in safety measures.

4.22.8.1 Landfill Gas Management

This landfill is proposed only for disposal of Inert and solid waste process rejects, however sometime organic matter may arrive. Due to the anaerobic decomposition of the organic material in the landfill, landfill gas is generated. Basically, this gas is consist of methane and carbon dioxide. Both passive venting and gas collecting under suction pressure are methods for handling the gas.

Since, Ambalamedu Landfill is going to receive mostly rejects which are inert in nature. There is very little organic content in rejects going into the SLF, the chances of landfill gas generation are very low. As such it has been suggested to have a passive gas venting wells placed at every 2500 sqm intervals to remove the landfill gas. The details of passive vents are shown in Figure 2-28.

Biological loss are not expected as there is no forest land is acquired and floral & faunal colonization is not found in the proposed area. Health and safety impacts are covered in subsequent sections

4.23 Post Closure Monitoring

The post closure monitoring is planned for 15 years. The KSWMP shall be responsible for maintaining the project facility post closure for a period of 15 years. During post closure it is planned to monitor air quality, odour & landfill gas, surface & ground water quality, cover system settlement, leachate treatment plant and quality of treated leachate water. The most important monitoring is ground water through 3 nos of piezometer installed around the site. Three piezometers shall be constructed on the downstream side of the landfill i.e. on the eastern side. One piezometer shall be constructed on the upstream side i.e. on the western side of the landfill. The groundwater table varies from 1 m to 8 m depending upon the season; accordingly, the depth of piezometer shall be 10m below ground level.

The piezometer shall be constructed 7 m from the outside edge of the embankment. The location of piezometer is shown in the SLF layout drawing.

4.24 Socio economic environment

The proposed SLF will provide additional employment opportunities and improved living conditions for our society. The project will provide the cleaner and protected environment to the surrounding area. The proposed project would enhance the existing infrastructure in the area by providing a cleaner and greener environment through CER activities earmarked during construction of the project.

4.25 Occupational Health and Risk

4.25.1 Impacts

The SLF project will not handle any flammable substances like diesel and thereby increasing potential risks due to storage of flammables are not expected.SLF will adopt necessary protective measures to safeguard the employee working at disposal site by providing suitable PPEs like earmuffs, goggles, facemask, hand gloves and gumboots to workers. Hence, any possible occupational health impact from exposure to such fugitive dust is not likely to be of major significance.

4.26 General Safety Measures

Considering the inert waste handled and stored at site; the following safety measures are provided at the SLF site.

- Requisite personnel protective equipment will be provided. Instruction/Notice to wear the same will be displayed and demonstrated. Further, it will be insisted to use the same while at work
- Provision of safety shower with eye washer in the wash room
- Regular training programme for safety awareness
- Provisions of First Aid Box and trained person in first aid
- Prohibition on eating, drinking or smoking at work-area
- Work area is monitored to maintain work environment free from any dust and to keep well within below permissible limit
- Provision of adequate fire extinguishers at site and training will be imparted to the workers also
- Maintaining the Fire-Protection System adequately as per norms.
- Availability of Self Breathing Apparatus at site
- Safety Posters and slogans will be exhibited at conspicuous places.
- Arrangement of Periodical Training to workers and supervisors.

4.26.1 Mitigation Measures

- The Developer/Operator of SLF & inert transport mechanism will develop Critical Controls for all expected High Energy Hazards, and implement a skill development plan which covers high energy hazards during construction, risk of slippage of material, transport using large trucks, Gail GAS Pipelines impacts, leachate & storm water breaches, operation slip, fall, trip, workshop activities, and risk of fire due to nearby industrial uses. Development of detailed OHS management plan, and Disaster Management and Emergency Response Plan for all phases of this subproject will be made part of Contractors EMP.
- Medical checkup would be carried out at a regular interval
- No: of workers will be minimal on site during filling. All filled areas & soil storage will be covered. Appropriate wetting & PPEs will be used. Soil used will not be fine sand.
- Landuses around are mostly industrial, and all workers will be informed of the activities & guided to use appropriate PPEs that will be made available on site. Health emergencies will be attended
- Emissions will be minimal captured & managed
- Noise level at nearby sensitive receptors will be minimal as houses & schools are at other side of the river mostly. However, activities will be nil after twilight. Noise monitoring, PPEs included in EMP
- Leachate management elaborated in FR & EMP. No worker will work directly on leachate, or on cleaning of drains, blocks etc. Machines will be used for cleaning, desilting etc; with proper use protocols
- During operation, proper care would be taken by SLF management, appropriate PPEs will be provided to site workers and staff members
- Appropriate personnel protective clothing to be used to prevent skin contact.
- Safety Goggles will be used to prevent eye contact.
- Hand gloves of natural rubber, neoprene, and polyvinyl chloride will be used as and when required
- Acoustic enclosures will be provided to DG sets and other noise generating equipment
-

From the foregoing study it can be concluded that additional maximum 22.3 µg/m^3 increase in PM is expected during construction and max. 2.66 µg/m^3 of PM increase during operation is expected. In case of other pollutant NOx and CO the increase is expected to be 0.322 µg/m^3 & 1.07 µg/m^3 which is very minimal as only inerts/rejects will be disposed at the SLF during operation phase. The estimated methane and H_2S emission is about 2.15 x 10^{-9} m^3/s and 0.645 x 10^{-9} m^3/s respectively during operation. The results of the noise modelling reveal that the maximum noise level will be 100 dB (A) at project site due to the SLF activity. The noise level at 100m, 500m and 1500m is predicted to the level of 75, 40 and 25 dB(A) respectively. The mitigation measures like construction of approach roads would minimize the PM concentration to maximum extent possible. The leachate generation is about 371 KLD which will be treated in Leachate Treatment Plant and treated water will be utilized for dust control purposes and avenue plantation. The greenbelt of 13,155 sq.m will be maintained.

5 Analysis of Alternatives

5.1 General

Analysis of alternatives for project site as well as process technology and their assessment for selection of the most suitable location as well in terms of environmental affability is prime concern of the project.

Considering the “rur-ban” or “rural – urban sprawl/settlement pattern” in Kerala, and high density of development, finding appropriate land parcel for development of SLF fulfilling all the criteria as per applicable regulations; and without nearby residences and other receptors is a difficulty, At the same time a sanitary landfill for disposal of inert and rejects is quintessential for overall wellbeing, considering the leakage of these unattended fractions to sensitive environmental features such as rivers, canals and forests. The possibilities of analysis of alternative sites and technology is dealt in this section.

5.2 Details of alternative site considered

Before identifying the location of landfill for Cluster 4, alternative sites have been considered for the project activity. The availability of land, location of waste collection station and other regulatory criteria as required to meet the site selection considerations and after analysing the permutation and combination of all the sites, this present site at Ambalamedu SLF for Cluster 4 has been finalized.

In this regard, three sites have been considered, the other two sites are Killimangalam at Thrissur district & Perumbavoor at Ernakulam district. The location of all the site is shown in Figure 5-1. The location of Killimangalam is shown in Figure 5-2 and coordinates are shown in Table 5-2. The location of Perambavoor is shown in Figure 5-3 and coordinates are shown in Table 5-3 and the Ambalamedu site location is shown in Figure 2-2 and coordinates are given in Table 2-2. Based on the land availability and compliance to SWM Rules, 2016 the Ambalamedu site is chosen.

Table 5-1 Activity parameters for site selection

Sl. No.	Activity parameters considered	Site 1 Killimangalam	Site 2 Perumbavoor	Site 3 Ambalamedu
1	Available area in acres	48.18	27.18	25
2	Elevation amsl	75 – 109 m	90 – 118 m	22 – 45 m
3	Location	Killimangalam	Perumbavoor	Ambalamedu
4	Classification of land	Agricultural land	Agricultural land	Grass land
5	Approach road	Other District Roads (ODR)	ODR	Major District Road (MDR)
6	Owner of the land	Private	Private	KINFRA - Government
7	Sensitive areas	Nil	Nil	Nil
8	Nearest settlements	25 m	20 m	550 m
9	Remarks	Considering the nearest settlements and agricultural land, the site not recommended for SLF.	Considering the nearest settlements, less road facility, the site is not recommended for SLF.	Considering the land availability, ownership and classification, the site is recommended for SLF.

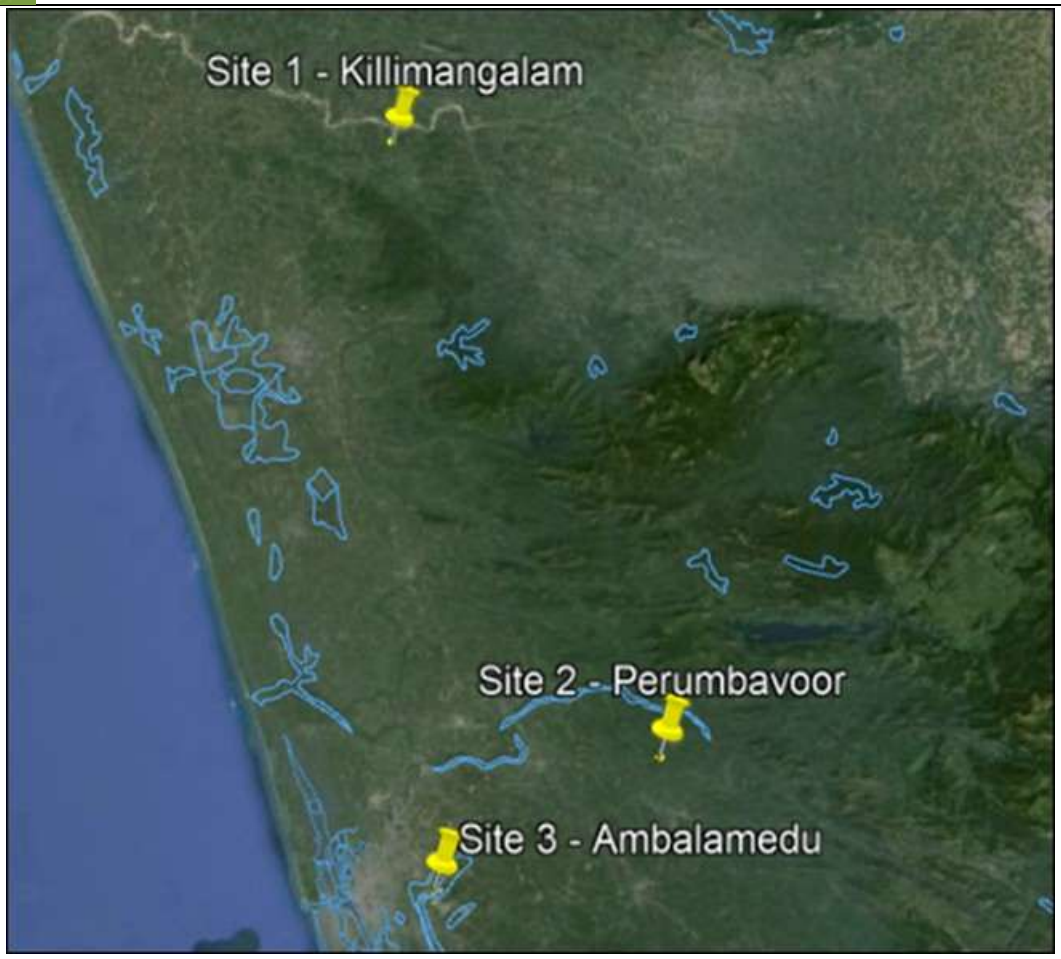


Figure 5-1 Google imagery showing alternate sites consideration

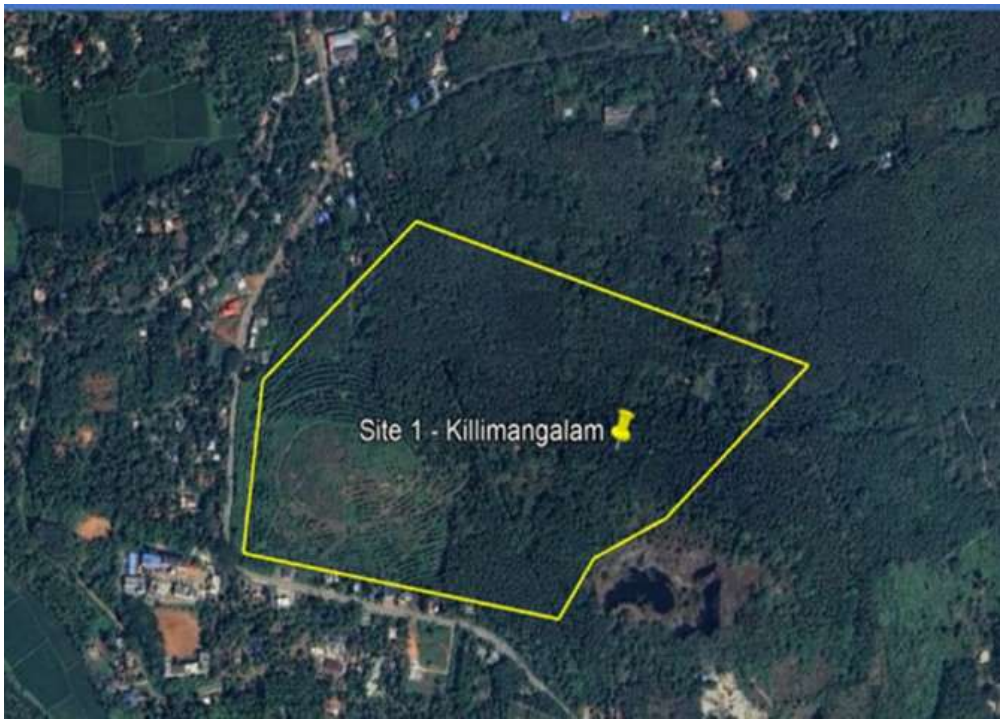


Figure 5-2 Alternate site 1 – Killimangalam, Trissur District

Table 5-2 Alternate site 1 – Geo coordinates

Sl. No.	Latitude	Longitude
1	10°44'5.75"N	76°18'51.60"E
2	10°44'0.62"N	76°19'8.21"E
3	10°43'55.14"N	76°19'2.18"E
4	10°43'53.71"N	76°18'59.12"E
5	10°43'51.55"N	76°18'57.65"E
6	10°43'53.90"N	76°18'44.28"E
7	10°44'0.09"N	76°18'45.10"E



Figure 5-3 Alternate site 2 – Perumbavoor, Ernakulam District

Table 5-3 Alternate site 2 – Geo coordinates

Sl. No.	Latitude	Longitude
1	10° 7'18.45"N	76°36'5.56"E
2	10° 7'18.74"N	76°36'9.07"E
3	10° 7'15.54"N	76°36'25.83"E
4	10° 7'15.09"N	76°36'27.07"E
5	10° 7'12.44"N	76°36'27.15"E
6	10° 7'12.85"N	76°36'12.51"E
7	10° 7'11.06"N	76°36'12.10"E
8	10° 7'9.78"N	76°36'8.91"E
9	10° 7'8.93"N	76°36'5.45"E

Out of three sites, site 3 Ambalamedu has been selected for proposed SLF.

5.3 Site selection criteria

The site selection study was carried out based on CPHEEO/SWM Rules, 2016. The criteria considered for site selection and the compliances of the criteria with respect to Ambalamedu SLF site area given in Table 4-4

Table 5-4 Compliance of Site selection criteria

Criteria for SLF	Required as per SWM Rules, 2016	Compliance to the norms
Design Life Period	20-25 years	designed for 25 years
Distance from River	>100 m	Chithtrapuzha river is identified beyond 100 m from the project boundary
Distance from Pond	>200 m	Complied as there is no pond in the vicinity of the site
Distance from Highway	>200 m	The proposed site is located at about 3.5 km from the highway.
Distance from Habitation	>500 m	No habitation is settlement within 500m from the project boundary
Distance from Public Parks	>200 m	No public parks exist in 200m from the project boundary
Distance from Water supply wells	>200 m	No water supply well is observed within 200m from the project boundary
Extremely high Water table*	Exclude	Ground water tables are identified below 2 m
Agricultural/forest area	Exclude	The proposed site is grass land with intermittent patches with wild bushes and trees.
Fault line	500m from fault line fracture	There is no fault line. The project site comes under Seismic Zone III (Moderate Risk) as per IS 1893 (Part-1): 2002
Airport/Airbase	>20 km	Cochin International Airport at 18 km Cochin port Airstrip at 10.4 km NOCs from Airport Authority of India is planned

The proposed site is neither within 100 m from the river bank, nor within 200m of lake or pond. The site is selected considering the maximum flood level likely to be encountered in this area. Accordingly, suitable embankment and raising the existing ground level are planned and included in the Project Detailed Report (PDR), and no public parks, State or National highways is cited within 200m. The proposed site does not fall under CRZ area, also not potentially unstable zone. The site is also under the ownership of Kerala Industrial Infrastructure Development Corporation (KINFRA) and the extent of land is admeasuring about 25 acres, which can accommodate 14.65 lakh MT of inerts and land is handed over to KSWMP.

Apart from selection criteria from regulatory bodies, site suitability study has also been carried out. The site suitability parameters assessed as per various applicable statutory norms like guidelines, rules, regulations to ensure environmental, social, ecological and disaster safety. The project site with footprint area around 25 Acres are considered by shifting Electrical High Tension (EHT) line which is passing through the site.

5.4 Alternative Technology

A brief of the technology including method of work and design parameters is given in Chapter-2 which is inline with SWM Rules, 2016 and the same briefed below. The proposed subproject follows a simple technology as suggested by CPHEEO Manual on SWM to ensure proper disposal of only rejects/inerts from solid waste in lined cells, by ensuring no leakage of leachate or material to nearby environmental components, while at the same time ensuring provisions to manage the minimal gas that may be formed.

Inert waste for SLF will be compacted in thin layers using heavy compactors to achieve high density of the waste. The landfill cell will be covered at the end of each working day with minimum 10 cm of soil or inert debris or construction material. Proper drainage will be constructed to divert run-off away from the active cell of the landfill. After completion of landfill, a final cover will be designed to minimise infiltration and erosion. The final cover will have soil layer comprising of 60 cm of clay or amended soil with permeability co-efficient less than 1 x 10^{-7} cm/sec. On top of the barrier soil layer, there will be a drainage layer of 15 cm. On top of the drainage layer, there will be a vegetative layer of 45 cm to support natural plant growth and to minimise erosion.

In order to prevent pollution from landfill operation, the storm water drain will be designed and constructed in such a way that the surface run-off water is diverted from the landfilling site and leachates from inert waste locations do not get mixed with the surface run-off water. Non-permeable lining system at the base and walls of waste disposal area is planned. For landfill will have liner of composite barrier of 1.5 mm thick High-Density Poly-ethylene (HDPE) geo-membrane overlying 90 cm of soil (clay or amended soil) having permeability coefficient not greater than 1 x 10^{-7} cm/sec is planned. The highest level of water table will be maintained at two meter below the base of clay or amended soil barrier layer provided at the bottom of landfills. Provisions for management of leachates including its collection and treatment will be implemented. The treated leachate will be recycled or utilized as permitted for other needy industries. As the technology is proven and being practised in India by various state government to manage the inert waste. Hence, more advanced technology for disposal of inert waste is planned which will meet the statutory as well as technological requirement.

6 Environmental Monitoring Program

6.1 General

Analysis of impacts and mitigation measures have been discussed in Chapter-04. Several measures have been proposed to mitigate the adverse impacts resulting from the construction and operation of the proposed SLF at Ambalamedu. In order to ensure that the measures adopted serve the intended purpose effectively to the required degree, a monitoring programme is to be implemented. Also based on the baseline data collected on various environmental parameters and with the prediction of impacts, it is essential to have an Environmental Monitoring Programme to establish the trend of various environmental parameters and their compliance with the discharge limits specified by the regulating agencies. This chapter describes the scope and details of the monitoring proposed program . A large part of the environmental attributes sampling and measurement activities will be concerned with long term monitoring aimed to provide an early warning of any undesirable changes or trends in the natural environment that could be associated with operation of the SLF. This is essential to determine whether the changes are in response to change of other environmental conditions or other activities nearby, or essentially contributed by the SLF itself. For any project, besides monitoring of conventional parameters around SLF, specific importance is given for ambient monitoring with additional parameters as required to meet the norms. GSR 826 (E) dt. 16th Nov. 2009. They are described under two separate categories.

- Onsite monitoring within the SLF at Ambalamedu site
- Monitoring program in public domain

Regular environmental monitoring for air quality, water quality, noise levels and soil quality program is also detailed in this chapter. The equipment as given in Table 6.1 will be procured for environmental monitoring by SLF operating authority.

Table 6-1 Environmental equipment for the laboratory

Sl. No.	Description of instrument	Numbers
1	High & Low volume air samplers	10
2	Spectrophotometer	02
3	Micro sensitive weighing balance	01
4	Portable air sampling survey meter	04
5	Automatic Weather Monitoring Station	01
6	Atomic absorption spectrometer	01
7	Other lab analytical apparatus as required to establish the lab	1 lot
8	CO analyzer	02
9	Piezometers around SLF area measurement	10

6.2 Purpose of Environmental Monitoring

Monitoring is an essential component for sustainability of any project and it is an integral part of environmental assessment process. This will ensure that there is consistent compliance to the regulatory requirement. It also helps in understanding potential deviations. The timely action based on this monitoring would help to comply with the regulatory requirements and sustainability of the project. It also ensures cordial relation with the community around the SLF site. It is important to predict with present and post-project environmental scenarios. Hence, monitoring of critical parameters is essential. The aim of monitoring is to provide information that will aid impact management and to achieve a better understanding of cause effect and to improve EIA prediction and mitigation methods. Both immediate and long-term benefits by undertaking monitoring as part of EIA are widely recognized.

6.3 Need for the Environmental Monitoring

The basic objective of the environment-monitoring program is as follows:

- Verify and support compliance with applicable Central & State environmental laws, regulations, permits, authorization, consent to operate, protocols and orders
- Identify potential environmental problems and evaluate the need for remedial actions or measures to mitigate the problems
- Detect, characterize, and report unexpected releases of gases from SLF
- Evaluate the effectiveness of leachate treatment and pollution control abatement measures
- Determine compliance with conditions stipulated in EC
- To identify the need for corrective action before irreversible environmental damage occurs;
- To provide scientific information about the response of an ecosystem to a given set of human activities and mitigation measures;
- To establish a database for future Impact Assessment Studies

The properties that require regular monitoring are mentioned below:

1. Air quality (Ambient Air including fugitive emissions & odour);
2. Water (surface, groundwater and leachate quality), LTP performance
3. Noise levels;
4. Greenbelt development;
5. Socio-economic issues,
6. Implementation of Corporate Environmental Responsibilities (CER)

6.3.1 Applicable Environmental Regulatory Framework

The proposed project will abide by the following Acts, codes, Rules & Notifications issued by the Govt. of India/Govt. of Kerala to protect the environment and development in sustainable way

1. The Solid Waste Management Rules, 2016 and its amendment
2. The Water (Prevention & Control of Pollution) Act, 1974
3. The Air (Prevention & Control of Pollution) Act, 1981
4. The EIA Notification dated 14th September 2006 and subsequent amendments
5. The Hazardous and other Wastes (Management and Transboundary Movement) Rules, 2016
6. The Noise Pollution (Regulation and Control) Rules, 2000 and its amendments.
7. The Fire Prevention and Fire Safety Act, 2005
8. The Occupational Safety, Health and Working Conditions Code, 2020
9. The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996
10. The Contract Labour (Regulation & Abolition) Act, and Rules, 1970
11. The Child Labour (Prohibition & Regulation) Act, and Rules 1986
12. Plastic Waste Management Rules, 2016, as amended, 2021
13. Rules for Management of Construction and Demolition Waste, 2016
14. The Pesticide Management Bill (PMB) of 2020
15. Kerala Municipality Building Rules – 2019

6.4 Types of Environmental Monitoring

The key issues associated with the life cycle of a project are the monitoring of environmental parameters. Three types of environmental monitoring are associated with the project, which includes.

a) Baseline monitoring (at site and in public domain)

b) Effects/ Impacts monitoring and
c) Compliance monitoring.

Baseline monitoring - Baseline monitoring deals with the measurement of environmental variables like air, noise, water, soil and ecological matrices during pre-project period to post-project to determine operation conditions and range of variation of the parameters if any;

Effects/impact monitoring – It involves measurements of environmental variable during construction and operation phase of the project to assess the impact that may have been caused by the project.

Compliance Monitoring- It consists of periodic sampling and continuous monitoring of pollutant emissions with respect to disposal of inert at SLF area.

6.5 Measurement Methodology

Ambient air, ambient noise, water, soil and leachate are to be monitored on regular basis. Monitoring of all environmental samples will be done as per the guidelines provided by CPCB/ SPCB.

The monitoring is required during;

1. Construction phase
2. Operation phase
3. Post closure phase

1. Construction Phase

The construction activities are expected to prolong for 28 months from the date of obtaining all statutory clearances. The main impact will be on the air quality during the construction. If the work is spilled over to rainy season, there will be carryover of silt from site, this impacting the Chitrapuzha River, drainage channels leading to the river. The nearest infrastructure is the KEIL TSDF which is not expected to be impacted by this. Due to the equipment used for construction, some amount of noise is also expected at the site and in the immediate neighbourhood. Therefore, the ambient air quality monitoring, noise level monitoring and surface water quality monitoring are to be carried out. The project team will monitor the compliances with the mitigation measures during the construction phase impacts. The monitoring program during construction phase is given in Table 6-2.

2. Operation Phase

Ambient air, ambient noise, surface water, ground water quality around landfill site, inert waste characterization, soil and leachate water, flora and fauna are to be monitored on regular basis. Monitoring of all environmental samples will be done as per the guideline's protocols in the MoEF& CC/SLF guidelines. The monitoring system during operation phase is given in Table 6-2.

3. Post Closure Phase

Table 6-2 Environmental monitoring program during construction phase

Sl. No.	Type	Locations	Parameters	Period and Frequency	Institutional Responsibility	
					Implementation	Supervision
Construction Phase						
1.	Ambient Air Quality	8 locations as selected during baseline study	PM10, PM2.5, Sulphur dioxide (SO2), Oxides of nitrogen (NO2), Carbon monoxide (CO), Hydrocarbon (HC), Volatile Organic compounds (VOC's)	24-hr (8hr for CO) average samples every quarter	Contractor through MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
2.	Ground Water	8 locations as selected during baseline study	pH, TSS, TDS, DO, BOD, Salinity, Total Hardness, Fluoride, Chloride and MPN (No. of coli forms/ 100ml), Heavy Metals	Quarterly	Contractor through MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
3.	Surface Water	3 locations as selected during baseline study	pH, TSS, TDS, DO, BOD, Salinity, Total Hardness, Fluoride, Chloride and MPN	Quarterly	Contractor through MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP

			(No. of coli forms/ 100ml), Heavy Metals			
4.	Drinking Water	8 samples from labour camps during construction phase	pH, TSS, TDS, DO, BOD, Salinity, Total Hardness, Fluoride, Chloride and MPN (No. of coli forms/ 100ml), Heavy Metals	Quarterly	Contractor through MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
5.	Noise	8 locations as selected during baseline study	24hrly Day and Nighttime Leq levels	Quarterly	Contractor through MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
6.	Soil	8 locations as selected during baseline study	Organic matter, C, H, N, Alkalinity, Acidity, heavy metals, and trace metals	Quarterly	Contractor through MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
Sl. No.	**Types**	**Action to be followed**	**Parameters for monitoring**		**Frequency of monitoring**	
7	Strom water Management	Ensure drainage system and specific design measures are working effectively. The design to incorporate existing drainage pattern and avoid disturbing the same.	Visual inspection of drainage and records thereof		Periodic check during construction activities	

8	Land Use	Implementing regular monitoring to track changes in land use patterns, soil quality, vegetation health, water quality, and other relevant parameters.	Trend of land use change for different categories	Data from various Government agencies across years
9	Health	Employees and contract labor health check ups	All relevant parameters as per OSHA	Regular check ups
10	Loss of flora and fauna	Re-vegetation as per Forest guidelines	No. of species at Ambalamedu SLF	During site clearance
11	Socio economic aspects	Conducting Regular FGD, Review of Project Grievance Redress Mechanism/ Complaint register	Issues raised through any grievances related with SLF project	Based on field survey and data collected

Operation Phase

Sl. No.	Type	Locations	Parameters	Period and Frequency	Institutional Responsibility	
					Implementation	Supervision
1.	Ambient Air Quality	8 locations as selected after consultation with SPCB	PM10, PM2.5, Sulphur dioxide (SO2), Oxides of nitrogen (NO2) Carbon monoxide (CO) Hydrocarbon	24-hr (8hr for CO) average samples every quarter	MoEF & CC approved agency	Independent Engineer (IE)/ PMC/KSWMP

			(HC) Volatile Organic Compounds (VOC's)			
2.	Ground Water	10 locations as selected after consultation with SPCB	pH, TSS, TDS, DO, BOD, Salinity, Total Hardness, Fluoride, Chloride and MPN (No. of coli forms/ 100ml), Heavy Metals	Quarterly	MoEF & CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
3.	Surface Water	3 locations as selected after consultation with SPCB	pH, TSS, TDS, DO, BOD, Salinity, Total Hardness, Fluoride, Chloride and MPN (No. of coli forms/ 100ml), Heavy Metals	Quarterly	MoEF & CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
4.	Noise	8 locations covering the project site and in the surrounding areas to be identified in consultation with SPCB	24hrly Day and Night time Leq levels	Quarterly	MoEF & CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
5.	Soil	8 locations as selected after consultation with SPCB	Organic matter, C, H, N, Alkalinity, Acidity, heavy metals and trace	Quarterly	MoEF & CC approved agency	Independent Engineer (IE)/ PMC/KSWMP

			metal, Alkalinity, Acidity			
6.	Treated potable water quality	Water Treatment Plant	Parameters for horticulture use - BOD, pH, S.S, Coliforms	Half Monthly	MoEF & CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
7.	Leachate quantity	LTP	Quantity monitoring	Half Monthly	MoEF & CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
8.	Leachate quality	LTP	As per CPCB discharge standard	Half Monthly	MoEF & CC approved agency	Independent Engineer (IE)/ PMC/KSWMP

Post Closure Monitoring

Sl. No.	Type	Locations	Parameters	Period and Frequency	Institutional Responsibility	
					Implementation	Supervision
1.	Leachate Quantity	Leachate Pond	Quantity monitoring	Twice in a year	MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
2.	Gas Quantity	SLF site	Quantity Monitoring	Once in a year	MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
3.	Surface water run-off	SLF site	As per Design Requirement	Thrice in a year	MoEF& CC approved agency	Independent Engineer (IE)/

						PMC/KSWMP
4.	Cover system Settlement	SLF site	As per Design Requirement	Thrice in a year	MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
5.	Leachate Quality	LTP	As per CPCB discharge standard	Half Monthly	MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
6.	Ground water quality at 4 well	3 locations as selected after consultation with SPCB	pH, TSS, TDS, DO, BOD, Salinity, Total Hardness, Fluoride, Chloride and MPN (No. of coli forms/ 100ml), Heavy Metals	Quarterly	MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
7.	Surface water quality	3 locations as selected after consultation with SPCB	pH, TSS, TDS, DO, BOD, Salinity, Total Hardness, Fluoride, Chloride and MPN (No. of coli forms/ 100ml), Heavy Metals	Quarterly	MoEF&CC approved agency	Independent Engineer (IE)/ PMC/KSWMP
8.	Gas Flaring Monitoring within the landfill	SLF site	As per Design Requirement	Once in a year	MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP

9.	Ambient Air Quality Monitoring	4 locations as selected after consultation with SPCB	PM10, PM2.5, Sulphur dioxide (SO2), Oxides of nitrogen (NO2) Carbon monoxide (CO) Hydrocarbon (HC) Volatile Organic compounds (VOC's)	24-hr (8hr for CO) average samples every quarter	MoEF& CC approved agency	Independent Engineer (IE)/ PMC/KSWMP

6.6 Logbook for treatment equipment

The logbook and record will be kept up to date and include all information relevant to each activity at Ambalamedu site as per SWM Rules, including mishaps (spills, injuries, fire accidents) and the actions taken. Daily records of accepted and disposed inerts taken from the waste station will be kept. This record will include all of the information specified in the SWM Rules, 2016.

1. Weight of inert of each batch
2. Treatment cycle timing and length, as well as total operation hours for LTP.
3. Detailed information on all operating parameters for each trips.

6.7 Documentation and reporting

Methodology of monitoring (sampling and analysis) will be prepared as separate documents as SOP (Standard Operating Procedure) wherever required. The records of the monitoring will be documented. Immediately upon the completion of monitoring as per the planned schedule, report will be forwarded to the concerned regulatory agencies.

6.8 Data Analysis

The monitored data will be analysed and compared with the baseline levels as established in the EIA study and the regulatory standards specified by different government agencies. The standards against which the different environment components will be compared are as per Table 6-4.

Table 6-3 Applicable environmental standards

S. No.	Component	Applicable Standards
1	Ambient Air Quality	National Ambient Air Quality standards, CPCB
2	Fugitive Emission	Fugitive emission standards for SLF at Ambalamedu
3	Source Noise Quality	Standards for workers, Insp. of Factories / OSHA
4	Ambient Noise Quality	Ambient Noise Standards, CPCB
5	Ground water quality/surface water	IS: 10500 Standards, BIS, Designated Best Use Water Quality Criteria Class B
6	Soil quality	Standard Soil Classification, ICAR
7	Leachate Quality	TCLP standards

6.9 Reporting Schedule

The monitoring results of the different environmental components will be compiled every six months during the construction as well as operation phase while submitting the six-monthly compliance reports to authority. The report will also list the project activities along with the environmental mitigation measures and will evaluate the efficacy of the Environmental Management Plan.

6.10 Budget Provision for Environment Monitoring Program

It is proposed to invest Capital cost INR 274.79 Crore with OPEX cost of Rs. 7.87 Crore for the project to establish SLF site at Ambalamedu. The monitoring cost for year is earmarked to the tune of INR 36,00,000/- excluding equipment cost. In addition, for occupational health & safety issues, development of green belt of about Rs. 15,00,000/- will be allocated for every year. The monitoring budget plan during construction and operation phase is given in Table 6-5.

Table 6-4 Monitoring budget Plan during Construction and Operation Phase

Sl No.	Item	Frequency	Cost/ Year (Rs.)
1	Environmental Monitoring Programme (All environmental attributes covered under baseline data & sludge analysis)	Half yearly	Rs. 36,00,000
2	Installation of piezometer	Half yearly	Covered in Capital Cost
3	Leachate Treatment Plant	Half yearly	
4	Storm Water drains	Half yearly	
5	Tyre wash arrangements	Half yearly	
6	Greenbelt development	Half yearly	Rs. 15,00,000
7	Occupational health & safety impacts	Half yearly	
8	Corporate Environmental Responsibility (CER) 1% of project cost	One time	Rs. 2,74,00,000
	Total		**Rs. 3,25,00,000**

6.11 Post project monitoring plan

Post-project monitoring of the landfill will be carried out primarily as a compliance requirement in addition to social responsibility. This also provides an early warning towards possible adverse impacts on human health and the environment. In this context, the installation and continuous monitoring of piezometers and monitoring wells are indispensable. These specialized instruments track the changes in groundwater levels and quality over time, providing a valuable data for assessing the project's long-term impact on hydrogeology and groundwater resources.

The piezometer data predominantly inter fluid pressure changes over time at a specific depth, providing insights into groundwater flows and aiding subsequent hydrogeological models. This information is important to predict water flow changes due to various factors like rainfall, pumping, or human activities.

Data from monitoring wells, however, often a broader understanding, bestowing readings of changes in water levels and also offering water samples for in-depth water quality analysis. They're typically employed in environmental studies, investigating potential pollutants and their vertical and horizontal spread in the subsurface.

Post project monitoring will be conducted to ensure that Capped SLF is performing in line with agreed parameters.

SLF shall prepare a written closure plan that describes the steps necessary to close the unit in accordance with the closure requirements. This plan must include the following information:

- A description of the final cover design and its installation methods and procedures
- An estimate of the largest area of the landfill requiring a final cover
- An estimate of the maximum inventory of waste on site during the landfill's active life
- A schedule for completing all required closure activities

The SLF must begin closure operations within 30 days of receipt of the final shipment of waste.

Post-closure care activities consist of monitoring and maintaining the waste containment systems and monitoring groundwater to ensure that waste is not escaping and polluting the surrounding environment. The required post-closure care period is 30 years from site closure. In India, as per regulation, re-use of the land once closed is possible after 15 years. That can help ensure protection of human health and the environment.

Specific post-closure care requirements consist of maintaining the integrity and effectiveness of (i) Final cover system, (ii) Leachate collection system, (iii) Groundwater monitoring system, (iv) Methane gas monitoring system

The owner/operator of a closed MSWLF must prepare a written post-closure care plan that provides the following information:

- A description of all required monitoring and maintenance activities, including the frequency with which each activity will be performed
- The name, address and telephone number of the person to contact during the post-closure care period
- A description of planned uses of the land during the post-closure care period

Any use of the land during this period must not disturb the integrity or operation of any of the waste containment systems or the monitoring systems. The owner/operator must certify that the post-closure care has been completed in accordance with the official post-closure care plan following the post-closure care period. This certification must be signed by an independent, registered professional engineer or the state director. Once signed, the certification is placed in the facility's operating record.

The monitoring shall be in line with applicable guidance & rules including Guidelines and Check-list for evaluation of MSW Landfills proposals with Information on existing landfills. Visual inspection of the layers, and Third party audit may be conducted to ensure post project monitoring.

The following records should be received by the Regulatory Authority at regular intervals: (a) Drawings (plan view, sectional view, major component details) of the Phase of Landfill proposed to be constructed in the coming year (annual). (b) Drawings (plan view, sectional view, major component details) of the Phase of Landfill completed in the previous year after filling with waste. These should include indication of deviations made from the previously submitted drawings. (c) Photographic record of important construction details with dates. (d) Leachate quantity and quality (3-monthly). (e) Environmental monitoring data (3-monthly) relating to ground water, surface water air quality etc.

The following should be checked by visual inspection during site visits by Supervision Consultant, Third Party, Officers of the Regulatory Authority. The basic intent is to confirm that the operator is adhering to the design, construction and operating procedures (a) During construction: (i) procedures of quality control adopted for welding of geomembrane in the liner as well as for compaction of the clay which is a part of the liner; (ii) verification of the components of the liner and cover (wherever visible). (b) During operation: (i) procedures for weighing of waste; (ii) procedures for sampling and testing of waste; (ii) record keeping at site; (iii) height of waste lift and slopes; (iii) adequate thickness of daily cover on waste; and (iv) leachate management during operation as well as leachate level / depth in wells. (c) After closure: (i) cleanliness and maintenance of the surface water drains; (ii) adequacy of vegetative growth on cover; (iii) signs of erosion due to rain water; (iv) presence of depressions on the cover due to large settlement which have not been repaired; (v) proper operation and maintenance of leachate management and gas management systems; and (vi) proper maintenance and operation of environmental monitoring systems.

Random sampling: the Operator shall provide samples of ground water, surface water or air for independent testing and verification.

6.11.1 Storm Water Management

The closure system is intended to prevent surface water infiltration. The top two cover layers, topsoil and drainage layer, flow into the peripheral storm water gutter created around the SLF. On the side slopes and at the bottom, the trenches will be trapezoidal channels formed of brick construction. The storm water trenches will drain runoff just from the closure area and open into a neighbouring drain. The storm water drains will open at the lowest drain, where the water will be carried to the pond and subsequently released into the natural water channel.

6.11.2 Piezometer

Piezometers, serving as geotechnical sensors, are employed to measure pore water pressure (piezometric level) in the ground, designed for assessing this pressure in soil, earth/rock fills, foundations, and concrete structures, functioning as instruments to gauge fluid pressure within systems, particularly utilized in hydrogeology to examine groundwater pressure at specific points. Additionally, the details on this approach given in the Table 6-6. The typical piezometer installation is shown in Figure 6-1.

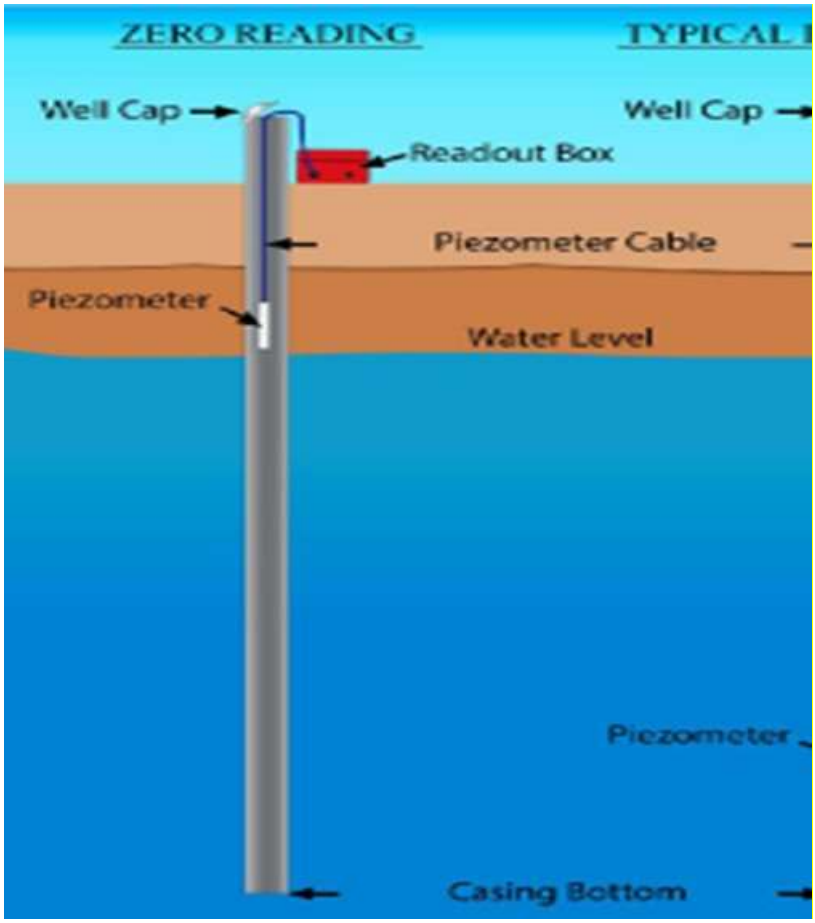


Figure 6-1 Typical section of piezometer

Table 6-5 Methodology of the piezometer

Principle	Parameters	Hydrostatic Pressure	Measurement Method	Data Interpretation	Application in Environmental Monitoring
Piezometers operate based on the principle of hydrostatic pressure within groundwater systems. When installed in the ground, piezometers consist of a sealed casing with a small opening or porous material at the bottom, allowing groundwater to enter. The groundwater level inside the casing rises to a height determined by the pressure exerted by the surrounding water table.	pH, Dissolved Oxygen, Conductivity, Temperature, Water pressure, Ground water level.	The height of the groundwater column inside the piezometer casing is directly proportional to the hydrostatic pressure exerted by the groundwater at that location. This pressure is influenced by factors such as the depth of the water table, the density of the groundwater, and the gravitational force acting on the water column.	Piezometers typically utilize a pressure sensor or transducer located at the top of the casing to measure the hydrostatic pressure exerted by the groundwater. This sensor converts the pressure into an electrical signal, which can then be recorded and analysed to determine the groundwater level.	The recorded pressure readings from the piezometer are converted into groundwater level measurements using established calibration equations. By monitoring changes in groundwater levels over time, environmental scientists and engineers can assess groundwater flow patterns, fluctuations in water table elevations, and potential impacts on the surrounding environment.	➢ Assess groundwater dynamics. ➢ Evaluate human influences on groundwater resources. ➢ Identify environmental risks. ➢ Evaluate the impact of construction, industrial operations, and other developments on groundwater and adjacent ecosystems.

7 Additional Studies

7.1 General

This chapter presents the results of the additional studies that have been carried out towards making a comprehensive and quantitative EIA. The additional studies are pertaining to three multidisciplinary areas. The first is concerned with the public consultation which will be held by pollution control board on receipt of draft report EIA/EMP report. The second is risk assessment study prevailing at present in the study area and the likely impact on it as a result of implementation of the proposed project. The third one is Social Impact Assessment that may arise due to the proposed project.

7.2 Public Consultation

(To be addressed on completion of public hearing).

7.3 Risk Assessment

Risk assessment is primarily carried out to identify and quantify the major hazards and the risk associated with disposal at project site, which may lead to emergency consequences (disasters) affecting the public safety and health. The emergency preparedness plan is prepared to mitigate the consequences. For this, the approach involves hazards identification, hazard assessment and evaluation. The following major hazards are anticipated in the proposed project:

- Hazardous pertaining to fires in SLF area
- Natural disaster (Earthquakes, flooding etc.)
- Electrical accidents
- Flooding from man-made causes
- Rainfall induced erosion
- Environmental & Health Aspects

7.3.1 Landfill Hazard

Like all industrial activities, there are inherent hazards associated with the operation of a landfill. Historically, accidents at landfills resulted as temporary nature - e.g. site roads, sharp bends and steep gradients due to vehicles & machinery operation are confined areas and in close proximity to each other. Reversing vehicles are a significant problem, particularly where staffs are required to cross the working area on foot or direct vehicles at the landfill face. Accidents can be minimized by the implementation of safety and training programmes and by effective site management.

These programs should include the following

- identification of potential sources of risk;
- assessment of the degree of risk from these sources;
- determination of procedures for addressing the risks;
- development of procedures to minimize accident/risks when they occur; and
- on-going monitoring to ensure proper implementation of safe working procedures
- Suitable protective clothing and equipment will be provided and maintained;
- emergency plans will be prepared and revised as necessary;
- unacceptable risks to health; and
- adequate welfare facilities for staff will be provided and maintained

It is a statutory requirement that the safety statement is up-dated in the light of changing circumstances at the site, any new legal requirement and good practice within the SLF. Risks to employees and others should be periodically re-assessed. Accordingly, the statement should be seen as an evolving, rather than static document. The Occupational Safety, Health and Working Conditions code, 2020 should be followed. All employees

should have read the safety statement, with managers and supervisors being fully aware of the statement's implications.

7.3.2 Safeguard Measures

7.3.2.1 Personnel

One or more persons within the organization must be formally designated in the Safety Statement with the responsibility for safety and for the implementation of the Act and Regulations. An important task is ensuring that all accidents are reported to the Health and Safety Authority if they involve an employee being on work for more than three consecutive days.

7.3.2.2 First Aid

- A first aid box should be available on site in a clearly marked location.
- The contents of the box should be monitored for use, so that supplies are checked regularly by a named individual responsible for its up keep. Eye wash facilities is available: these should either employ running water or involve non-reusable eye wash bottles.
- Any bottle with a broken seal must be disposed off immediately and replaced.
- The operator should arrange for recognized occupational first aid training, with a minimum of one person with a first aid qualification regularly present at site.
- All staff should be familiar with the first aid facilities available at site.
- The Health and Safety Authority should publish the guidelines on first aid.

7.3.2.3 Personal Protective Equipment

High visibility clothing should be provided and worn by all site staff and visitors. Safety boots, goggles and facemask should be issued to all site workers. They should have steel toecaps and have a steel insert in the sole to resist injury from projections of glass, metal or other items in the deposited wastes. Gloves should be issued as required.

The type of glove should be puncture resistant and should be suitable for the relevant task, e.g. litter collection, vehicle fuelling, cold weather conditions. Safety helmets and eye protection should be available as necessary. Ear defenders should be available for those driving site machinery or working in high noise areas. Operatives at landfill sites working all weather conditions and will need to be provided with suitable windproof wet weather clothing.

7.3.2.4 Landfill Gas

All site staff should be made aware of the possible hazards from landfill gas. Smoking on site should be forbidden except in designated areas in the site cabins. Buildings and other enclosed structures located at the landfill should be designed to prevent the accumulation of flammable gas within them. Facilities to permit the free circulation of fresh air will generally be required for buildings. It is imperative that all cabins, other store rooms and voids such as those below weighbridges and cabins should be regularly monitored for the presence of flammable gas. All service duct entries to buildings should be seen as possible gas pathways and hence appropriately monitored. Where it has been established that concentrations of landfill gas are above 20% of the lower explosive limit (LEL), the relevant building should be evacuated for venting purpose.

7.4 Safety measures at Landfill Site

The Occupational Safety, Health and Working Conditions code, 2020 should be followed for all safety measures at landfill site. In case of applicability of safety code 2020, the Irish code "The Safety, Health Welfare at Work (Construction) Regulations 1995 (SI No 138 of 1995) pertaining to SLF can be followed. Under the Regulations a project supervisor must be appointed for the design and development stages of all construction

works. A safety and health plan will be proposed. The purpose of the Plan is to co-ordinate health and safety requirements which may affect all persons present on the site. As construction is an on-going process at a landfill, the requirements of these regulations need to be addressed throughout the life of the site. In the light of these provisions, the operator should ensure the safety, health and welfare at work of all persons employed on the landfill. This duty should include the following priorities:

- the landfill should be constructed and maintained in a safe condition;
- a safe means of access to the site for staff and vehicles should be provided;
- SLF site and machinery should be maintained in a safe condition;
- risks should be appraised, and safe systems of work planned, organized and performed;
- suitable safety information, instruction, training and supervision should be provided

Regular site safety inspections should be undertaken by a designated safety officer in accordance with the safety statement. Written reports of inspections should be maintained at the site or at the operator's principal offices.

7.5 Natural Disasters and Other Hazards

Natural disasters such as earthquakes, cyclones, cloud bursts, and flash floods etc., pose an eminent threat to the proposed project. As there is no way of avoiding such disasters, the following measures can be adopted in case of such occurrences. The Natural Disaster and Action plan is given in Table 7-1 and the responsibility matrix as provided in the Ernakulam district Disaster Management Plan, 2015 is given in Table 7-2. Accordingly, the disaster management group will be working in coordination with district Disaster Management Authority. The checklist to be maintained at site is given in table 7-3.

Table 7-1 Natural Disaster and Action plan

Natural Disaster	Action
Earthquake	The project falls under seismic zone III, all the civil designs are meant to meet the above requirement. In case the earthquake occurs, the following precautions will be followed. ➢ Move to open area of the site ➢ People stay should stay outdoor and avoid being inner vicinity to any building or facility.
Cloud bursts	Cloud bursts are not common phenomenon in Kerala. However torrential rain is expected during rainy seasons. The following safety measures are advised; ➢ Stay Indoors and decide based on the situation ➢ Listen to the authorities and safety officials ➢ If there is any possibility of a flash flood, move immediately to higher ground elevation site/places.

Table 7-2 Responsibility Matrix

Time	Task	Depaartment/Agency
D-72 Hr	Warning and analyzing the information	IMD,SEOC,INCOIS
D-48 Hr	Evacuation, Arrangement of temporary shelters.	Revenue, Police, Coast guard
D-24 Hr	Mitigation Measures	Revenue, Police, Fire & Rescue, Health, Navy, Coast Guard, NGO's, PWD

D-0 Hr	Activate the Incident Command System	DDMA, Police, Fire & rescue, health
D+15 MIn	Serch and Rescue, Providings aids to affected people	Revenue, Police, Fire & Rescue, Health, Navy, Coast Guard, NGO's, PWD

Source: Ernakulam District Disaster Management Plan

Table 7-3 Checklist for Emergency Preparedness Measures

Sl. No.	Preparedness Measures
1	Update District Disaster Management Plan, twice a year containing phone numbers, officials, details of offices and facilities.
2	Check upon communication network, phone wireless, fax, internet, HAM, etc.
3	Identify by Hazard, Vulnerability and risk and prepare road maps of the district
4	Activate District and Sub divisional control rooms. Assign employees to the control room.
5	Fix the location of response base
6	Designate In-charge officials of the Response base
7	Convene meetings of District Disaster Management Authority
8	Convene NGOs, PRIs and ULBs meeting, Prepare a list of NGOs and PRIs with their functional specialization and geographical coverage.
9	Check the availability of food grains in PDSs shops and other stockings and distributors in the district
10	Prepare a list of Relief Items for distribution in the height of local habits, customs etc.
11	Determine quantity, quality of relief items as per minimum standards, and expenditure to be incurred on it.
12	Prepare a transport and alternate transport plan for evacuation and distribution of relief.
13	Prepare a media plan for dissemination of information to the people of the district; local newspaper, radio, TV and cable etc.
14	Ensure appropriate stocking of relief material received from outside.

Source: Ernakulam District Disaster Management Plan

7.5.1 Environmental & Health Aspects

There are potential risks to environment and health from improper handling of solid wastes. Direct health risks concern mainly the workers in this field, who need to be protected, as far as possible, from contact with wastes. For the general public, the main risks to health are indirect and arise from the breeding of disease vectors, primarily flies and rats.

The most obvious environmental damage caused by inert wastes is aesthetic, the ugliness of littering and degradation of the urban environment and beauty of the landscape. More serious and often in negligence is occurrence of pollution to surface water and ground water. Air pollution can be caused from the emanation of methane from the SLF site, either in open air, or in SLF's that lack effective collection facilities from the gaseous effluents. The generation of stinking odour around the site is a major source of discomfort amongst the inhabitants. The local wind conditions may aggravate this problem further.

Epidemiological studies have shown that a high percentage of workers who handle refuse, and of individuals who live near or on disposal sites, are infected with gastrointestinal parasites, worms and related organisms. Contamination of this kind is likely at all points where waste is handled. A major adverse impact is due to the attraction of rodents and vector insects for which it provides food and shelter. Further the decomposing matter in the land fill is the beehive for flies, other insects and disease vectors such as cholera, typhoid, dysentery, malaria, jaundice and other communicable diseases particularly skin problems, nausea, vomiting, headaches induced in the in habitants around the site.

The workers and rag pickers working at the site fall prey to such diseases who come in direct contact with the potential risks as described in terms of various diseases. Respiratory diseases are prevalent amongst the workers due to fugitive dust and particulates generated during the handling and unloading operations. Another aspect involved is injuries involved during working at the site. Many a times, the Inert contains piece of broken glasses, piercing wires, stones etc. remains unnoticed and undetected while working which may afflict with severe injuries which are potential to other form of diseases such as septic deterioration of wounds, and or other communicable diseases.

The SLF site is located in an isolated place where habitants are not identified. The nearest settlement is located at a distance of 600 m. From the historical wind rose, it is evident that the wind direction is towards east which is represented in Figure 7-1. It can be seen from the figure, that the nearest settlement in the east is about 3.15 km. Hence, the potential impact due to SLF is not expected. A periodic health checkup of the workers operating in the area needs to be done to identify and control the diseases. It shall be very helpful in knowing the prevailing conditions by organizing health checkup camps for the workers and also the inhabitants in the neighbourhood.

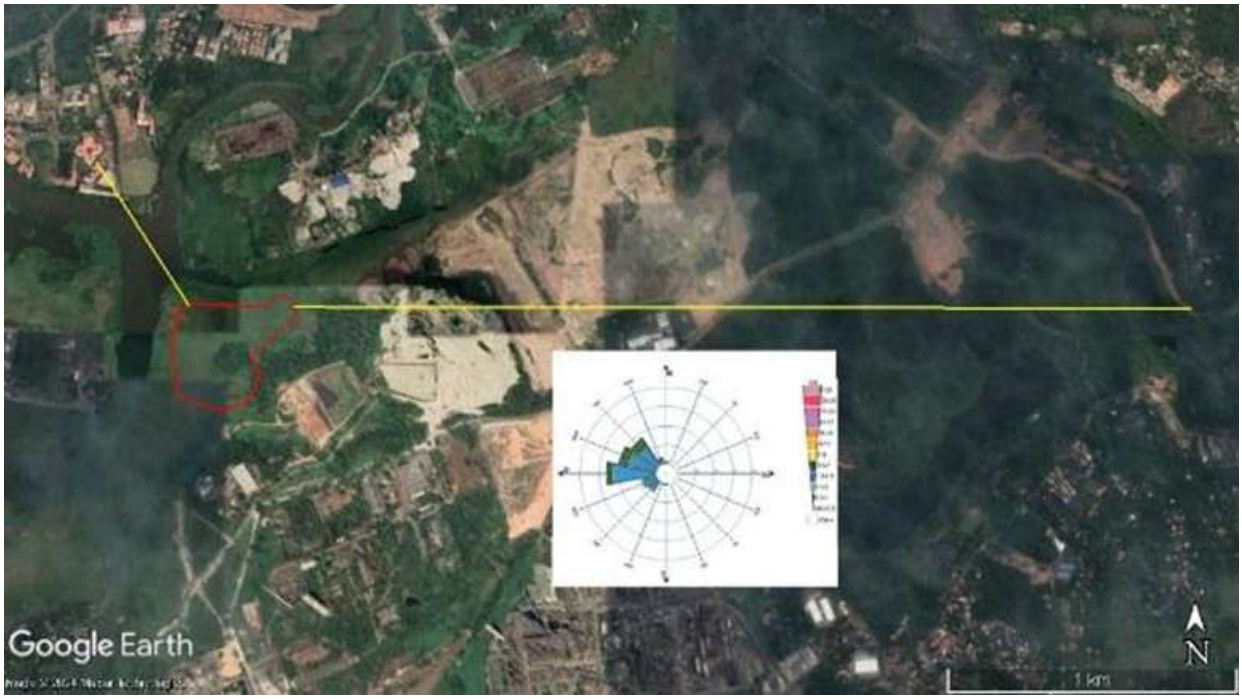


Figure 7-1 Wind rose direction towards east

7.6 Disaster Management Plan (DMP)

The objective of disaster management plan is to localize a disaster and to the maximum extent possible contain it to minimize the impact on life, the environment and property. The disaster management plan is broadly divided into following steps as given in Figure below



Figure 7-2 Steps for DMP

7.6.1 Nature of Emergency

The emergencies at the proposed SLF can be broadly classified into three levels:

Level - 1:

The leakage of methane gas or emergency related to that, which is confinable within the SLF area. It may be due to -

a) Local fire within the SLF area

b) Collapsing of equipment/slope that do not affect outside premises.

Level- 2:

The emergency, which is confinable within the SLF area. It may arise due to -

a) Major fire inside the SLF premises.

b) Medium scale explosion confined to the SLF premises.

c) Heavy toxic/flammable gas leakage for short duration.

Level - 3:

The emergency, which is not confinable within the SLF premises and general public in the vicinity likely to be affected. It may arise due to -

a) Explosion of high magnitude affecting the adjacent area

b) Heavy / Profuse leakage of toxic / flammable gases for a long duration.

7.6.2 Objectives of DMP

The objectives of the emergency management system are summarized as under.

- To identify and assess types of emergencies due to different types of hazards.
- To work out plan with all provisions to handle emergencies and safeguard employees and people in the vicinity of the SLF.
- To provide for emergency preparedness and the periodical rehearsal of the plan.
- To plan mode of proper communication and actions to be followed in the event of emergency.
- To keep all necessary information with respect to hazard/accident control and emergency contacts in one document for easy and speedy reference.
- To inform employees, general public and the authorities about the hazards/risk if any and the role to be played by them in the event of emergency.
- To control and contain the accident.

- To effect rescue and treatment of casualties.
- To inform and help relatives of casualties.
- To secure rehabilitation of affected area and restore normalcy.
- To provide information to media and government agencies.
- To preserve record, equipment etc. for investigating cause of emergency.
- To be ready for “mutual aid” if need arises to help neighbouring units.

7.6.3 Action On-Site

The emergency time activities shall be divided into two parts viz.

- Pre-emergency activities
- Post-emergency Activities

7.6.3.1 Pre-Emergency Activities

Internal Safety Survey

A safety committee shall be constituted as per Factories Act. The nominated members of the committee shall be assigned the responsibility to conduct safety survey once in a month before safety meeting. The internal safety survey includes –

- Identify various hazards in the premises
- Check whether protective equipment’s are in sound working condition
- Check various safety installations located at various locations for proper working
- Check sprinklers, showers, etc.
- Suggest extra modifications/ requirements to make systems more reliable
- Check presence of toxic gases by the help of dragger tube

Third Party Survey

A safety survey shall be carried out once in two years by an external agency. It shall include –

- Inspection of building, structures for strength and stability
- Identify and study the hazards inside SLF area including leachate treatment plant & pond.
- Check safety system for its adequacy.
- Suggest modifications or additions in the operating practices and safety system, if necessary.

Vessel/Machineries Testing/Examination

- To carry out preventive maintenance of valves & fittings on all machinery (valves, pipelines, pressure gauge, all related instruments and emergency vent lines)
- To arrange for testing and examination of all machineries as per the rules of Factories Act by govt. certified competent person on due date.
- To maintain record of testing and certificates issued by competent person and make them available to Factory Inspector at the time of inspection.
- Frequency of Pressure Vessel Testing / Examination: Twice in a year

Fire System Testing

To prepare list of various fire-fighting equipment (Fire Extinguishers, etc.) Installed at various locations in the unit along with detailed specifications.

- To prepare schedule for testing of all this equipment and check operability
- To maintain record of testing and mark dates of testing on the equipment.
- To carry out repairs/replacement of defective equipment

- Frequency: Once in a month

Mutual Aid Scheme

Oil storage /processing units and fertilizer plant surround the proposed SLF. Already a mutual aid scheme is under practice. The same will be extended to SLF or the SLF operating authority will prepare a mutual aid scheme, which is compaction with existing mutual aid scheme, and enter into agreement with the neighbouring units for getting or extending help during emergency

- To appoint coordinator for follow-up under mutual Aid Scheme
- To review the scheme once in a year with coordinators of neighbouring units w.r.t. Scope of help, type of aid, contact persons, etc.
- To include the scheme in mock drills

Mock Drills

- To conduct minor mock drills to train employees about their role / duties during emergency
- To check whether various members of emergency control committee remember their role / duties properly and to find out the faults and points of improvement in their performance.
- To check whether the various equipment for emergency control are operating satisfactorily and find and rectify the draw-backs if any.
- To conduct major mock-drills with permission from the authorities
- Emergency Control Organization shall regularly conduct mock drills in our unit and the findings are compiled to analyse whether employees are familiarized with the emergency control procedures and what sort of training is required to be given.

Safety Training

To organize regular training for the employees for handling of safety equipment, use of personal protective equipment, first-aid, etc. by internal/external faculty, as well as by sending persons outside to attend safety programs etc. The topics covered in safety training will be –

- Training on fire fighting
- Training on toxic release control
- Training on good housekeeping
- Training on use of PPE

The Safety and Environmental department shall maintain the records of the training programs. New topics will be included in the safety training programs year by year to upgrade safety knowledge among the workers.

Personal Protective Equipment

To procure adequate number of personal protective equipment (aprons, hand gloves, safety goggles, helmets, masks, safety belts, gas cartridges, self-breathing apparatus, safety shoes etc.) suitable for SLF operations and maintain records of use.

- To have proper system for issuing the PPE and disposal of used PPE
- To train the workers about proper use of PPE.
- To check the fresh air blowers provided at confined spaces for fresh air to workers.

Communication

- To maintain internal/external telephones in working order
- To check alarms / siren / loudspeakers for workability
- To provide manual emergency bells at various location for use during power failure
- To periodically check wind pane.
- To check lightning arrestors installed at different locations for physical condition and proper earthling connection.

7.6.4 Post–Emergency Activities

These activities are to be carried out after an emergency is over to establish the cause of the emergency and decide the measures to be taken to prevent its re-occurrence. These activities are –

1. Collection of records of accident, injury, damage to property, buildings, equipment, material and loss of production
2. Conducting enquiries and concluding preventive measures
3. Making insurance claim for the materialistic loss / damage
4. Implementation of enquiry report's recommendations
5. Rehabilitation of affected persons within and outside the plant
6. Restarting the plant and normalizing the operations.

Control Action

1. Anyone who notices the release shall inform to IC and IC shall ask security to wail emergency siren.
2. IC who is at site, shall immediately rush to the scene and assess the situation. For toxic release from a reactor, he activates the on-site plan as -

- He/She evacuates all the persons to safe assembly point.
- SMC informs mutual aid teams and asks for necessary help.
- Mutual aid teams shall be asked for help in the form of first-aid, transport etc.
- The essential workers stop all the charging pumps of that reactor and the nearby reactors.
- HR head arranges first-aid / hospitalization for the affected persons.
- Maintenance department will attend the vessel / rupture disc/gland packing.
- The incident shall be recorded
- SMC arranges to inform families / relatives of injured / dead.
- SMC issues authorized statement to press / media.
- SMC informs Factories Inspector about the incident and related information

Evacuation & Transportation

All non-essential workers shall be evacuated from incident area and adjacent areas to safe assembly points. Assembly points shall be clearly marked and assembly point incharge will also be designated. The assembly point in-charge will be a well-trained supervisor who shall keep record of persons arriving at the assembly point and direct them for proper gathering. He shall also inform the ECC about the persons gathered at the assembly point. Those in need of medical treatment shall be transported to first-aid center / hospital as the case may be. In case of major emergency all non-essential workers shall be transported to temporary shelter.

Safe Close - Down

As per the instructions from IC or SMC, the essential workers shall close down some parts or full of the SLF.

Use of Mutual Aid

Mutual aid from neighboring units shall be called up as and when required. The aid shall be taken under the supervision of SMC.

Help of External Authorises

Outside authorities such as Police, District Emergency Authority (DEA), Factory Inspector, Disaster Management Centre, Nearest GIDC officer, Industries Association, Regional Pollution Control Board, nearby hospitals etc. shall be informed of the on-site and off-site emergency plans and called in as per need.

Medical Treatment

Injured workers shall be located and given prompt first-aid by essential workers and key personnel. Those requiring medical treatment shall be taken to the hospital / outside medical center.

Accounting for Personnel

Through daily muster rolls and with the help of shift-in-charge the head count shall be undertaken to find out whether persons are missing and if so immediate search shall be carried out to locate them. The list shall include company employees, contract workers as well as visitors. Help from local authority or fire-brigade shall be taken if required. This list shall be kept with time keeper / security officer at any time and shall be used to account for personnel. Injured shall be taken to hospitals and their families/relatives shall be informed Casualties would be identified, their families and local authority shall be informed.

Access to Records

In order to inform families/relatives of injured/dead, a up-to-date list of names and addresses of all the workers is maintained in addition to the muster roll where shift-wise attendance is marked. Such list includes health records. This list will be available at the ECC and one such copy shall be available at our head office.

Public Relations

SLF IC shall be the only nominated person to issue administrative statement about the accident or emergency to news/media. No other person shall divulge any information to any news / media person.

Rehabilitation

In case of fire, the Senior Fire-Brigade Officer shall ensure that the area is cooled down and there are no chances of re-ignition. IC shall arrange for clean-up of the area and then only people shall be allowed to re-enter the area for work. Even when all clear has been given, great care shall be taken when re-entering affected areas and no work in connection with the salvage, collection of evidence or start up shall be taken up until a thorough examination of the area has been carried out. The statutory powers of the Factory Inspector shall be kept in mind before any evidence is disturbed. Particular care shall be taken to avoid the introduction of possible sources of ignition, such as diesel engines, hand or power operated tools, flame cutting equipment, etc. until it has been established that no flammable materials are present where they could be ignited.

7.7 R & R Action Plan

The land is allotted by KINFRA and it is a grass land and devoid of any habitant /encroachment. Hence, R&R is not envisaged.

7.8 Socio – Economic Environment

Social Impact Assessment is a major pre-requisite to begin any new project. The assessment is made through a socio-economic survey and secondary data analysis. 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, wage income, market effects, public services, retail business, quality of life and artistic qualities of the community. Qualitative assessment of community perceptions about the development is considered as an important measure of the proposed project impacts. Assessing proposed developments in socio-economic context will help the community leaders and local people to identify potential social equity issues, evaluate the adequacy of social services and determines whether the project has adverse effect on overall social well-being or not.

7.8.1 Methodology

The socio-economic profile has been studied through random sampling of primary surveys, secondary data and conducting FGD. Primary census abstract 2011 is the main source of secondary data. Collection and evaluation of baseline data for various socio-economic parameters in and around the proposed sites has been carried out. On the basis of a preliminary reconnaissance survey, a questionnaire was developed to make it suitable to fulfill the objectives of the study. The data collected during the above survey was analyzed to evaluate the prevailing socio-economic profile of the area.

The project area is situated in an industrial area. But after considering the 10 km radius as Buffer zone it is identified that there are Six (6) villages and Four (4) urban areas falling in the study area.

7.8.2 Baseline Information

Baseline data according to the 2011 census Ernakulam district has a total population of 32,82,388. The male population is 16,19,557 and female population is 16,62,831. The sex ratio of Ernakulam is 1027 per 1000 males and under (0-6) age group the sex ratio is 961.

As mentioned in the methodology Kunnathunad is the sub district and the total project areas falling under this Taluk. Kunnathunad comprises of both rural and urban areas. Six villages and four urban areas are falling under the 10 km buffer zone from the project site. Among these villages Vadavukode has the lowest population and there are only two schedule tribes are resides in this area. The population ratio is almost equal in every village. Along with Kerala, the literacy level is also reached above 94% in average for these villages. The Census Town has population of 22,881 of which 11,360 are males and 11,521 are females as per report released by Census India 2011.Population of Children with age 0-6 is 2,490 which is 10.88% of Kunnathunad (CT). In Kunnathunad Census Town, Female Sex Ratio is of 1,014 against the state average of 1,084. Moreover, Child Sex Ratio is around 971 compared to Kerala State Average of 964. Literacy rate of Kunnathunad town is 94.32% higher than the state average of 94.00%. In Kunnathunad male literacy rate is around 96.79% while female literacy rate is 91.90%. Among the populations 37.20% are Hindus followed by Muslims (33.21%) and Christians (29.51%). There are a few other religions consisting only 0.02%. Schedule

Caste (SC) constitutes 17.95% while Schedule Tribe (ST) are 0.27% of total population of Kunnathunad. It has total administration over 5,377 houses to which it supplies basic amenities like water, electricity and has a underground sewage collection system. Majority of population are engaged in work or Business activity. In Census survey, worker is defined as person who does business, job, service, cultivator and labour activity. Almost 85.98% of total population is engaged in Main work while 14.02% of total workers are engaged in marginal work. The eastern part of the district is primarily agrarian in nature. Rice is the principal crop cultivated in the wet lands. The area under paddy cultivation in the district has been decreasing steadily over the past 3 decades. Ernakulam district is the largest producer of nutmeg and pineapple in the state.

7.8.3 Demographic pattern

The population parameters of Ernakulam district is shown in Table 7-4.

Table 7-4 Population Parameters of Ernakulam District

S.No	Description	2011 Actual	2025 Estimated
1.	Population		
A	Rural	10,48,025	22,83,339
B	Urban	22,34,363	48,48,733
	Total	32,82,388	71,32,072
2.	Population Density	1072	-
3.	Decadal Growth Rate	5.69%	-
4.	Sex Ratio (per 1000 males)	1027	-

Population is projected @5.69% as per 2011 census

The demographic population of rural is 10,48,025 and the urban is 22,34,363 and the total is 32,82,388. The population density is 1072 and the decadal growth rate is 5.69%. The sex ratio is 1027. The social profile of Ernakulam district is given in Table 7-5.

Table 7-5 Social Profile of Ernakulam district (2011 Census)

S.	Description	Ernakulam district
1	Total geographic area (in sq km)	3,068 square kilometers
2	Total population (2011)	32,82,388
3	Male population (2011)	16,19,557
4	Female population (2011)	16,62,831
5	Literacy (2011)	95.89%
6	Major occupation	The major occupations are industry, agriculture and tourism.
7	Major crops	Rice is the principal crop cultivated in the wetlands. The district is the largest producer of nutmeg and pineapple in the state: more than 55% of pineapples produced in the state is cultivated in the district.

The total geographical area of Ernakulam district is 3,068 sq. kilometer. The male population is 16,19,557 and the female population is 16,62,831. The literacy rate is 95.89%. The major occupations are industry, agriculture and tourism. The population of

10km radius of project area including municipal corporation is as follows. The population also includes 7 villages falling within 10km radius.

7.8.4 General information about the project site

The SLF site is adjacent to the factory areas of FACT – CD and away from the residential area. The borders of the district are surrounded by the Arabian Sea in the West, Thrissur District in the North, Idukki District in the East and Alappuzha and Kottayam District in the South.

7.8.5 Study area

The study area consists of the core area and the buffer zone. The core area is where the project is expected to come up and a buffer area encircling the project area with a radius of 10 kilometers from the periphery of the project site. Kochi in Ernakulam is a Municipal Corporation and there are 11 Municipalities. In Ernakulam there are 14 Development Blocks and 88 Panchayats. The language people speaks in Ernakulam is Malayalam which is the mother tongue of Kerala. The list of the local bodies within 10km radius from SLF site is given in Table 7-6. The Demographic details and Occupational pattern of the study are given in Table 7-7 & 7-8.

Table 7-6 List of local bodies within 10 km radius from SLF site

Sl. No.	Local body	Study area
1.	Vadavucode puthencruz panchayath	Project Site
2.	Thripunithura municipality	Local bodies within the study area of 10km radius
3.	Thrikkakara municipality	
4.	Kochi corporation	Local bodies within the buffer zone of the study area
5.	Kizhakkambalam panchayath	
6.	Thiruvaniyoor panchayath	

The study area of Vadavucode Puthencruz panchayath is rural area in which the number of households are 5,638. The total number of population is 22,378 in which the male and female population is 11,014 and 11,364. The male and female scheduled caste population is 2,348 and 2,385. The male and female schedule tribe population is 331 and 360. The male and female literate population is 70,061 and 68,749. The thripunithura municipality is the urban area in which the number of households are 28,971. The total number of population is 92,550 in which the male population is 45,298 and the female population is 47,252. The male and female scheduled caste population is 5,175 and 5,375. The male and female scheduled tribe population is 131 and 127. The male and female literate population is 41,045 and 42,204.The Thrikkakara municipality is urban area in which the number of households are 19,348. The total number of population is 77,319 in which the male and female population is 38,035 and 39,284. The male and female schedule caste population is 3,487 and 3,636. The male and female scheduled tribe population is 188 and 192. The male and female literate population is 33,348 and 33,353. The Kochi corporation is the urban area in which the number of households are 1,58,535. The total number of population is 6,33,533 in which the male and female population is 3,12,358 and 3,21,195. The male and female scheduled caste population is 10,893 and 11,393. The male and female scheduled tribe population is 1,214 and 1,130. The male and female literate population of Kochi corporation is 2,77,690 and 2,82,463. The Kizhakkambalam panchayath is the rural area

in which the total number of households are 5,551. The total number of population is 23,186 in which the male and female population is 11,375 and 11,811. The male and female scheduled caste population is 1,072 and 1,095. The male and female scheduled tribe population is 27 and 44. The male and female literate population is 9,918 and 9,912. The Thiruvaniyoor panchayath is the rural area in which the total number of households are 6,413. The total number of population is 25,327 in which the male and female population is 12,438 and 12,889. The male and female scheduled caste population is 2,348 and 2,385. The male and female scheduled tribe population is 74 and 99. The male and female literate population is 9,733 and 9,677. The demographic details are shown in Table 7-7. The occupation pattern of the study area is shown in Table 7-8.

Table 7-7 Demographic Details of the Study Area within 10km radius

Sl. No.	Name of Settlement	Rural/ Urban	No. of House Holds	Population			Schedule Caste		Schedule Tribe		Literate	
				Total	M	F	M	F	M	F	M	F
1	Vadavucode puthencruz panchayath	Rural	5638	22378	11014	11364	2348	2385	331	360	70061	68749
2	Thripunithura municipality	Urban	28971	92550	45298	47252	5175	5375	131	127	41045	42204
3	Thrikkakara municipality	Urban	19348	77319	38035	39284	3487	3636	188	192	33348	33353
4	Kochi corporation	Urban	158535	633533	312358	321195	10893	11393	1214	1130	277690	282463
5	Kizhakkambalam panchayath	Rural	5551	23186	11375	11811	1072	1095	27	44	9918	9912
6	Thiruvaniyoor panchayath	Rural	6413	25327	12438	12889	2348	2385	74	99	9733	9677
	Total		2,24,456	8,74,293	4,30,518	4,43,795	25,323	26,269	1,965	1,952	4,41,795	4,46,358

Sources: ernakulam.nic.in/en/census

Table 7-8 Occupational Pattern of the Study Area

Sl.	Name of Settlement	Total Workers		Main Workers		Cultivators		Agricultural Labor		Other Workers		Marginal Workers		Non-Workers	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F
1	Vadavucode puthencruz panchayath	6234	2529	5301	1817	126	17	138	35	4962	1736	933	712	4780	8835
2	Thripunithura municipality	25252	11185	22786	9540	51	16	116	64	22279	9317	2466	1645	20046	36067
3	Thrikkakara municipality	20753	8214	18853	6623	81	23	132	51	18367	6445	1900	1591	17282	31070
4	Kochi corporation	178407	62384	167234	52849	193	117	664	216	163445	51576	11173	9535	133951	258811
5	Kizhakkambalam panchayath	6430	2645	5692	1883	363	71	323	144	4914	1641	738	762	4945	9166
6	Thiruvaniyoor panchayath	7151	3205	6420	2509	99	43	88	104	5347	2133	731	696	5287	9684
	Total	244227	90162	226286	75221	913	287	1461	614	219314	72848	17941	14941	186291	353633

Sources: ernakulam.nic.in/en/census

The above Table 7-8 is the occupational pattern of the study area. The total number of male and female workers in Vadavucode puthencruz panchayath is 6,234 and 2,529. The male and female main workers are 5,301 and 1,817. The male and female cultivators are 126 and 17. The male and female agricultural labor are 138 and 35. The male and female other workers are 4,962 and 1,736. The male and female marginal workers are 933 and 712. The male and female non-workers are 4,780 and 8,835. The total workers of male and female population in Thripunithura municipality is 25,252 and 11,185. The male and female main workers are 22,786 and 9,540. The male and female cultivators are 51 and 16. The male and female agricultural laborers are 116 and 64. The other workers of male and female population is 22,279 and 9,317. The male and female marginal workers are 2,466 and 1,645. The non-workers of male and female population is 20,046 and 36,067. The total workers of male and female population in Thrikkakara municipality is 20,753 and 8,214. The main workers of male and female population is 18,853 and 6,623. The male and female cultivators are 81 and 23. The male and female agricultural laborers are 132 and 51. The other workers are male and female population is 18,367 and 6,445. The marginal workers of male and female population is 1,900 and 1,591. The non-workers of male and female population is 17,282 and 31,070. The total workers of male and female population in Kochi corporation is 1,78,407 and 62,384. The main workers of male and female population is 1,67,234 and 52,849. The male and female cultivators are 193 and 117. The male and female agricultural laborers are 664 and 216. The other workers of male and female population is 1,63,445 and 51,576. The marginal workers of male and female population is 11,173 and 9,535. The non-workers of male and female population is 1,33,951 and 2,58,811. The total workers of male and female population in Kizhakkambala panchayath is 6,430 and 2,645. The male and female population of main workers are 5,692 and 1,883. The male and female cultivators are 363 and 71. The male and female agricultural laborers are 323 and 144. The male and female population of other workers are 4,914 and 1,641. The male and female marginal workers are 738 and 762. The male and female non-workers are 4,945 and 9,166. The total workers of male and female population in Thiruvaniyoor panchayath are 7,151 and 3,205. The male and female main workers are 6,420 and 2,509. The male and female cultivators are 99 and 43. The male and female agricultural laborers are 88 and 104. The other workers of male and female population 5,347 and 2,133. The male and female marginal workers are 731 and 696. The non-workers of male and female population is 5,287 and 9,684

7.8.6 Social Composition of Ernakulam District

From the baseline data, it can be observed that Ernakulam consist of total population 32,82,388 as per official census 2011 and projected population as on 2024 of Ernakulam district is 34.78 lakh population. Hindu are majority in Ernakulam state. Hinduism constitutes 45.99% of Ernakulam population. Christian plays important role in electoral of Ernakulam state forming significant 38.03% of total population. Muslims forms about 15.67% of total population. The other religion like sikh, buddhist, jain constitutes about 0.30%, 0.20% and 0.04% respectively

The Nairs, Brahmins, Ezhavas, Viswakarma, Nadars, scheduled castes, and 11 tribes form the majority of the Hindu community. Christians belong mainly to the Latin Catholic Church, the Malankara Catholic Church, the Church of South India and the Syriac Orthodox Church. The Muslim community forms second major division of the total population. Economic, social, and other ties bind the members of religious groups at the local level. People co-exist peacefully, influencing and being influenced by one another's culture. The project would be promoting employment and improving the living standards of local population. Most of the population in this region is engaged in industrial activities.

The proposed site is surrounded by Aluva, Kochi, Kanayanur, Kuthanaud and Paravur taluks and the social composition of these taluks have been collected and detailed below. The hindu population in Aluva is 41.83% and the chrisitan population is 38.86% and the muslim population is 18.93%. The jain population is recorded 0.01% in Aluva taluk. The religious composition of Kanayannur shows that the hindu and the Christian population is 63.35% and 36.33% respectively whereas the muslim population is 0.21%. In case of Kunnathunad the hindu and Christian population is 37.20% and 29.51% respectively. The muslim population is recorded as second highest i.e. 33.21%. The religious population in Kochi recorded with in 43.78% for hindu and 38.12% for christian. The muslim population is 17.56% and the sikh population is 0.08%. The buddhist and jain population is 0.04% and 0.17% in Kochi area. Studying the overall social composition it is observed that the hindu population is predominant followed by Christian population.

7.8.7 Economy of Ernakulam District

The media and information technology sectors are mainstays of Ernakulam district's economy, and other major sectors are tourism, agriculture, and education. India's first animation park, the KINFRA Animation Park, is in the district. As of 31 March 2023, Kerala State Industrial Development Corporation (KSIDC) units employed 9,262 people and had invested Rs. 3439.4 million. In 2002, there were 901 registered working factories, including oil mills, cashew factories, Cotton mills, Sawmills, printing units, rubber industrial units, chemical units, match factories, general engineering units, and automobile workshops. It contributes 41.74% of the total state revenue. The sea along the entire coast of the district and the backwaters abound in fish of various kinds offer enormous natural facilities for both marine and inland fisheries. Kochi is an ideal place that supports fisheries in its various aspects like education, research and development.

As the economy is justified based on the region which is having potential for tourism, port and harbor, fisheries, information technology facilities and agriculuture. The site is located in Ernakulam district which is having the above potential. With respect to site it is located within the industrial area like FACT, oil companies like HPCL, IOCL, BPCL LPG Bottling plant,etc., The site is devoid of any specific tourist spots of attraction. However, Ernakulam is located at a distance of 5km which is having all the above mentioned facilities. Hence the people’s economy dependent on the above sources.

7.8.7.1 Agriculture

Agriculture department deals with the formulation and implementation of various programme to augment production of both food crops and cash crops in the State. It undertakes activities among farmers to promote scientific methods of cultivation plant protection etc. and also arranges the supply of high yielding varieties of seeds, seedlings, planting materials and plant protection chemicals to farmers. The department also formulates policies and programme relating to provision of credit to farmers. Agricultural Research, Education and Extension are three important functions of the department. It runs agricultural farms and also has an engineering wing.

Ernakulam district in Kerala, India, is known for its rubber, coconut, and vegetable production. The district also grows other crops, including bananas, pineapple, and tubers.

Crops grown in Ernakulam

- **Rubber**: The most-grown cash crop in the district, covering 40% of the total cultivated area
- **Coconut**: The second most-grown crop, with over 17 crore coconuts produced in 2021-22
- **Vegetables**: The district produced 52,694 tonnes of vegetables in 2021-22
- **Fruits**: The district produced 23,290 tonnes of fruits in 2021-22
- **Tubers**: The district produced 10,990 tonnes of tubers in 2021-22
- **Bananas**: The district produced 77,056 tonnes of bananas in 2021-22
- **Pineapple**: The district produced 58,571 tonnes of pineapple in 2021-22
- **Areca nut**: The district produced 3,033 tonnes of areca nut in 2021-22
- **Nutmeg**: The district produced 5,362 tonnes of nutmeg in 2021-22
- **Cocoa**: The district produced 782 tonnes of cocoa in 2021-22

Organic farming

In 2022, the district expanded organic farming to 7,000 hectares

The district has formed groups to promote organic farming and vegetable production.

The area under nutmeg cultivation is showing an upward trend continuously. More than 55% of the total pineapple produced in the state is cultivated in the district. Pineapple is largely cultivated in Muvattupuzha and Vazhakulam. Rubber is the most cultivated plantation crop in the district and the district is the second largest producer of rubber in the state behind Kottayam. The other important crops cultivated in the district bare Tapioca, Black Pepper, Arecanut, Coconut, turmeric, Banana and Plantain.

7.8.7.2 Culture

There is no notable churches and temples were identified within the 10km of radius. However a small temples, churches and mosques are found in the villages within 10km radius.

A strong film culture prevails in the district. The city is home to animation companies, including Toonz India Ltd. & Tata Elxsi Ltd. The KINFRA Film and Video Park, Near the Technopark, is an advanced film and animation production facility.

However, beyond 10km radius there are a few important historical places which reflects the culture of the project area is detailed below. Tradition is that this church was founded by the Three Kings who visited Jesus. St. Mary's Church (Cheriapally) at Angamaly was founded in 405 A.D. Adi Shankaracharya was born in Kalady town of the district, which is considered as a major pilgrimage centre for Hindus around the world. Kallil Kshethram (Jain temple) near Perumbavoor is very famous temple. The eight-day lent (Ettunombu) fest at St. Mary's Jacobite Syrian Valiyapally, Thamarachal is a very famous religious event in Ernakulam. St. George Jacobite Syrian Orthodox Church at Kadamattam near Muvattupuzha is very old and was founded by Mar Abo Syrian Metropolitan in the 5th century A.D. He brought a cross from Persia, which is preserved in the church. The festival at the Latin church of Vallarpadam on 24 September attracts people belonging to all religions. The icon of Virgin Mary in this church is credited with many miracles. Celebrating the full moon day has two purposes. For the beginning of field cropping with prayers and some puja. On this day women of India generally having fasted of full day and pray for her brothers, father, husband and Nation.

7.8.7.3 Basic Amenities

The project site is endowed with basic amenities like Education Institutes, Medical facilities, Postal Services, Electricity and Water Supply, Road Connectivity and Network, Transport and Commutation facility, Drainage and Sanitation and they are detailed below:

Educational

The project site is located at village Puthencruz which is 16 km away from Ernakulam which has facility of all levels of schools and colleges. The Rajagiri School of Engg. & Tech. (Kakkanad) is about 1.2 km, in NW direction, The Rajagiri Chritsu Jyanti Public School is about 1.6 km in North direction and Dawn International School is about 3.8 km in West direction. The institutions are accessible by private and public transports. Most of the institutes are having their own transport which facilitates the commutation. The details of the educational institution as follows.

a) Government Schools – 34
b) Private Aided Schools – 67
c) Unaided Schools – 31
d) CBSE Schools – 62
e) IGCSE Schools – 2
f) ICSE Schools – 9
g) Humanities and Social Science Colleges – 38
h) Teaching and Education Colleges – 28
i) Science Colleges – 27
j) Nursing Colleges – 23

The number of libraries in Ernakulam District is 417.

Medical

Ernakulam has all medical facilities like Nursing Home, Charitable Hospital, and Civil Hospital besides many private clinics which are about 16 km from the project site village Puthencruz. Ernakulam Medical centre at Chakkalakkal Kochi is about 5.6 km, in NW direction, Sunrise Hospital at Kakakand 5.1 km in North direction, Medical Trust Hospital at Pallimukku Kochi is about 8.4 km in SW direction. The people access these facilities either by public or private transport facilities. The Ernakulam is connected with local government and private transports. The hospitals as available in the district is follows.

a) Allopathic Hospitals – 94
b) Govt. Ayurveda Hospitals – 13
c) Homeo Hospitals – 3
d) Community Health Centre – 23
e) Primary Health Centre – 75
f) Mental Health Centre – 5
g) Sub Health Centre – 410.

Electricity

Electricity is available in all villages of study area.

Housing and Drinking water

The study area falls in urban part of Kerala and most of the houses in the study area are pucca houses. During the study period thatched houses are unnoticed. If at all if it is there, it may be negligible in number. It is also observed that all the houses are having

dug wells which were used for drinking and domestic purposes. The drinking water needs also met by tube wells. The KWA Municipal pipe water supply also available which can be tapped on payment basis. Some of the houses utilize tube well for drinking and domestic purpose. It is worth to mention here the dug wells as available are secured and well protected from the event of falling leaves and dust from the surrounding environment by covering with suitable nets.
There are multiple sources of drinking water in Ambalamedu, Ernakulam, including 24-hour water suppliers by municipality.

Transport

The proposed scientific landfill site is not well connected either by MDR or by village roads. Hence, there is no transport facility is available to reach the site. However unmetalled roads are existing to connect the various parts of the site. The site is mainly approachable by motorable road through FACT junction.

The general mode of transportation is by road. Private vehicles like rented Cars, Taxis, Auto Rickshaws and private buses services share a major responsibility of the transport in the study area. Numbers of buses, private and state Government operated public transport like Kerala State Road Transport Corporation (KSRTC) is rendering road services to connect urban, sub-urban and rural area. The existing local transport facility appears to be sufficient. Cochin International Airport is located 18.90 km away from the project location and the nearby railway station (Ernakulam) 8 km away from the project location. The leading bus depot in ambalamedu.

Post Office and Telecommunication
The nearest post office is Eroor Sub-Post office which is located at a distance of 3.3km in south-west direction of the project site.There are many network providers in Ernakulam, including broadband and mobile service providers. Some of the popular broadband internet service providers are Airtel, Asianet, BSNL, JioFiber and Hathway. The study area is connected through mobile network.

Place of Historical or Archaeological Interest
No place of Historical or Archaeological importance exists near the proposed project site. But the district Ernakulum is famous for its ancient temples, churches, and mosques. Ernakulam district also hosts the highest number of international and domestic tourists in Kerala state. Malekkurish Church Pallikkara commonly known as ‘Malekkurish Palli’ is a Thomas Pilgrim center situated at Pallikkara, Cochin. It was established in the holy memories of St. Mary, St. Thomas, St. George and Parumala Mar Gregorious Thirumeni. The notable historical places are Hill Palace Museum, Museum of Kerala History, Coconut Museum and Kerala Folklore Museum etc., located within 10km radius. Among the historical places the Kerala Folklore Museum and Hill palace are identified as archaeologically important. Ambalamedu holds some archaeological significance due to its association with various historical and cultural aspects of the region. Ambalamedu and its surrounding areas contain several megalithic sites, including burial sites, stone circles, and other ancient structures.

7.8.7.4 Industrial Area

Ernakulum is one of the Industrial belts in the Kerala State. Owing to the international airport, water ways, railways, and road ways, Ernakulam is one of the most connected districts in the state. Ernakulam district is highest revenue yielding district in the state

and is known as Commercial capital of Kerala. Ernakulam district is the richest district in Kerala in terms of GDP and per capita income.

Prominent Industries in Ernakulum

It is a prominent town in the Micro/Small/Medium/Large Enterprises. Since past few years, Insecticides, Cargo -related business has been booming in the region & it is the major largest exportable items. Ernakulum is famous for its Marine frozen food, Sea food, Software Solution, Species, Rubber and Gloves, made in Ernakulum and is sold in various parts of foreign country. KSIDC has over 5 decades of proven track record of attracting a commendable volume of investment to the State. The KSID corporation has so far promoted more than 750 projects in the State and has played a vital role in the setting up of pioneering organizations are as follows: -

- Bharat Petroleum Company Ltd
- Cochine Refineries Ltd.
- Cochin Shipyard Ltd
- Fertilisers and Chemicals Travancore (FACT) Ltd.
- Hindustan Insecticide Ltd
- Hindustan Machine Tools
- Hindustan Organic Chemicals
- Indian Rare Earths Ltd.
- IOC Bottling Plant.
- Kerala Agro Machinery Corporation
- Kerala Shipping & Inland Corporation.
- Transformers and Electricals Kerala Ltd.
- Kerala Stae Maritime Development Corporation Ltd.
- Travancore Cochin Chemicals Ltd.
- Vazhakulam Agro and Fruit Processing Company

Industries around the site:

The project site admeasuring about 25 acres of land and itself located within the KINFRA Industrial site. There are a few industries located around the project site namely FACT, Oil companies like HPCL, IOCL, BPCL LPG Bottling plant and storage facilities Hindustan Organic Chemicals. Among these, the notable industry is BPCL's Cochin refinery and Hindustan Organic Chemicals.

Ernakulum is a thickly populated area due to major industrial belt of Kerala. Owing to this reason, a huge amount of Municipal Solid Waste is generated each day and it is growing with the time. So, the common SLF will serve more in future to maintain the environmental and social balance of our society. The project has provided a direct job opportunity to the locals as both technical and non-technical workers. With the growth of other industries in this area the workload and scope of job opportunity is increasing by day. A major part of this labour force is mainly from local villagers. This enhances their income and lead to overall economic growth of the area. The following socio-economic changes are expected due to project activities:

Approximately 70 people will be employed in landfill site.

- The project is having positive impact on income through multiplier effect.
- The employment shall be in the form of skilled, semiskilled as well as unskilled workers. A new working culture is emerging here because of local people are

involved in the project. Previously these people were facing lack of job opportunity and had to survive on only agriculture.

- There will be positive effect on livelihood of people living in this area. It creates a great impact on environment.
- Like this way a cumulative positive social impact is created through the project.
- Not only income generation it is creating a better environment to live through store, or dispose of the waste properly.

7.9 Focus Group Discussion (FGD)

The Focus group discussion (FGD) was organized to sensitize the people about the proposed scientific landfill site planned at Ambalamedu. FGD were conducted at Vadavucode puthencruz, Thirupunithura and Chitetukara, Thirkakara on 13th and 14th May 2024 to discuss on the issues faced by the people located nearby the project site.

The meeting proceedings held at the Karimugal Meeting Hall, Vadavucode Puthencruz, Grama Panchayat (Ambalamedu), Irumbanam Community Hall, Thirupunithura Municipality and Chitetukara, Thrikakara Municipality, Ernakulam District of Kerala. The focus group discussion participants are Common people, Elected Members, NGO's, SHG's and Volunteers etc. Initially, the people have been sensitized about the need of the project which will be helping the people to live in an environmentally friendly and hygienic condition.

Comprehensive Meeting Proceedings:

The focus group discussion held at three places on two days among the common people to find out their opinion and the present and future problems likely to arise due to proposed scientific landfill site due to the project. The other local issues were discussed with them to know about their other problems, basic needs, and major demands. Their view and opinion of the local people is well recorded and documented during the meeting proceedings. Each and every stakeholder, local representatives, elected members, NGO representatives, Self-Help Groups and local volunteers were invited respectively for the meeting proceedings to give their views and suggestions on KSWMP site.

Key Discussions and Outcomes:

The various issues were discussed in the meeting like industrial pollution, air emission, water pollution, post-covid impact, soil pollution and employment issues etc. The industrial waste (like gypsum) dumped nearby the KSWMP proposed site affects the environment and cause major damage to the life of the residents and cause impacts on their livelihood. The quality of water was affected by its pollution and water shortage was also faced by the local residents. The local people were facing health issues like breathing problem, eye irritation, vomiting sensation, and headache issue. The health condition of the people feels that the proposed scientific landfill will also add the health impact. The main concern of the stakeholders was to protect and conserve the environment. Some of the people also migrating from the concerned area due to the pollution faced by the local residents due to various other industrial plants. This issue was discussed in the meeting proceedings.

The participants were expressing their views on the basic amenities, major area required for the project, and their socio-economic issues. The common people expressed their views on building check dams, medical, educational, electricity, water and transportation facilities, employment opportunities, environmental protection and conservation, and safety precautionary measures. The opinion of the people was documented to meet their demands and expectations.

The local residents expressed that they are facing water shortage during peak summer. The surrounding industries emissions are polluting the ground water and reduces its

availability. The urbanization of the Ambalamedu area were affecting the availability of water and causes water shortage in the concerned area and affect the fertility of the agricultural land and its production is also their concern. The demands of the local people was to build check dams for fulfilling their water requirements. They also in opinion that if the check dams are built, it will increase the ground water level and availability of surface water level to meet their domestic needs. The immediate requirement of preventing the water pollution and protecting the purity of water against its pollution and conserving and preserving for the requirement of the future generation. The people also opined that the solid waste management project must cover the required pollution control measures as per norms. The concerned government authorities must check and monitor the rules and regulations of solid waste management whether it is properly followed by the nearby industries.

The participants expressed their opinion on conducting medical camps for them because of the presence of major industries nearby the residential area. The major concern of the participants was their health problem. The people were facing major health issues due to the pollution in respect to air, water and land. They feel the water contamination affects the health condition of the people. The water borne disease may lead to causing fever and new viral infection among the people. The participants were discussed on post-covid impact on the livelihood of the local people. They also expressed that covid and post-covid situation affected their day-to-day business of the people and made economic loss to them.

The people demanded more educational institutions in their local area for addressing the skill gap among the younger generation. The significance of education was expressed in the meeting proceedings. The educational institutions can meet the skill demands of the young graduates and make them employable in the industrial job market and boost the GDP level of the state.

The participants expressed their opinion on the availability of the electricity facility in their local area. The major portion of electricity was consumed by the various industries rather than the household needs. The transportation facility was also one of the main concerns of the local people. The participants also expressed their opinion on increasing the transportation facility in the local area for their residents. The roads must be well constructed and maintained by the concerned authorities. The rash driving of goods vehicles or container vehicles was affecting the movement of local residents. The road damages can be monitored on a regular basis by the concerned authority to prevent the road accidents. Sometimes, fire accidents broke out in the solid waste disposal site which affect the environment and cause air pollution to the residential area. People were facing breathing issues and eye irritation due to the fire smoke. One major fire accident also occurred in the Brahmapuram and the fire smoke was prolonged for two weeks in the nearby residential area. Still now, the people were recalling the fire accident. The government authority must monitor whether any untoward incident like fire damage or water stagnation/contamination in the proposed site.

The environmental protection and conservation was discussed in the public meetings. The safety precautionary measures must be followed in the industries to prevent the fire accidents. The wastages of the industries must be properly segregated and separated to avoid any major leakage by its hazardous waste which may lead to gas leakage and affect the quality of air and might lead to air pollution. The participants made their opinion on conservation, preservation and protection of the environment for achieving the sustainable development goals (SDG). Sustainability was one of the main concern among the local residents due to the presence of major industries in the local area.

The participants were expressed their opinion on air quality, water quality, soil quality, and preventing the pollutions, eco-friendly environment, sustainability, and conservation

and preservation of environment. The focus group discussion were conducted to record and document the people's opinion and views on the major issues faced by them nearby the project site. The valid points and suggestions would help the organizers, the government authorities and the stakeholders such as the representatives from the local body,representatives from the FACT,Health workers,Social Workers etc.

7.10 World Bank Social Safeguard policies

The Bank's social safeguard policies are designed to prevent and mitigate undue harm to people and their environment in the implementation of specific development projects, and to ascertain that project benefits reach the target population.

7.10.1 Social Risk Identification

The Social Standards formulated by World Bank is adopted here and the various environmental risk and impacts during design, construction and operation phases of SLF with suitable mitigation measures have been detailed below. The project design of SLF subsumes good social management. It is designed to promote the best social practices for the SLF and has an inbuilt planning component, with a strong base on studies and research. The criteria for determining significance are generally specific for each social aspect but generally, the magnitude of each potential impact is defined along with the sensitivity of the receptor. Generic criteria for defining magnitude and sensitivity are summarized in the following subsections.

The proposed project SLF activities are socially positive in nature and thus are expected to bring about long-term positive impacts to the region. Labor influx during civil construction and implementation is expected which will have marginal impact. Implementing Agencies will assess and manage risks and some interventions are aimed at improving the health and management. In addition, there could be loss of access to common property but relocation and loss of livelihood is not anticipated due to SLF. But then again due to small to medium scale and positive nature of investments coupled with early screening and embedding strategic social assessment and planning, risks and impacts are expected to be localized, manageable and reversible. The project will adopt Social Management Framework to screen subprojects and guide the assessment/preparation of sub-project specific risks and impacts management plans and mitigation measures. The social screening list is shown in below Table 7-9. From the check list it can be ascertained that the social impact is very minimal and with the suitable mitigation measures are inbuilt in the proposed project.

Table 7-9 Social Screening Checklist

Issues	Answer		Comments
	Yes	No	
1. **Land acquisition**			
i. Does the project require land acquisition (public or private) temporarily or permanently?		✓	Land belongs to KINFRA
ii. Would the project cause house demolition (including operating and non-operating ones)?		✓	No settlement with in the project site

iii. Are people going to be prohibited from using their daily economic resources (such as fishing sites, economic forests, planting land)?		✓	The land belongs to industrial activity and people are not to prohibited to reach the chithrapuzha river.
iv. Would the project result in involuntary resettlement of individuals or families?		✓	
v. Is the project in Site or Area in a schedule VI area?		✓	
2. Impacts			
vi. Will the project cause loss of livelihood, housing, structure, CPRs, etc.		✓	
vii. Will the project affect any Vulnerable & Disadvantage groups		✓	
viii. Will the proposed project benefit both women and men?	✓		
ix. Would the project seek to identify and respond to needs and priorities of various subgroups of the project community (the poorer members of the community, ethnic and religious minorities etc.)?	✓		
x. Do gender-based disparities exist in areas such as power relations, decision-making and the ability to influence others		✓	
xi. What is the proportion of households headed by women? Are these households significantly poorer than male-headed households?			
xii. Are there differences in gender relations between subgroups of the community (indigenous groups, religious or ethnic affiliation, socioeconomic strata) that should influence project design?		✓	
3. Institutions, rules and behaviour			
xiii. What institutional arrangements, organizational structures and social norms support or constrain the productive activities of men and women, particularly in the project?	✓		KSWMP will follow the all social norms like equal renumeration, gender-based violence, reservation, employing, and gender action plan
xiv. Do women participate equitably in leadership and decision-making processes in institutional and organizational social structures?	✓		

xv. How can the project strengthen or modify existing social structures and processes, and utilize existing organizational resources (such as grass-roots women's community organizations) to increase gender equity and project sustainability?	✓		as stated by Kerala government The existing SHG will be consulted during employment of the SLF
xvi. Can the project provide opportunities to create new organizations that promo tegender equity?	✓		
4. **Stakeholders**			
xvii. Who are the male and female stakeholders in the project? Do they support or oppose the project?	✓		The panchayat members and municipality members are the male and female stakeholders of the project. All the NGO's working is in the area are stakeholders. All the statutory clearances providing for the project government and non-government are stakeholder apart from KSWMP. By providing equal oppurtunites in the employment from the design stage is planned for the project. Hence, conflict of interest is avoided.
xviii. What degree of influence are they likely to have on the project?	✓		
xix. Does the project threaten the interests (actual or perceived) of either men or women?		✓	
xx. How can the project avoid or minimize potential male-female conflicts of interest, and promote social cohesion?	✓		
xxi. Are there stakeholders (NGOs that work with women, all-male work unions) that might be expected to actively further or hinder the gender-related goals of the project?		✓	
5. Participation			
xxii. Will both women and men participate fully in the project?	✓		
xxiii. What specific project components will ensure this?	✓		
xxiv. Are the costs of participation (forfeiting income-earning opportunities, increased workloads due to labor contributed to self-help projects) different for women than for men?		✓	
xxv. How can the project be designed to strengthen the individual capabilities of both men and women? (by providing experience in leadership roles, project management, opportunities to work with governmental and	✓		Capacity building for women will be provided by the project group

administrative bodies and community-based groups)			
6. Social risk			
xxvi. Does the local, regional or national environment pose threats to project success in terms of addressing gender issues? (Such threats may include socio-economic crises, physical disasters, civil conflict or unrest and so on).		✓	
xxvii. IIs the area vulnerable to active or passive conflicts due to certain demographic or socio-economic aspects (rural-urban, migrants, illegal settlements ethnic minorities etc.)		✓	
Does the project pose potential threats to either women or men by altering gender relations (the balance of power or decision-making patterns within the family, access to resources etc.)?		✓	
xxviii. Is the area vulnerable to active or passive conflicts due to certain demographic or socio-economic aspects (rural-urban, migrants, illegal settlements ethnic minorities etc.)		✓	
xxix. Site or area in a schedule VI area		✓	
xxx. Affect any Vulnerable & Disadvantage groups		✓	

7.11 Laws applicable to this project

The socio-economic Acts and Rules applicable to this project along with roles and responsibilities of the project proponent is given in the Table 7-10.

Table 7-10 Acts & Rules applicable to this project

Legal Channel	Responsible Ministries/Bodies	Objective of Legislation	Roles and Responsibilities
Kerala Municipality Act 1994 & its Amendment Act 2012	Local Self Government Department (LSGD)	The Director of Urban Affairs is the inspecting authority for all municipal bodies and is responsible for appointing and disciplining staff.	Every municipality to make adequate arrangement to: • The regular sweeping and cleansing of the streets and removal of sweepings therefrom; • The daily removal of the fifth and the carcasses of animals from private premises; • The removal of solid wastes; and • The daily removal of rubbish from dustbins and private premises
GOK's State Tribal Laws and Policies	Ministry of Tribal Affairs	The objective of the Tribal Laws are the following: Preserving Traditions, Prevent Discrimination, Promote Inclusive Development, Provide Security, Promote Economic Empowerment, Ensure Dignity, Promote Employment, improve access to services, Reduce poverty and unemployment and recognize rights	• Tribal laws, which include codes, constitutions, ordinances, resolutions, and regulations, govern many aspects of tribal life. Tribal laws are similar to those of other sovereigns, and cover topics such as civil and criminal law, and civil procedure. • Tribal laws are based on a tribe's unique cultural heritage, including their beliefs, values, traditions, and perceptions of the universe. Tribal communities have also developed their own traditional systems of social control, which are enforced through distinct mechanisms and an unwritten code of conduct.
The Sexual Harassment of Women at Work place (Prevention, Prohibition and	Ministry of Women and Child under which Department of Social Welfare	The objective of the Act is to create a safe work environment, Define Sexual harassment, provide a mechanism for	• The Act aims to create a safe and conducive work environment for women and provide protection

Redressal) Act, 2013	and Women Empowerment	redressal, and apply to the entire country	against sexual harassment. • Employers must undertake awareness programs provide a safe working environment and display information about the act at the workplace
73rd Constitutional Amendment Act 1992	Ministry of Panchayati Raj	The objectives of the act is to decentralize power, strengthen local government, recognize panchayats, ensure uniformity and allow autonomy	• The roles and responsibility of the act is to strengthen Panchayati raj institution, standardize gram panchayat, provide autonomy, hold independent elections and empower women.
The 74th Constitutional Amendments			• Entrusted the Urban Local Bodies (ULBs) to prepare plans for economic development and social justice and their implementation under relevant schedules (Article 243 G and 243 W of the Constitution of India). • Accordingly, the local government institutions are mandated with many responsibilities including Solid Waste Management • Every ULB in India is having its own legislation for governance, planning development and assessment and taxation. The ULBs are committed to updating and modernizing their Municipal Acts and the rules framed under the Acts to best serve the citizens.
Solid Waste Management Rules, 2016	MoEF&CC, CPCB, SPCB	Management & Handling of Solid Wastes without damaging the Environment	• "Every municipal authority responsible for the collection, segregation, storage, transportation, processing, and disposal of municipal solid wastes". It fixed certain responsibility for municipal authorities,

			State. Governments, and UT Administrations as well as Central Pollution Control Board and the State Board or the Committees in infrastructure development, setting up landfills and other waste processing and disposal facilities, monitoring and ensuring eco-friendly compliance and submitting Annual Reports.
The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act (RFCTLARRA), 2013	Local Self Government Department (LSGD)	The objective of ensuring just and fair compensation and rehabilitation for the affected families due to compulsory acquisition of land for public purpose.	• It states that the R&R Policy is applicable all land acquisition in the State and by Direct/Negotiated for fair purchase.

8 Project Benefits

8.1 General

The benefits arising from the project is improved environmental, living conditions and public health in the vicinity of project site. Benefits are achieved through more effective removal of waste from in and around inhabitant areas and prevention of pollution arising due to accumulation of solid waste and the waste leachate entering into the drains, waterways and groundwater. Improved disposal of waste will also result in more pleasant surroundings by a reduction in odour and an improvement in the aesthetic quality of drains, waterways, low-lying areas and other areas where waste is dumped.

From the proposed project the major benefit is improving the degraded environment by establishing a Scientific Municipal Solid Waste Landfill Facility. As a result of the proposed project there will be horizontal and vertical benefits to society and environment respectively.

- Direct employment and indirect employment will benefit locals
- Owing to proposed project the physical infrastructure of the region will improve
- Social infrastructure facilities will come up in nearby areas
- Demand for housing and other facilities will increase
- The State Government will also benefit directly from the proposed project, through increased revenue from royalties, excise duty and stowing duty
- Landfills are designed both to store and to decompose the wastes in scientific manner.
- Much of the potential risk from unscientific landfill results from the migration of contaminated leachate and landfill gas which can be eliminated.
- Major emissions leachates are considerably controlled in Scientific landfill thereby the greener environment is protected for the society.

8.2 Environmental & Health Benefits

However, quantifying environmental and health benefits are difficult because of the need for data to establish the magnitude of impacts of the improvements and to separate out the effects of improved waste collection and scientific disposal system from other factors such as personal hygiene habits, housing standards, water quality etc.,

Research findings indicate that sanitation improvements result in more health benefits, mainly in terms of reducing the waterborne/airborne diseases. Sanitation improvements in urban areas will help to reduce this high incidence of annual household medical expenditure by reducing the impact of waterborne/airborne diseases considerably. This will apply to the present project town also. The inadequacies of the waste management system were considered major contributing factors to personal hygiene and public health conditions. The risk of environmental sanitation related diseases would be reduced with properly maintained and functioning waste management together with increased public awareness on the effects of indiscriminate disposal of wastes into waterways and dumping of rubbish in open areas.

8.3 Socio-Economic Benefits

- With coming up of the proposed project, the employment opportunities (direct as well as indirect) will increase and local people will be employed on the priority basis as per their skills.
- The transportation of the material will involve a network of persons engaged in collection and transportation of material, thus developing the indirect employment opportunity.

- The proposed project will help in creating pollution free clean environment and will generate source of income from otherwise considered waste. This will help in improving the living conditions of the people.
- The project will involve the treatment of waste in scientific way without causing environmental problems such as odour, health hazard etc.
- Due to proposed project, the surrounding environment will not face any problem related to pollution because appropriate pollution control equipment will be followed by SLF management.
- Owing to the project the region attracts investment and thereby CER activities which may be beneficial to the local people.

9 Environment Cost Benefit Analysis

9.1 General

Environmental Cost Benefit analysis is not recommended at the scoping stage. Hence, it is not required as per the standard/Specific ToR given by SEIAA – Kerala vide ToR Identification no. TO24B3401KL5888163N, dated 08-08-2024. However, this chapter provides the information regarding the capital cost of the project and expenditure for the implementation of environmental mitigation measures. The cost envisaged for pollution control is included in the capital cost. Cost towards environmental monitoring facilities along with specific groundwater monitoring by installing piezometers are additionally included. In the analysis of capital cost, recurring cost is also included to know the yearly expenditure. The safety measures like fire hydrant, slope stability, surface run-off drains are included in the capital cost of the project. Other features like Leachate Treatment Plant and capping of SLF forms integral part of the project are included in the analysis. Expenditure towards environmental monitoring plan is detailed in Table 9-1.

9.2 Project Cost

The estimated project cost is INR 274.79 crore. A good fraction of project cost is earmarked towards pollution control measures. Table 9-1 gives the breakup of the cost for various control measures.

- In addition to those indicated in the table, there are a number of other features, which forms an integral part of the SLF design which contributes to either safety or to environment. Those components are not included in this environmental cost.
- Likewise, the costs of fire protection and physical protection measures are not considered, although there may be secondary environmental consequences due to fire or health lapses
- The salary of staff and capital depreciation are not included.

9.3 Budgetary Provisions for Environmental Control

The updated environmental capital and recurring cost for the environmental facilities for the SLF site INR 7.87 Crore including CER amount of Rs. 3.6 Crore for 2 years.

Table 9-1 Cost of Environmental Management Plan

Sl.No.	Activities	Cost (lakh)	
		Capital	Recurring
1	Air pollution control (Installation of passive gas vent at interval of every 2500 m^2 (total top area 60,276 m^2) on the top of SLF 25 Nos.)	2.50	0
2	Water pollution (Construction of LTP)	269.12	27
	Tyre Washing facilities	25	1.0
	Installation of piezometer for ground water monitoring at 15 location	30	3
4	Noise Pollution control	10	0
5	Greenbelt Development of 13,155 m^2 which is 15% of total area including drip/sprinkler irrigation	100	2.5
6	Energy Conservation Measures (Solar street light for 90 Nos.)	45	4.5
7	Occupational Health and safety measures	10	10
8	Environmental Monitoring Programme	36.18	-
9	CER budget	360	-
	Total	787.08	50.5

10 Environmental Management Plan

10.1 General

Kerala Solid Waste Management Project under State Project Management Unit is committed to act as a responsible for steadfast towards protection of environment and the community. SLF has consecrate to employ best environmental management practices, regular maintenance and keep track record consistent in operation of pollution control methods, Leachate treatment plants, adoption of cleaner and environment friendly technologies etc. The concerted efforts planned to be implemented through an Environmental Management System (EMS) are expected to result in resource conservation and storing of inert in a scientific way which will decrease the pollution and provide cleaner environment which will ultimately increase the green cover in an environmental benign condition.

The Environmental Policy of KSWMP emphasizes "adopting environmental management system and continual improvement in environmental quality by applying best available practices".

The importance of environmental control has been recognized by KSWMP/SLF management and it has taken necessary steps to identify and control pollution in the SLF site and also in the peripheral areas. Environment management has been considered as one of thrust areas of operation. A three-tier strategy has been adopted and they are as follows:

- Developing a well-organized monitoring/analysis and inspection setup
- Adopting best environmental management practices in operation of SLF site
- Contributing to regional development in terms of social capital building, infrastructural development, catering to immediate and long terms primary needs of local inhabitants (medical, secondary and direct employment, boosting local activities and protecting ethnic culture)

In line with KSWMP/SLF management's commitment for environmental protection, the project strives to:

- Conduct processing operation in compliance with relevant environmental legislations and regulations.
- Employ best management practices and environment control for sustainable development of the region
- Consider regional carrying capacity in resource and pollution discharge related decisions and give emphasis to conserve energy, other natural resources and minimize waste generation
- Periodic pollution monitoring to review performance of pollution abatement measures and reporting the same to statutory agencies
- Modernization of occupational health set up facility including regular health monitoring of employees and villagers those who area need in the vicinity of the project.
- Strengthen the safety management strategy. Prepare emergency/disaster control plan and a properly trained group to meet the emergency situations
- Green belt development in and around the project site.
- Involvement in area development activities and inviting people's participation in area development projects. Increase awareness in employees and villagers towards environmental preservation
- R & D activities with regard to specific pollution problems
- Periodical review of the system for continual improvement

10.2 Organizational Set Up

10.2.1 Environmental Monitoring Cell

It is imperative to establish an effective organization to implement, maintain, monitor and control the environmental management system. A separate section Environmental Monitoring Cell (EMC) has been established to carry out day to day environmental Monitoring and inspection of SLF site. The environmental monitoring cell comprises of environmental engineer, chemist, lab assistant and other supporting staffs.

10.2.2 Quality Control Department

Quality Control Department is responsible for quality assessment of the inert material which is coming from authorized waste collection stations. Quality assessment of leachate and treated water is carried out by quality control office in association with EMC. In addition to above, services of external agencies are also taken on periodical basis to carry out the necessary monitoring work. Casual labourers etc. are employed for plantation, drain cleaning and rain water harvesting structures etc. as and when required. Services of recognized laboratories for sampling and monitoring the leachate quality and emission are availed.

In addition, the waste acceptance criteria as mentioned in chapter 2 forms a major part of Quality Control Department which is reproduced below.

“The waste acceptance criteria must be formulated. The following waste acceptance criteria are suggested:

- Inert waste will be routinely accepted if the truck/tipper has authorized documents indicating the source, quantity and composition of waste.
- Inert waste laden in authorized trucks from all authorized station within Kerala will be subjected to physical & visual inspected at waste inspection facilities and will be allowed for disposal. A waste screening and weighing platform is also provided for this purpose”

Environmental impact register has been prepared for various activities of SLF site. Operation Control Procedure (OCP) is available for various environmental aspects to control the pollution.

The various Standard Operating Procedures (SOPs) are:

1. Dust control procedure
2. Noise control procedure
3. Leachate treatment plant procedure
4. Inert waste disposal procedure
5. Fire-fighting procedure

10.2.3 SLF Safety Committee

Dedicated safety committee will be constituted are functions and operation of SLF. The safety committee looks after and reviews the safety aspect of the operations involved in disposal. The safety committee comprises of engineers, medical officer, environmental engineer, workmen, occupational health in- charge etc. The committee reviews the safety aspect of the operations periodically and the minutes of the meeting is communicated to higher management. The recommendations of the committee as well as corrective actions are planned to be implemented.

10.2.4 Activities under EMS

A surveillance for environmental parameters is carried out under EMC in SLF. Guidelines of KSPCB, MOEF&CC, are being followed. EMC will carry out monitoring of all relevant parameters with respect to hygienic significance for SLF and surrounding

natural environment. The monitoring data generated on routine basis serve as tools for assessment and control of operations impact; and to ensure environmental protection and to demonstrate the regulatory compliance as and when required. The basis of control measures to be adopted is in line with recommendation of SEAC.

Activities of environmental management cell are:

1. Emission from the DG stacks and passive gas vents provided for SLF monitoring
2. Water quality monitoring for LTP
3. Ambient Air Quality monitoring
4. Soil quality monitoring
5. Rainwater harvesting monitoring
6. Groundwater monitoring with Piezometers
7. Plantation and greenbelt development
8. Occupational health & safety surveillance
9. Socio-economic awareness about the SLF activity and advance information to the local peoples
10. Implementation of various regulatory guidelines

The details of monitoring programme with frequency is covered in Chapter -06.

10.2.5 Reporting procedure

A built in mechanism for reporting on compliance of the environmental and other related aspects has been evolved. The compliance conditions and other data is reported to higher authorities as shown in Table 10-1. As per guidelines of MoEF &CC, all the Environment Clearances and status of their compliances will be shown in the website of KSWMP. Periodic auditing and performance measurement will be taken up to look for improvement.

Table 10-1 Responsibility matrix for Environmental management

Attributes	In-house Environmental management					Reporting & receiving feedback from statutory authority	
	Primary responsibility and report generation	Short term and time series analysis & generation of status report	Approval of status report & decision on actions	Implementation of follow up action	Verification of follow up action & reporting back to approval authority	Who will do?	Whom to report?
Environment Monitoring (Air, Water & Noise)	EMC	EMC	Unit head	EMC	EMC	EMC	Regional MoEFCC / KSPCB
Plantation & Greenbelt development	EMC			EMC			
Reclamation progress [Biological reclamation]	EMC			EMC			
Social Welfare	CER cell and EMC			CER cell		CER	EMC
Drainage network maintenance and rain water harvesting	EMC			EMC		NA	
Water and Energy Utilization	Mechanical, Electrical and Civil Maintenance			Mechanical, Electrical and Civil Maintenance			
Occupational Health Monitoring	OH & S			OHC,			
Environmental and safety related training	EMC	EMC		EMC			

Note: EMC = Environmental Engineering Cell; OHC = Occupational Health & Safety; CER = Corporate Environment Responsibility; KSPCB = Kerala State Pollution Control Board

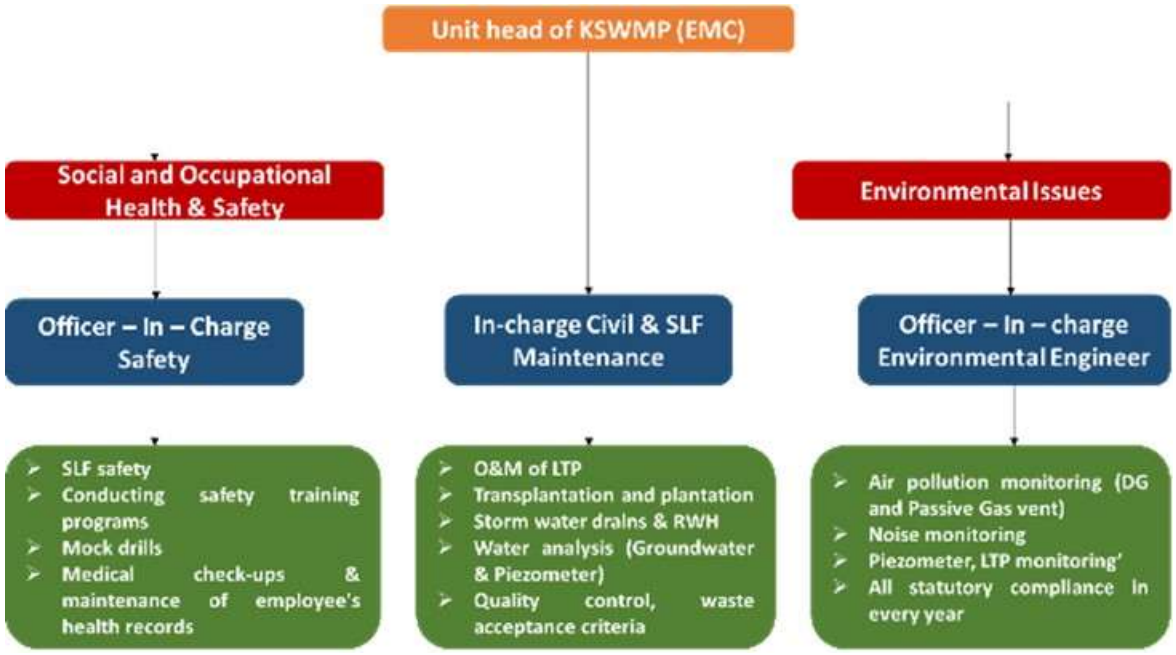


Figure 10-1 Organogram of EMC

In his day to day work, the EHS head is assisted by chemists, laboratory assistants and other staffs. Services of forest officials are also taken for effective implementation of plantation and capping schemes. For development and maintenance of jobs like drainage, clearing settling pits etc. assistance from the SLF's civil engineering department will be taken. The officers of the department meet frequently to assess the progress and analyses the data collected during the preceding fortnight/month. Total manpower of EMC is shown in Table 10-2. If required, this will be augmented suitably on completion of construction work.

Table 10-2 Manpower of EMC

Description	Nos.
Environmental Engineer for Statutory compliances	1
Civil Engineers for Air & Water pollution control	1
Occupational Health & Safety officer	1
Chemists for Sample analysis	1
Laboratory assistant	1
Field assistant	2
Gardeners	2
Laborers	2

10.2.6 Duties of EMC

In order to carry out environmental monitoring, EMC performs following functions:

- The EMC oversees the implementation of environmental control measures as per approved EC and consent.
- Plan for conservation of treated water and land to reduce the footprints
- Identify and record the constraints in respect of environmental planning and implementation

- Systematically document and maintain records w.r.t environmental issues
- Working of environmental engineering laboratory
- Field monitoring and laboratory analysis
- Monitoring of green belt, plantation development and capping
- Compliance of environmental regulations and specific stipulations of regulatory authorities
- Communication with concerned department (of the SLF site) on environmental issues. The same are also discussed with the top management of the company.
- Interaction and liaison with State/Central government departments / agencies/local people.

The EMC has also a well-equipped laboratory to undertake routine environmental monitoring. Environmental Survey Laboratory of SLF is in charge of carrying out all surrounding monitoring covering background levels in air, water, soil, and social. The data of EMC will be shared with unit head for corrective measures if any.

10.2.7 Carbon Footprint

The expected carbon footprints due to the project is estimated to be 424.43 tCO2e/year, which can be offset by 3000 trees, it is expected that every year, the amount of carbon absorbed by the greenbelt planned on the project site will increase indicates the carbon absorption over the intervals of 5, 10, and 15 years. The detail estimations are shown in impact and mitigation measures chapter.

10.2.8 Occupational Health & Safety

Functions of the Occupational Health, M/s. KSWMP

- Employee including contract labours are to be examined for medical checkup and health records are to be maintained and yearly checks are to be appended
- Emergency treatment of patients in case of burns, gas inhalation, mechanical injuries like head injury and fracture.
- First aid treatment in case of minor abrasion, contused lacerated wound, etc. Referral services to higher centre as and when required.
- Pre-employment medical examination of all the employees before their joining to decide their fitness and to decide their placement in various location of SLF.
- Periodical medical examination every 6 monthly for all the employees.
- Maintenance of Form no. 33 after pre-employment medical examination.
- Maintenance of Form no. 32 after periodical medical examination
- Placement and maintenance of first aid boxes to the various departments in the company. First aid boxes are checked twice in a month and replenished with the materials needed.
- Preparation of injury report on daily basis.
- First aid training to the company employees.
- Preparations of monthly report and annual reports describing injuries and sickness.
- Contractual worker's pre-employment physical check-up on daily basis.

Pre-Medical/Periodical Medical Examination

Pre-Medical/Periodical medical examination of worker exposed and other staff members will be carried out as per the requirement.

Pre-Employment Screening / Examinations

All employees will be subjected to pre-placement medical examinations to determine their fitness for the jobs on site. Potential exposures to the work environment will be considered before placing an employee on the job.

Periodic Medical Examinations

Periodic medical examination is the same as the pre-employment screening and may be modified according to current conditions, such as changes in the employee's symptoms, site hazards or exposures. However, List of tests is proposed to done during half yearly employee check-up: -

- Height
- Weight
- Audiometry
- ECG
- Eye Vision
- Complete Blood Count (26 parameters)
- Pulmonary function testing
- Blood Sugar
- Blood pressure
- Urine Routine & Microscopy

M/s. KSWMP will allocate Rs.10,00,000 Lakhs per year for the purpose of occupational, health and safety for the employees.

First aid Boxes

A first aid kit is a collection of supplies and equipment for use in giving first aid. First Aid boxes will be kept available in Admin Block. First Aid items will be issued to injure only by authorized persons.

Following are the contents of First Aid Box,

1. Dettol – Antiseptic solution
2. Ciplox – Eye Drops
3. Soframycin – Skin ointment
4. Silverex – Burn ointment
5. Betadine – Microbicidal solution
6. Iodex – Pain reliever
7. Sterilized Cotton Wool
8. Surgical Paper Tape
9. Small Sterilized Dressings
10. Medium Sterilized Dressings
11. Roller Bandage – 5 cm wide
12. Roller Bandage – 10cm wide
13. Band Aid
14. Crocin / Paracetamol Tablet

Implementation of OHS Standards as per OSHAS

The overall objective is to provide a system that is capable of delivering healthy and safe workplace. Following measures will be adopted for implementation of OHS standards:

- Health surveillance and maintenance of health record.
- Rules and procedure for effective implementation of Safety Health and Environment policy and made to know all employees.
- Sufficient number of First aid boxes.
- Risk assessment of each and every activity.
- Implementation of OHS management program.
- Training, awareness program and work place talk.

Personnel Protective Equipment

SLF management will provide full range of Personnel Protective equipment to its workers for their safety. A complete list of Personnel Protective equipment has been listed below:

List of Personnel Protective Equipment

- Safety Helmets
- Safety Hand Gloves – PVC, Rubber Cotton, Cum, Leather Asbestos
- Safety Goggles - Spectacle Type, Panoramic Type
- Face Shield
- Aprons – PVC, Cotton
- Safety Gum Boots
- Gas mask
- Safety emergency
- Fire extinguishers
- First aid box
- Emergency siren switch
- While handling the inert waste, use most appropriate PPE's like hand gloves, face shield, safety goggles, gum boots or even respiratory masks with suitable cartridges.
- Once in a month, the items of the Equipment will be inspected and recorded by EHS representatives of the individual area.

10.2.9 Work Zone Monitoring Equipment

The SLF site will install the ground water monitoring kit all over the facility for regular monitoring and these will provide the ground water level and ground water pattern.

10.2.10 Proposed Safety System

Fire extinguishers

Depending on the combustible material, fires have been classified into four types.

Table 10-3 Suitability of Extinguishing Media for Different Fires

Sl. No	Class of fire	Suitable Fire Extinguisher
1	**Class B**: Flammable Liquid and Flammable Gases i.e.,	Mechanical Foam, CO_2 and DCP

The SLF management will train personnel for firefighting and intends to improve the firefighting skills of employee by conducting frequent training on Firefighting.

10.3 Interaction with statutory bodies

EMC will be in regular touch with KSPCB and the Regional Office of MoEF&CC and sends them periodic compliance report on EMP compliance in the prescribed format. Any new regulations/ guidelines considered by KSPCB/CPCB is taken care of by EMC. Action is taken to update the EMP on regular basis in accordance to the guidelines of regulatory authorities as KSPCB/MoEF&CC etc.

11 Summary and Conclusion

Introduction

The project aims to improve Solid Waste Management (SWM) service in a decentralized manner and will improve SWM service delivery of all Urban Local Bodies (ULBs). The safe and effective operation of landfills depends on sound planning, administration, and entire waste management system.

In order to achieve the above goal, KSWMP proposed a cluster approach for the planning, design and development of scientific landfill. Totally five Clusters are planned to be covered under this SWM programme for which development of Regional Scientific Landfill (RSLF/SLF) is proposed. Out of five Clusters, the Cluster-4 (Ambalamedu) is identified, to manage inert rejects generated initially from five districts namely Ernakulam, Alappuzha, Kottayam, Idukki, and Thrissur and later stage the inert / rejects from other Urban Local Bodies (ULBs) shall also be assigned to the Ambalamedu SLF by Govt. of Kerala as on need basis.

The project is falling under Sl. No. 7(i) category 'B1' and its subsequent amendments of EIA Notification, 2006. The proposal was granted with Terms of Reference (ToR) issued by SEIAA – Kerala vide ToR Identification no. TO24B3401KL5888163N, dated 08-08-2024.

Project type, location & connectivity

KSWMP has acquired land admeasuring about 25 acres and the green field with landfill capacity of 4.0 lakh tonnes of Inert waste which is located at Ambalamedu village, Kunnathunadu taluk, Ernakulam district of Kerala. The site and study area of 10 km radius falls in the SOI topo sheet no. of 58B/8 & 58C/5. It is extended between the coordinates of 9°59'20.10"N, 76°21'58.51"E and 9°59'18.76"N, 76°21'56.41"E. The project site is located along the bank of Chitrapuzha River with setbacks to meet the SLF criteria of 100m. The site can be accessed by SH41 (3.5 km – N) & NH85 (3 km – SSW) which is connecting the Cochin port and Cochin International Airport. The nearest railway station is Tripunithura located in the SSW direction at a distance of about 4 km. The Cochin International Airport in the NNE direction at a distance of 18 km. The nearest city is Ernakulam at a distance of 4 km to the west.

Land requirement

The proposed site is under the ownership of Kerala Industrial Infrastructure Development Corporation (KINFRA) and the extent of land is about 25 acres earmarked for KSWMP SLF, out of which 18.14 acres is planned for SLF footprint area. About 15% of land i.e. 3.25 acre is earmarked for green belt and balance 3.55 acres are planned for vehicle washing, Leachate Treatment Plant and other facilities.

Capital cost and estimated time of completion

The estimated capital cost is about Rs.274.79 Crore. The project is scheduled to be completed in a period of 28 months. About 7.87 crore is estimated for EMP covers pollution control and CER measures.

Site selection criteria

The criteria for selecting the site were considered as per SWM Rules, 2016. The proposed site meets all the criteria laid SWM Rules, 2016 like 100 m away from the river bank and 200m away from lake or pond. The site is selected considering the maximum flood level likely to be encountered in this area. Accordingly, suitable embankment and raising the existing ground level are planned. The proposed site does not fall under CRZ area, also not potentially unstable zone.

Process Description

The fraction of solid wastes which can neither be composted nor recycled into secondary raw materialsand which are non-combustable is called inerts which is planned to be disposed at Ambalamedu site. Inerts mainly comprise of stones, ash and silt which enter the collection system due to littering on streets and at public places.

Scientific Landfill

Proposed scientific landfill is to dispose the inert waste likely to be generated from various ULB's. The construction of landfill planned to be taken up into phase wise. The filling of inert waste will be carried out in two phases. After filling, top cover will be provided progressively to meet SWM Rules. The waste is disposed in thin layers and will be well compacted to maximize the density. The waste is covered with soil on daily basis. Any landfill gas such as methane from the anaerobic degradation of organic material will be emanated through horizontal and vertical vent pipes. The facilities at the scientific landfill include leachate collection & treatment system, and storm water management system to avoid ground and surface water pollution & erosion respectively.

The general layout covers about 73,615 m^2 of SLF footprints out of total 1, 01,123 m^2. The site requires about 7.0 lakh m^3 plus 3 lakh m^3 for preloading. of borrowed material which will be sourced from nearest filling earth mines which is having valid Environmental Clearance. The other SLF facilities are LTP, administrative buildings, groundwater monitoring well, firefighting system, tyre washing system, greenbelt and other associated facilities. The maximum height envisaged for SLF is 23m from the AGL. The slope will be maintained at 1:4 horizontal - vertical ratio. The requisite setbacks distance is also shown in general layout. The SLF will also have greenbelt width of 2m along the periphery.

Waste Collection Stations

The waste collection station helps in optimizing the transportation cost of rejects/ Inerts by consolidating the waste in a larger vehicle for final disposal at SLF. Several stations have been identified for five districts are proposed for the transportation of the inerts from station to Scientific landfill proposed at Ambalamedu Site.

Collection & Transportation of Inert

The loading and unloading of inerts will be from TS through refuse compactor vehicles (RCV) of different carrying capacities such as 10, 16.5 and 20 Cum. No separation of wastes will take place at the TSs.

SLF Site Development

It is planned to raise the site by a minimum of 4m with 7 Lakh m^3 of borrowed soil excluding 3 lakh m^3 for preloading as surcharge fills to be in safer side of floods. The pit for borrowed soil is identified closest to the proposed site. In order to strengthen the filling height, it is proposed to allow the consolidation time of about nine months.

Steps for Landfill Development

Ground clearing

The site is unapproachable due to growth of wild bushes around the lavish green area. The site is presently occupied by patchy vegetation, which needs to be removed in order to develop the proposed landfill.

Ground Improvement

The Existing Ground Level (EGL) is largely below High Flood Level (HFL) and is normally very close during monsoon and post monsoon winter seasons with surface water. Hence, ground stabilization & filling needs to be carried out to raise the project area. Ground improvement average depths can vary between 3.8m to as high as 5.25m. It is envisaged to adopt Prefabricated Vertical Drains (PVD) below the existing ground level. Preliminary analysis shows that due to load of 300kPa (target SBC), consolidation settlement will be around 1300mm considering the compressible thickness layer as 6m.

Additional technical measures to enhance SLF Volumetric capacity

The analysis was made in order to add technical measures for improving the life and capacity of SLF and it was recommended to construct reinforced earth walls. The Reinforced Earth Wall (RE wall) has mainly three components, the facia, reinforced earth soil and inner facia. The RE wall will be constructed in phased manner with the height of 15m.

Estimation of Ground Level Raising

The proposed land parcel has the elevation ranges between (-) 2.0m to 0m in some patches and 0 to 10m above Mean Sea Level in the eastern portion of the land. It is planned to raise the ground by minimum 2m above HFL 1.65m i.e., to the level of 3.65m and there would be minimum buffer of 3.65 – 1.782 = 1.868m which is the flood level of after 40 years from as on date.

SLF Components

As per SWM Manual 2016 base clay layer of 0.9m thickness is provided for the SLF. However, it is proposed to replace the base clay layer of 0.9m thickness with clay layer of 0.3m thickness and Geo Clay Liner in order to reduce the dependence on good soil from borrow pit and reduce environment impact if any.

SLF Subgrade preparation

After installation of PVDs and raising the existing ground by 3.65 meter by filling with suitable material, the subgrade of well compacted 0.3 m thick soil of good earth/ murrum will be provided. The natural ground/filled up with soil as well as SLF subgrade of 0.3m thick will be

levelled and compacted to a maximum dry density of 90–95%. There will be a 1V:100H longitudinal slope and 2V:100H lateral slope of the bottom soil subgrade of the SLF is proposed.

SLF Embankment

The embankment of suitable section will be constructed around the periphery of the SLF simultaneously along with the base of 0.3m thick soil subgrade.

Base sealing/ Liner system

It is proposed to replace the base clay layer of 0.9m thickness (as per SWM manual, 2016) with clay layer of 0.3m thick and additional Geo Clay Liner in order to reduce the dependence on good soil from borrow pit and reduce environment impact also. After construction of the SLF base subgrade of 300mm are made of compacted clay layer and the base liners such as Geo Clay Liner will be laid as bottom lining with 300mm cover clay layers. Above GCL then HDPE Geomembrane on 1.5 mm thick will be laid, the geomembrane layer is employed to avoid leachate seepage. Then above HDPE layer, the Geotextile of 800 GSM (GT-800 GSM) will be installed as the landfill height is planned more than 20 meters. It will act as protective layer for the HDPE Geomembrane. Above GT 800 GSM, then a 300mm thick layer of gravel or aggregates (size 20–25mm) will be provided as leachate drainage media/layer so that any leachate produced from waste/rejects/inert will be collected in a leachate collecting system. To collect the leachate and drain it to a leachate pond, the Header and Lateral HDPE pipes will be placed in the leachate drainage media/layer. The geotextile of 400 GSM (GT-400 GSM) is provided as filtration and separation layer above the leachate drainage media/layer. It prevents clogging of leachate drainage media/layer and perforated leachate pipe line. As a protective layer 200 mm of soil or soil bags is proposed to protect GT-400 GSM from Rejects/ Inert and landfill vehicular movement. Leachate Pond of sufficient capacity shall be provided to store leachate, from which it will be removed for treatment in the Leachate Treatment Plant (LTP).

Leachate Drainage Layer, Storage & leachate treatment drainage system

Above GT 800 GSM, a 300mm thick layer of gravel or aggregates (size 25–50mm) of hydraulic conductivity of >1 x 10-2 cm/s as per SWM Manual 2016, will be provided as leachate drainage media/layer so that any leachate produced from inert wastes will be collected in a leachate collecting system.

In order to fulfill the discharge standards, the leachate generation is estimated at the rate of 75mm/sq.m. The leachate quantity estimated to the tune of 300 KLD.

HDPE lateral pipes 200 mm will be placed in the drainage layer to collect the leachate and supply to the Main Header Pipe. The entire leachate through the Main Header Pipe will flow to leachate collection sumps by gravity and further will be pumped to the leachate pond, from which it will be pumped to the leachate treatment plant for treatment, disposal, and reuse.

A solar evaporation pond is proposed for collection, storage and evaporation of leachate. It is proposed to collect the leachate first in the leachate solar evaporation pond and allowed to flow the same on the sloping side walls of the pond to evaporate the maximum possible leachate. The balance leachate will be pumped to the Leachate Treatment Plant (LTP) for treatment and

disposal. The treated leachate will be utilized for road sprinkling to control the dust and watering for the landscaping provided at the site. The excess water will be available for the uses of nearby industries which will be explored.

The Leachate Treatment plant of capacity of 400 KLD is planned for full leachate generation. The concentration of biodegradable and non-biodegradable organic material, certain hazardous elements, ammonia and nitrate ions, sulfides, odorous chemicals, and suspended solids may typically need to be reduced or to be removed in the proposed Leachate Treatment Plant. Dewatered sludge from LTP will be dried and disposed in line with Kerala State PCB norms, or in KEIL TSDF nearby if tested hazardous.

SLF Equipment

The landfill equipment like 2 nos. of Landfill compactors, 2 nos. of dozers, 2 nos. of water tankers with 5KL capacity, 2 nos. of tippers with 10.5 cum capacity and 2 nos. of front-end loader with back – hoe.

Storm Water Drain

It is proposed to have a storm water gutter with a 1.1m depth x 1.2m wide around the scientific landfill. The proposed gutter will have enough slopes to direct rainwater into a nearby waterbodies. The interception and diversion hume pipes of 1.2m diameter are proposed at every 200m distance all around the perimeter towards north and north-west side of the SLF footprint area.

Scientific capping/closure of SLF

The Scientific Landfill will be closed/capped after it is filled up to its full height and capacity in phase wise manner. The capping liner system is proposed as per guidelines and SWM Rules,2016. However, it will be executed at the end of design life.

Final closure layers of SLF

Once the waste has been filled to the designated capacity in the scientific landfill, it will be capped/closed to prevent rain water ingress. To minimize storm water infiltration in the landfill body and to allow storm water drainage, a surface sealing system will be built following the final completion of each landfill portion

Landfill Gas Management

Since, Ambalamedu Landfill is going to receive only rejects which are inert in nature. There is very little organic content in rejects going into the SLF and hence chances of landfill gas generation are very low. As such, it has been suggested to have a passive gas venting wells placed at every 2500 sq.m intervals to remove the landfill gas

Raw Material Requirement

The construction raw materials required for the proposed SLF includes land filling (borrow materials) and other construction materials like sand, cement, steel and aggregate. About 7.0 Lakh cubic meter of borrow material plus 3 lakh m^3 for preloading. is estimated. The sand, cement, steel and aggregate requirements are approximately 283 tonnes, 65 tonnes, 1440 tonnes (course & fine aggregates) respectively.

Greenbelt development

The greenbelt would cover an area of 13,155 sq.m which constitute about 15% of the total land area. A greenbelt of native species plant and trees are proposed with width of minimum 2m along the periphery of the site as green buffer to control ambient air quaintly and for better aesthetics.

SLF Allied Infrastructure

Allied infrastructures like internal roads, site approach road, compound wall with entry & exit gates, administrative office, weighing bridge & security surveillance, parking, vehicle cleaning, washing area & workshop, water tankers with 5000 liter capacity to control odor, dust & fire, Groundwater Monitoring well/piezometers will be installed for environmental monitoring purposes.

Planning approach

The major utility lines (GAIL Gas Pipeline, and EHT Lines) are passing very closely with the proposed landfill footprint area. The GAIL (KKBPL Gas Pipeline) is located adjacent on the eastern side of the proposed land parcel while the Electrical High-Tension Lines (EHT) of KSEB are passing through the footprint area of the proposed land parcel. There are five high-tension lines of 110kv at the site, three lines out of these five lines are crossing from the proposed land parcel. The re-alignment/shifting of EHT line is planned by Kerala State Electricity Board (KSEB) as a separate project. Existing GAIL gas pipeline – in the proximity to the footprint area of the proposed site. 5m Right of Way will be provided to ensure the safety of existing utilities and will have suitable earth covers.

Utilities

Drinking water requirement to the tune of 3 +/- 0.75 KLD will be supplied through KWA. The treated water from Leachate Treatment plant will be used for flushing, landscaping, sprinkling, dust suppression and wheel washing purposes. The excess water from the LTP will be available for nearby industries which will be explored in future.

Two Sanitary blocks with toilet and bath arrangement for male and female with water supply tank are proposed at the entrance and exit of the site.

A three-phase electrical connection is proposed at the site, with sufficient cable size and feeders and other required infrastructure. The estimated power requirement for the Scientific Landfill is 88.52 kW which will be sourced from Kerala State Electricity Board (KSEB) Limited.

Description of Environment

This section incorporates the description of existing environmental baseline within the area of 10 km radius around the project site. To assess the environmental stress from conventional pollutants generated from the above SLF, baseline data collection of the site was carried out during non-monsoon season December 2023 to February 2024.

The environmental monitoring/samplings have been carried out for micro-meteorology, ambient air quality, water quality, soil characteristics, noise levels, constitutes the physical environment of the study area. Demographic and socio-economic conditions of the study area were also considered during the study period.

Micro meteorology

Historical meteorological data had been collected from IMD data bank. However, to establish site specific parameters of micro meteorological data for summer season, Automatic Weather Monitoring Station (AWS) was installed at site from December 2023 to February 2024. Meteorological parameters such as temperature, relative humidity, wind direction, wind speed was recorded continuously during the monitoring period. Form the wind rose, the maximum wind speed was observed as 16.1 m/s with average wind speed of 2.55 m/s. From the wind rose, it can be observed that the predominant wind is mainly from ESE and WNW during December 2023 to February 2024. The overall calm was observed to be 38.22%. Atmospheric inversion levels have been collected from the published data and it is in the range of 50 to 100m during post monsoon.

LU/LC studies

The LU/LC studies have been carried out by ABC Techno Labs during the year 2024 for the proposed SLF site. The LULC was studied by procuring satellite data of Resources Bhuvan web service. Satellite imagery to prepare a detailed land use map of the project site and its study area. In the study area of 10 km radius, from the LU/LC studies it could be corroborated that, the project area falls under grass land and covers about 1.12 Sq.km and the built-up area is predominant to the extent of 221.42 Sq.km (about 70.34%). River and canal system occupies about 15.23 sq.km. The second predominant land is agricultural land which is about 23.06 sq.km.

Geotechnical Investigations

The details of the geotechnical investigation are extracted and included in EIA report. There are 11 boreholes were drilled at SLF area. Based on the soil investigations it is understood that the subsoil is very weak and rock levels vary. Without any ground improvement the subsoil will not be capable of transferring the bearing pressures of the order of 250 to 300 kPa on account of its very high compressibility characteristics. Therefore, ground improvement is necessary to improve the weak/very weak sub-soil noticed at the Project site. To overcome this constraint, in many scientific landfills, the approach these days is provide a confinement on the periphery like Retaining walls /Reinforced Soil walls. The same shall be examined during detailed engineering study by contractor before implementation and approval taken from the client. The good earth used for preloading surcharge for accelerating consolidation will be used for Earth works such as SLF embankment, subgrade, bed slopes, daily soil cover, and intermediate cover.

Ambient air quality

Ambient air quality monitoring was carried out at eight locations covering up, down and cross wind directions for the parameters such as PM_{10}, $PM_{2.5}$, SO_2, NO_X, and CO as per ToR requirements. In addition, the other parameters in line with NAAQ have been recorded and included in the baseline. All the recorded values with respect to AAQ are well within the AAQ norms. The recorded concentration ranges are as follows:

- PM_{10} = 37 – 64 µg/m^3
- $PM_{2.5}$ = 17 – 28 µg/m^3
- SO_x = 5.1 – 11.6 µg/m^3

- NO_x = 12.7 – 22.9 µg/m^3
- CO = BDL (<0.1) – 0.31 µg/m^3

Surface and groundwater quality

In case of surface water quality, three samples were collected from the various sources like river and ponds. The analytical results of 39 parameters indicate that all the parameters are within the prescribed norms of CPCB, Class B.

Akin to surface water, ten groundwater samples were also drawn considering up and down gradient with respect to proposed SLF from existing bore wells and open dug wells in the study area. The physiochemical characteristics of ground water collected from 10 locations in the study area are presented in this report and is compared with the standards (IS 10500: Indian Standards/Specific for Drinking water) reference values. It was observed that most parameters are well within the permissible limits of drinking water norms of IS: 10500 except Odor in GW1 & GW2 were agreeable and odorless at rest of the locations. The reason could be the sample location is surrounded by various oil storage plant and other chemical industries. On the whole, the groundwater quality in the study area is observed to be good and suitable for domestic consumption.

Noise quality

The noise pressure levels were collected from eight locations covering industrial, commercial, residential, silent zones and are well within the permissible limits laid by CPCB during day and nighttime from industrial, commercial, residential and silent zones.

Soil quality

For studying soil quality of the region, eight (8) sampling locations were selected to assess the soil conditions in and vicinity of the project area based on various land use conditions. The physical and chemical concentrations were determined. The samples were collected from different specified depths viz., 30 cm, 60 cm and 90 cm. From the study, it was observed that the soil in the study area shows moderately fertile and ideal for plant growth. Soil amendment is not required for any plantation purposes.

Fauna and flora studies

The assessment of the flora & fauna of the study area is done by an extensive field survey of the area of 10 km radius. About 67 species of trees, 23 shrubs, 54 species of herbs, 33 Climbers and 2 epiphytes are identified within the study area. Qualitative analysis of vegetation is made by two different methods such as floristic (by simple studying various genera and species of various plant groups i.e. herbs, shrubs, trees, etc.).

Ground surveys are carried out by trekking the study area for identification of important animal groups such as birds, mammals and reptiles for sampling of animals through the following methods. In the study area of 10 km radius, about 13 species of mammals, 78 species of avifauna, 12 species of reptiles & Amphibians, 10 species of butterflies have been reported. Emphasis is given to identify avifauna and mammals to determine the presence and absence

of Schedule-1 species, as per listed in the Wildlife Protection Act 1972, as well as in Red List of IUCN.

Marine Environment

Sea bed sediments and Marine water samples were collected from 3 locations within 10 Km radius of the project site and securely sealed for further analysis. The collected marine sediment & sea water samples were analyzed and results of both analysis shows that the analytical heavy metal parameters are between below detectable limit to within the permissible limit.

Traffic study

Traffic survey was carried out at two locations viz. NH - 85 & SH - 41 by manual vehicle counting method for different types of vehicles near propose site. The counting was done for 24 hours. The traffic survey monitoring was performed to predict the future traffic growth and the load on the approach road and surroundings due to the proposed project. The present PCU is 1294 and 2199 agianst the carrying capacity of 15000 and falls excellent category of Level of Service.

Archaeological important places in the study area

There are two archaeological important places were found such as Kerala Folklore museum at a distance of 9 km in SW direction and Hill Palace museum at a distance of 3.62 km in S direction.

Anticipated Impacts & Mitigation Measures

Construction is the first phase activity of the project and it involves Site clearing, levelling and raising the ground level to above the flood level, Construction of access roads, Construction of the bottom liner system, leachate removal and drainage system, Plantation development and others. As the site is mildly undulated, hence cutting and filling is involved in the project which will impact the environmental matrices like air, noise, soil and ecological environment of the site. The construction period is expected to be prolong for 28 months. Hence, it can be stated that the impacts if any, will be short term impact and the remedial measures likely to be taken at the time of construction are discussed in the EIA report.

The project site is mainly governed by simple dendritic/trellis drainage system. The surface run-off water from the project site is naturally diverted into surface water drainage system which is already existing on towards Chithrapuzha river. It is proposed to construct surface storm water drainage network along the SLF. The maximum intensity of the rainfall to design the storm water drain is about 223mm/hr. the minimum width 1200mm and height is 1100mm is considered for SWD which is sufficient to mitigate the storm water problem of SLF.

The SLF project involves in land disturbance as the land is mildly undulated and disturbance is limited to 25 acres. Hence, soil erosion is not expected. However, a minor amount of erosion may occur due to filling activities during 12 months of filling period. Soil removed by erosion may become airborne and create dust problem or be carried by water into natural waterways and pollute them. The appropriate mitigation measures will be taken for erosion and sediment control. To ensure that there is no health risk or damage to amenity due to dust emission, many additional measures are adopted to reduce dust problems are the same as those taken to minimize erosion and sediment run-off.

Air emission during construction phase

The AERMOD view dispersion model has been used based on Steady state Gaussian plume dispersion is used for predicting the Ground Level Concentrations. It is evident that the GLC increases substantially more during the construction phase than in the operation phase. The reason may be due to the transportation of borrowed earth amounting to about 7.0 lakh m^3 plus 3 lakh m^3 for preloading,site levelling, construction of embankment & its associated activities. In our case, the transportation of material in haul road (unpaved approached road) was considered for a distance of 1km from the SLF site on the FACT Road. The maximum GLC observed during the construction phase corresponds to 22.3 µg/m^3, 2.04 µg/m^3, & 1.07 µg/m^3 for parameters PM, NOx & CO respectively.

Air emission during operation phase

The expected air pollutants are methane and non-methane hydrocarbons. These pollutants are expected to be released through passive gas vents provided at every 2,500 m^2 from the 300mm diameter gas collection layer provided below the SLF. It was observed that the maximum of all C_{98} pollutant concentrations in the study area for PM_{10}, $PM_{2.5}$, SO_x and NOx are 58, 27, 5.4 and 19.4 µg/m^3 respectively due to existing industrial activities, road transport and urban activity in the study area.

It is evident that the GLC increases substantially more during the construction phase than in the operation phase due to reduced vehicle operations. In our case, the transportation in Haul Road was considered for 1km from the SLF site to the Fact Road. The maximum GLC observed during the operation phase corresponds to 2.66 µg/m3, 0.322 µg/m3, & 1.07 µg/m3 for parameters PM, NOx & CO respectively.

Estimation of methane emission concentration

The estimates on annual emissions produced by Mass Balance Calculation are considered as per IPCC guidelines as it is suitable for SLF as it gives result based on the mass balance which will reflect the worst-case scenario. This worst-case scenario is generally considered for predicting the environmental contributions. Average H_2S generation is 30% of total methane = $2.15 \times 10^{-9} \times 0.30 = 0.645 \times 10^{-9}$ m^3/s. As the generation is very meagre the SLF is safe and does not warrant for further analysis.

Carbon Footprint

The expected carbon footprints due to the project is estimated to be 424.43 tCO2e/year, which can be offset by 3000 trees, it is expected that every year, the amount of carbon absorbed by the greenbelt planned on the project site will increase indicates the carbon absorption over the intervals of 5, 10, and 15 years. The detail estimations are shown in impact and mitigation measure chapter.

Noise environment

Initially, it is expected 4 trucks per day with 40-ton capacity each will be deployed to SLF site to dispose the inert waste collected from various places. Similarly, 1 dozer will be operating at

SLF to compact the inert material. The operation of dozer at SLF site will be maximum of 2 hours in a day. Noise generated from DG sets will have a permanent effect to the workers working in the nearby vicinity of SLF.

During operation phase, noise is generated from the above sources only and the propagation modelling considered for operation and the predicted noise level at source during operation is 100 dB(A).

The results of the noise modelling reveals that the maximum noise level will be 100 dB(A) at project site due to the SLF activity. The noise level at 100m, 500m and 1500m is predicted to the level of 75, 40 and 25 dB(A) respectively. The results are predicted without any attenuation factors. It is expected with attenuation factors as given in mitigation measures will reduce the noise level to the extent possible/within the permissible norms. The noise contours are shown in below figure.

Water environment

The total water requirement during operation phase is estimated about 3 KLD which will be sourced from Kerala Water Authority (KWA). On Operation, the SLF wastewater generation from leachate is estimated to be about 300 KLD which will be treated in Leachate Treatment Plant (LTP) having capacity of 400 KLD. The entire treated water of 300 KLD planned to be used for dust control purposes and avenue plantation. About 2.55 KLD of sewage will be generated and the same will be treated in LTP. The treated water from LTP will be reused for plantation and green belt to reduce the fresh water consumption.

In addition, the efficient rainwater management plan is also adopted for entire SLF area according to the topography. Groundwater recharge, storm water management also considered as mitigation measures. To check the status of clay layers 7 nos. of piezometers will be installed around the SLF. In the location of the piezometers are shown in the general layout. The depth of the piezometers will be about 10m.

Land environment

The total land area likely to be occupied by the SLF is estimated as 1,01,171 Sq.m (25 Acres). Out of which the SLF footprint is estimated to be 73,615 Sq.m. The existing land use pattern will be altered due to disposal of inert waste.

Biological Environment

The impact on terrestrial ecology will be due to emission of gaseous pollutants like Methane. The gaseous pollutants at a very low dose as estimated and that will be restricted within the norms. Development of adequate greenbelt of 13,155 sq.m will be maintained in and around the site will help in reducing the impacts on the flora and fauna as the plant species will act as air and noise pollution sink.

Socio economic environment

The proposed SLF will provide additional employment opportunities and improved living conditions for our society. The project will provide the cleaner and protected environment to the surrounding area. The proposed project would enhance the existing infrastructure in the area by providing a cleaner and greener environment through CER activities earmarked during construction of the project.

Occupational Health and Risk

The SLF project will not handle any flammable substances like diesel and thereby increasing potential risks due to storage of flammables are not expected. However, SLF will handle inert waste of about 160 tonnes initially to 220 tonne per day. SLF will adopt necessary protective measures to safeguard the employee working at disposal site by providing suitable PPEs like earmuffs, goggles, facemask, hand gloves and gumboots to workers. Hence, any possible occupational health impact from exposure to such fugitive dust is not likely to be of major significance.

Analysis of Alternatives (Site and Technology)

Based on the land availability and compliance to SWM Rules, 2016 guidelines the Ambalamedu site is chosen out of three sites. The compliance to the site selection criteria is given in the EIA report.

Table 11-1 Activity parameters for site selection

Sl. No.	Activity parameters considered	Site 1 Killimangalam	Site 2 Perumbavoor	Site 3 Ambalamedu
1	Available area in acres	48.18	27.18	25
2	Elevation ASML	75 – 109 m	90 – 118 m	22 – 45 m
3	Location	Killimangalam	Perumbavoor	Ambalamedu
4	Classification of land	Agricultural land	Agricultural land	Grass land
5	Approach road	Other District Roads (ODR)	ODR	Major District Road (MDR)
6	Owner of the land	Private	Private	KINFRA - Government
7	Sensitive areas	Nil	Nil	Nil
8	Nearest settlements	25 m	20 m	550 m
9	Remarks	Considering the nearest settlements and agricultural land, the site not recommended for SLF.	Considering the nearest settlements, less road facility, the site is not recommended for SLF.	Considering the land availability, ownership and classification, the site is **recommended for SLF**.

Alternative technology

The technology envisaged for the project is customized civil work and suitable for identified site. A brief of the technology including method of work and design parameters are in line with SWM Rules, 2016 and the same briefed below.

Inert waste for SLF will be compacted in thin layers using heavy compactors to achieve high density of the waste. The landfill cell will be covered at the end of each working day with minimum 10 cm of soil or inert debris or construction material. Proper drainage will be constructed to divert run-off away from the active cell of the landfill. After completion of landfill, a final cover will be designed to minimise infiltration and erosion. The final cover will have soil layer comprising of 60 cm of clay or amended soil with permeability coefficient less than 1×10^{-7} cm/sec. On top of the barrier soil layer, there will be a drainage layer of 15 cm. On top of the drainage layer, there will be a vegetative layer of 45 cm to support natural plant growth and to minimise erosion.
In order to prevent pollution from landfill operation, the storm water drain will be designed and constructed in such a way that the surface run-off water is diverted from the landfilling site and leachates from inert waste locations do not get mixed with the surface run-off water. Non-permeable lining system at the base and walls of waste disposal area is planned. For landfill will have liner of composite barrier of 1.5 mm thick High-Density Poly-ethylene (HDPE) geo-membrane overlying 90 cm of soil (clay or amended soil) having permeability coefficient not greater than 1×10^{-7} cm/sec is planned. The highest level of water table will be maintained at two meter below the base of clay or amended soil barrier layer provided at the bottom of landfills. Provisions for management of leachates including its collection and treatment will be implemented. The treated leachate will be recycled or utilized as permitted for other needy industries. As the technology is proven and being practised in India by various state government to manage the inert waste. Hence, more advanced technology for disposal of inert waste is planned which will meet the statutory as well as technological requirement.

Environmental Monitoring Programme

A large part of the environmental attributes sampling and measurement activities will be concerned with long term monitoring aimed to provide an early warning of any undesirable changes or trends in the natural environment that could be associated with the SLF at Ambalamedu activity. Besides monitoring of conventional parameters around SLF at Ambalamedu site, specific importance is given for ambient monitoring with additional parameters as required to meet the norms. GSR 826 (E) dt. 16th Nov. 2009. They are described under two separate categories.

- Onsite monitoring within the SLF at Ambalamedu site
- Monitoring program in public domain

Regular environmental monitoring for air quality, water quality, noise levels and soil quality program will be carried out during construction, operation and post operation phases. Environmental Monitoring Programme information from each phase will be noted, recorded, documented and reported on regular basis. The monitored data will be analysed and compared with the baseline levels as established in the EIA study and the regulatory standards specified by different government agencies.

It is proposed to invest INR Rs. 285.74 Crore for the project to establish SLF site at Ambalamedu. The monitoring cost for six months is earmarked to the tune of INR

Rs.10,00,000/- excluding monitoring equipment cost. In addition, for occupational health & safety issues, development of green belt of about Rs. 15,00,000/- will be allocated for every year.

Post closure monitoring plan

Closure of capping layer includes Compacted Clay Layer (CCL) as a barrier. In addition to the CCL. Geosynthetic Clay Layer (GCL) is added as a liquid barrier. To ensure proper GCL installation, all standard processes must be rigorously followed. Above the GCL, a 1.5 mm thick High-Density Polyethylene Geomembrane. Gas collection layer is planned with a 15 cm thick granular gas drainage layer formed by crushed gravel or crushed demolition waste to facilitate gas collection. Drainage composite for planar drainage made by thermo-bonding a draining core - HDPE geonet - with two non-woven geotextiles (GTX) that operate as separation, filter, and protection layers. A drainage layer 5 mm thick with 450 GSM Geotextile will be provided. The top layer should be of vegetative soil of 45 cm thickness with the slope of top cover shall be 1:4. This layer will aid in the growth of the grass which helps to avoid erosion during wet season. Geocell is comprised of ultrasonically welded HDPE strips that expand to form a honeycomb-like structure on-site helps to keep the infill in the cell when it is loaded.

Additional Studies

The additional studies are pertaining to three multidisciplinary areas. The first is concerned with the public consultation which will be held by pollution control board on receipt of draft report EIA/EMP report if it is instructed by SEIAA in the ToR. The second is risk assessment study prevailing at present in the study area and the likely impact on it as a result of implementation of the proposed project. The third one is Social Impact Assessment of the risk that the public and environment might be subjected to as a result of the proposed SLF.

The emergency preparedness plan is prepared to mitigate the consequences. For this, the approach involves hazards pertaining to fires in SLF area, Natural disaster, Electrical accidents, flooding from man-made causes, Rainfall induced erosion, Environmental & health aspects. Providing safeguard measures like first aid boxes, personal protective equipment, safety measures at landfill site.

Emergency preparedness and prevention through good design, operation, maintenance and inspection in case of natural disaster or man-made disasters like, Fire hazard, natural disaster and environmental & health aspects.

Project benefits

From the proposed project the major benefit is improving the degraded environment by establishing a Scientific Municipal Solid Waste Landfill Facility. As a result of the proposed project there will be horizontal and vertical benefits to society and environment respectively.

Research findings indicate that sanitation improvements result in more health benefits, mainly in terms of reducing the waterborne/airborne diseases. Sanitation improvements in urban areas will help to reduce this high incidence of annual household medical expenditure by reducing the impact of waterborne/airborne diseases considerably.

With coming up of the proposed project, the employment opportunities (direct as well as indirect) will increase and local people will be employed on the priority basis as per their skills. The proposed project will help in creating pollution free clean environment and will generate

source of income from otherwise considered waste. This will help in improving the living conditions of the people. The surrounding environment will not face any problem related to pollution because appropriate pollution control equipment will be followed by SLF management. The region attracts investment and thereby CER activities which may be beneficial to the local people.

Environmental cost benefit analysis

Environmental Cost Benefit analysis is not recommended at the scoping stage. Hence, it is not required as per the standard/Specific ToR given by SEIAA – Kerala vide ToR Identification no. TO24B3401KL5888163N, dated 08-08-2024.

The estimated project cost is INR Rs. 274.79 crore. A good fraction of project cost is earmarked towards pollution control measures. The updated environmental capital and recurring cost for the environmental facilities for the SLF site INR 7.87 crore including CER amount of Rs. 3.6 Crore for 2 years.

Post project monitoring plan

Regular environmental monitoring for AAQ, water quality, environment noise levels and soil quality, Storm water collection monitoring, plantation & greenbelt development, Occupation, Health & Safety surveillance, Socio-economic awareness are planned. The organogram of Environmental Monitoring Cell (EMC) for both occupational health & safety and Environmental issues is set up in order to maintain the conditions as post closure maintenance.

EMC will be in regular touch with KSPCB and the Regional Office of MoEF&CC and sends them periodic compliance report on EMP compliance in the prescribed format. Any new regulations/ guidelines considered by KSPCB/CPCB is taken care of by EMC. Action is taken to update the EMP on regular basis in accordance to the guidelines of regulatory authorities as KSPCB/MoEF&CC etc.

Conclusion

It can be concluded from the EIA study that the proposed SLF be benign with the environment as the suitable control measures are suggested in the report. At the same time, the project is considered as important to the state as there are no scientific sanitary landfill currently. The establishment of the SLF will ensure that the state complies with the SWM Rules.

Disclosure of Consultant

General

This chapter describes about the environmental consultant engaged in preparation of Environmental & Social Impact Assessment for Proposed Scientific Landfill at Ambalabedu Site, Ernakulam District of Kerala for Environmental Clearance.

Introduction

ABC Techno Labs India Private Limited (formerly ABC Environ Solutions Pvt. Ltd.) is an ISO 9001, ISO 14001 & OHSAS 18001 Certified Company & leading Environmental Engineering & Consultancy Company constantly striving towards newer heights since its inception in 2006. Our Company is dedicated to providing strategic services in the areas of Environment, Infrastructure, Energy, Engineering and Multilab.

It is the first firm to be accredited by NABET (National Accreditation Board for Education and Training), Quality Council of India, as an EIA Consultant, approved for carrying out EIA studies and obtaining environmental clearance for various sectors such as Thermal Power Plants, Infrastructure, Industrial Estates/Complexes/Areas, Mining, Township & area development and Building construction projects etc. ABC Techno Labs is equipped with in-house, spacious laboratory, accredited by NABL (National Accreditation Board for Testing & Calibration Laboratories), Department of Science & Technology, Government of India.

Since establishment ABC Techno Labs focus on sustainable development of Industry and Environment based on sound engineering practices, innovation, quality, R&D and most important is satisfying customers need. The company has successfully completed more than 100 projects of a variety of industries, in the field of pollution control and environmental management solutions. The company is also dealing in the projects of waste minimization and cleaner production technology.

The team of technocrats and scientist are well experienced to deal with the design, Manufacture, Fabrication, Installation, commissioning of Effluent/ Wastewater treatment plants, Sewage Treatment plants, and Combined Treatment plants. The company is having well-experienced team of Scientists & Engineers who are looking after environmental projects & well-equipped analytical laboratory with a facility including analysis of physical, chemical and biological parameters as per the requirements of the State Pollution Control Board and our clients.

Services of ABC Techno Labs India Private Limited Environmental Services

- Environmental Impact Assessment (EIA)
- Environmental Management Plan (EMP)
- Social Impact Assessment (SIA)
- Environmental Baseline data collection for Air, Meteorology, Noise, Water, Soil, Ecology, Socio-Economic and Demography etc;
- Environmental Monitoring
- Socio-Economic Studies
- Resettlement & Rehabilitation Plan
- Ecological & Human Health Risk Assessment Studies

- Ecological Impact Assessment
- Environmental Management Framework
- Solid Waste Management
- Hazardous Waste Management
- Internship & Training
- Turnkey projects
- Water Treatment Plants Sewage Treatment Plant
- Recycling & Water Conservation Systems
- Other services
- Operation & Maintenance of Water & Waste Water Plants
- Water & Waste Water Treatment Chemicals
- Pilot Plant studies
- Feasibility studies & preparation of budgetary estimates
- Zero Discharge System
- Other services
- Operation & Maintenance of Water & Waste Water Plants
- Water & Waste Water Treatment Chemicals
- Pilot Plant studies
- Feasibility studies & preparation of budgetary estimates
- Laboratory services
- Chemical Testing
- Environmental Testing
- Microbiological Testing
- Food Testing
- Metallurgical Testing

Sectors Accredited by NABET

Sl.No.	Name of sectors	NABET Sector No	MoEF&CC Sl. No.
1.	Mining of Minerals including Opencast/Underground Mining	1	1 (a) (i)
2.	Offshore & Onshore Oil and gas exploration, development & productions	2	1 (b)
3.	River Valley Projects	3	1 (c)
4.	Thermal Power Plant	4	1 (d)
5.	Mineral Beneficiation including palletisation	7	2 (b)
6.	Metallurgical Industries – (Ferrous & non-ferrous)	8	3 (a)
7.	Cement Plants	9	3 (b)
8.	Petroleum Refining Industry	10	4 (a)
9.	Leather/Skin/hide processing industry	15	4 (f)
10.	Chemical Fertilizers	16	5 (a)
11.	Petro-chemical Complexes	18	5 (c)
12.	Petrochemical based processing	20	5 (e)
13.	Synthetic organic chemicals industry	21	5 (f)
14.	Distilleries	22	5 (g)

Sl.No.	Name of sectors	NABET Sector No	MoEF&CC Sl. No.
15.	Integrated Paint Industry	23	5 (h)
16.	Sugar Industry	25	5 (j)
17.	Oil & gas transportation pipe line (crude and refinery/ petrochemical products)	27	6 (a)
18.	Airports	29	7 (a)
19.	Industrial estates/ parks/ complexes/ areas, export processing Zones (EPZs), Special Economic Zones (SEZs), Biotech Parks, Leather Complexes	31	7 (c)
20.	Ports, Harbors, Jetties, Marine terminals, break waters and desilting	33	7 (e)
21.	Highways, Railways, Transport terminals, mass rapid transport system	34	7 (f)
22.	Common Effluent Treatment Plants (CETPs)	36	7 (h)
23.	**Common Municipal Solid Waste Management Facility (CMSWMF)**	**37**	**7 (i)**
24.	Building and large Construction projects including shopping malls, multiplexes, commercial complexes, housing estates, hospitals, institutions	38	8 (a)
25.	Townships and Area development projects	39	8 (b)

Study Team

ABC Techno Labs India Private Limited has carried out this Environmental Impact Assessment (EIA) study. The multidisciplinary team included expertise in Environmental Impact Assessment, Air & Water pollution & Control measures, Noise Control measures, Ecology & bio-diversity, Land use, Geology, Environmental Chemistry and Socio-Economic planner. The team members involved in EIA study area.

Sl.No.	Functional Areas	Name of the Expert/s
1	WP	Vaishnavi Dhinakaran
	SHW	
2	AP	Haneesh KR
3	EB	Abhik Saha
4	AQ	Haneesh KR
	NV	
5	HG	Dr. Veezhinathan Subramaniyam
	GEO	
6	LU	Dr. N Rama Krishnan
	SE	
Team Members		
1	FAA	Banu Priya J
2	FAA	P.S.Bhuvnesh
4	Environmental Engineer	Logesh Kumar Paraman
5	Jr. Environmental Engineer	Ameenur Rahman K

6	Environmental Executive	Mr. Robson Chinnadurai
7	Jr. Environmental Chemist	Dhanush H
8	Senior Chemist	Mr.Venkateshwaralu
9	Field Technician	Mr. Thavanesan

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NABET

National Accreditation Board for Education and Training

Certificate of Accreditation

ABC Techno Labs India Private Limited, Chennai

ABC Tower, 400, 13th Street, SIDCO Industrial Estate, North Phase, Ambattur, Chennai 600098

*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 including opencast/ underground mining	1	1 (a) (i)	A
2	Offshore and onshore oil and gas exploration, development & production	2	1 (b)	A
3	River Valley projects	3	1 (c)	A
4	Thermal power plants	4	1 (d)	A
5	Mineral beneficiation including pelletisation	7	2 (b)	A
6	Metallurgical industries (ferrous & non-ferrous)	8	3 (a)	A
7	Cement Plants	9	3(b)	A
8	Petroleum refining industry	10	4 (a)	A
9	Leather/skin/hide processing industry	15	4 (f)	A
10	Chemical fertilizers	16	5 (a)	A
11	Petro-chemical complexes	18	5 (c)	A
12	Petrochemical based processing	20	5 (e)	A
13	Synthetic organic chemicals industry	21	5 (f)	A
14	Distilleries	22	5 (g)	A
15	Integrated paint industry	23	5 (h)	B
16	Sugar Industry	25	5 (j)	B
17	Oil & gas transportation pipeline, passing through national parks/ sanctuaries/coral reefs / ecologically sensitive areas including LNG terminal	27	6 (a)	A
18	Airports	29	7 (a)	A
19	Industrial estates/ parks/ complexes/ Areas, export processing zones(EPZs), Special economic zones (SEZs), Biotech parks, Leather complexes	31	7 (c)	A
20	Ports, harbours, break waters and dredging	33	7 (e)	A
21	Highways	34	7 (f)	A
22	Common Effluent Treatment Plants (CETPs)	36	7 (h)	B
23	Common Municipal Solid Waste Management Facility (CMSWMF)	37	7 (i)	B
24	Building and construction projects	38	8 (a)	B
25	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 June 09, 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/23/2795 dated July 11, 2023. The accreditation needs to be renewed before the expiry date by ABC Techno Labs India Private Limited, Chennai following due process of assessment.

Sr. Director, NABET
Dated: July 11, 2023

Certificate No.
NABET/EIA/2225/RA 0290

Valid up to
Nov 16, 2025

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to the QCI-NABET website.

ANNEXURES

Annexure I- ToR issued under the Provision of EIA Notification 2006

issuance by SEIAA

सत्यमेव जयते

File No:
Government of India
Ministry of Environment, Forest and Climate Change
(Issued by the State Environment Impact Assessment Authority(SEIAA), KERALA)
***

Dated **08/08/2024**

To,

Divya S. Iyer IAS, Project Director
Kerala Solid Waste Management Project, LSGD, Govt of Kerala
Ground Floor, Trans Tower,Vazhuthacaud., Ambalamedu, Ernakulam, Kerala, 695014
pdkswmp@gmail.com

Subject: Grant of Standard Terms of Reference for the Common Municipal Solid Waste Management Facility at Ambalamedu, Ernakulam under the provision of the EIA Notification 2006-regarding.

Sir/Madam,

This is in reference to your application for Grant of Terms of Reference under the provision of the EIA Notification 2006-regarding in respect of project Proposed Scientific Landfill for KSWMP at Ambalamedu,Ernakulam District, Kerala State submitted to Ministry vide proposal number SIA/KL/INFRA2/469934/2024 dated .

2. The particulars of the proposal are as below :

(i) TOR Identification No.	TO24B3401KL5888163N
(ii) File No.	
(iii) Clearance Type	Fresh ToR
(iv) Category	B1
(v) Project/Activity Included Schedule No.	7(i) Common Municipal Solid Waste Management Facility (CMSWMF)
(vii) Name of Project	Proposed Scientific Landfill for KSWMP at Ambalamedu,Ernakulam District, Kerala State
(viii) Name of Company/Organization	Kerala Solid Waste Management Project, LSGD, Government of Kerala
(ix) Location of Project (District, State)	Ernakulam, Kerala
(x) Issuing Authority	SEIAA
(xii) Applicability of General Conditions	yes
(xiii) Applicability of Specific Conditions	yes

3. In view of the particulars given in the Para 1 above, the project proposal interalia including Form-1(Part A and B) were

submitted to the Ministry for an appraisal by the State Environment Impact AssessmentAuthority(SEIAA) Appraisal Committee (SEIAA) in the Ministry under the provision of EIA notification 2006 and its subsequent amendments.

4. The above-mentioned proposal has been considered by State Environment Impact Assessment Authority(SEIAA) Appraisal Committee of SEIAA in the meeting held on 28/06/2024. The minutes of the meeting and all the application and documents submitted [(viz. Form-1 Part A, Part B, Part C EIA, EMP)] are available on PARIVESH portal which can be accessed by scanning the QR Code above.

5. The SEIAA, in its meeting held on 28/06/2024, based on information & clarifications provided by the project proponent and after detailed deliberations recommended the proposal for grant of Standard Terms of Reference under the provision of EIA Notification, 2006 and as amended thereof subject to additional studies as detailed in Annexure (1).

6. The SEIAA has examined the proposal in accordance with the Environment Impact Assessment (EIA) Notification, 2006 & further amendments thereto and after accepting the recommendations of the State Environment Impact AssessmentAuthority(SEIAA) Appraisal Committee hereby decides to grant Standard Terms of Reference with additional studies as in Annexure I for instant proposal of M/s. Kerala Solid Waste Management Project, LSG Department, under the provisions of EIA Notification, 2006 and as amended thereof.

7. The Ministry reserves the right to stipulate additional conditions, if found necessary.

8. The Terms of Reference to the aforementioned project is under provisions of EIA Notification, 2006. It does not tantamount to approvals/consent/permissions etc. required to be obtained under any other Act/Rule/regulation. The Project Proponent is under obligation to obtain approvals /clearances under any other Acts/ Regulations or Statutes, as applicable, to the project.

9. This issues with the approval of the Competent Authority.

Copy To
N/A

Annexure 1

Specific Terms of Reference for (Common Municipal Solid Waste Management Facility (Cmswmf))

1. Environmental Studies

S. No	Terms of Reference
1.1	Detailed hydrogeological study incorporating water table contour, water table fluctuations and water quality variations.
1.2	Additional safeguards for sanitary landfill considering marshy or near marshy condition of the proposed site.
1.3	Safeguards measures for sanitary landfill to prevent the emission of gases, considering the proximity to HPCL LPG Plant, IOCL and BPCL Plants and other industrial units and institutions.
1.4	Post-closure care of landfills with long term monitoring and maintenance strategies.
1.5	Evaluation of flood risk exposure to the proposed project area and the safeguards for sanitary landfill.

Annexure 2

Details of Products & By-products

Name of the product /By-product	Product / By-product	Quantity	Unit	Mode of Transport / Transmission	Remarks (eg. CAS number)
Landfill site	Landfill site	52800	Tons per Annum (TPA)	Road	N/A


e-Payments
Validity unknown
Digitally Signed by : Dr Kalyan U Kelkar
IAS
Member Secretary - SEIAA
Date: 08/08/2024

ANNEXURE II: BASELINE DATA

List of important physical environmental components and indicators of EBM

Environmental Component	Environmental Indicators
Climatic variables	➢ Rainfall patterns – mean, mode, seasonality ➢ Temperature patterns ➢ Extreme events ➢ Climate change projections ➢ Prevailing wind - direction, speed, anomalies ➢ Relative humidity ➢ Stability conditions and mixing height, etc.
Topography	➢ Slope form ➢ Landform and terrain analysis ➢ Specific landform types, etc.
Drainage	➢ Surface hydrology ➢ Natural drainage pattern and network ➢ Manmade channels ➢ Rainfall runoff relationships ➢ Hydrogeology ➢ Groundwater characteristics – springs, etc. ➢ All analysis in line with existing drainage pattern including sensitive areas.
Soil	➢ Type and characteristics ➢ Porosity and permeability ➢ Sub-soil permeability ➢ Run-off rate ➢ Infiltration capacity ➢ Effective depth (inches/centimeters) ➢ Inherent fertility ➢ Suitability for method of sewage disposal, etc.
Geology	➢ Underlying rock type, texture, depth ➢ Surgical material ➢ Geologic structures (faults, shear zones, etc.) ➢ Geologic resources (minerals, etc.) ➢ Identification of fault lines and fractured lines within 500m.
Water	➢ Raw water source and infrastructure facilities. ➢ Water quality ➢ Surface water (rivers, lakes, ponds, gullies) – quality, water depths, flooding areas, HFL etc. ➢ Ground water – water table, local aquifer storage capacity, specific yield, specific retention, water level depths and fluctuations, etc. ➢ Coastal, wetlands, marsh ➢ Floodplains

	➢ Wastewater discharges ➢ Waste discharges, etc.
Air	➢ Ambient Air Quality (PM10 & PM2.5) ➢ Airshed importance ➢ Odour levels, etc.
Noise	➢ Identifying sources of noise & vibration ➢ Noise due to traffic/transportation of vehicles ➢ Noise & vibration due to heavy equipment operations in and around the site ➢ Noise level identification covering sensitive receptors like Hospital, Schools (nearby – across the rivulet) Commercial, Residential, Industrial. ➢ Duration and variations in noise over time, etc.
Socio-economic condition	➢ Population of 1,3,5 and 10 km will be assessed. ➢ Male, Female population working force labours combination. ➢ Availability of infrastructure facilities like PHC, Primary Schools, Universities etc will be assessed. ➢ During construction and operation, engagement of labours and their management plan will be assessed and incorporated. ➢ Accordingly Labour management plan (LMP) will be covered in the ESIA report.
Biological	➢ Species composition of flora and fauna ➢ Flora – type, density, exploitation, etc. ➢ Fauna – distribution, abundance, rarity, migratory, avifauna, species diversity, habitat requirements, habitat resilience, economic significance, commercial value, etc. ➢ Fisheries – migratory species, species with commercial/recreational value, etc. ➢ The study covers the sensitive areas.
Landuse	➢ Landuse pattern, etc.

(Detailed Quality Analysis of Environmental Parameters attached separate PDF)

ANNEXURE III: CIAL AIRPORT NOC

(In the Process of receiving NOC. Will add once received)

ANNEXURE IV: Focus Group Discussions

Focus Group Discussion

for

Proposed Scientific Landfill for KSWMP at Ambalamedu, Ernakulam District, Kerala State

By

Kerala Solid Waste Management Project (KSWMP)

Ground Floor, Trans Tower, DPI, Vazhuthacaud, Thiruvananthapuram, Kerala 695014

Project/Activity Sl. No. 7(i), Category (B)

Environmental Consultant

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Quality Uncompromised

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Branch offices @ Delhi | Mumbai | Kolkata | Coimbatore | Hyderabad | Bangalore | Jaipur | Guwahati.

Focus Group Discussion (FGD)

FGDs were conducted at Vadavucode Puthencruz, Thripunithura and Chittethukara,Thrikkakkara on 13th and 14th May 2024 to discuss on the other issues faced by the people located nearby the project site. The FGD was organized to sensitize the people about the proposed scientific landfill site planned at Ambalamedu.

The meeting proceedings held at the Karimugal Meeting Hall, Vadavucode Puthencruz, Grama Panchayat (Ambalamedu), Irumbanam Community Hall, Thripunithura Municipality and Chittethukara, Thrikkakkara Municipality, Ernakulam District of Kerala. The focus group discussion participants are Common people, Elected Members, NGO's, SHG's and Volunteers etc. Initially, the people were sensitized about the need of the project which will be helping the people to live in an environmentally friendly and hygienic condition. Concerned Officials of SPMU, DPMU of KSWMP, and the EIA Consultants also participated.

The focus group discussion held at three places on two days among the common people to find out their opinion and the present and future problems likely to arise due to proposed scientific landfill site due to the project. The other local issues were discussed with them to know about their other problems, basic needs, and major demands. Their view and opinion of the local people is well recorded and documented during the meeting proceedings. Each and every stakeholder, local representatives, elected representatives of the Panchayat where the landfill is located, and nearby local bodies, NGO representatives, Self-Help Groups and local volunteers were invited respectively for the meeting proceedings to give their views and suggestions on KSWMP site.

Key Discussions and Outcomes:

The various issues were discussed in the meeting like industrial pollution, air emission, water pollution, post-covid impact, soil pollution and employment issues etc. The industrial waste (like gypsum) dumped nearby the KSWMP proposed site affects the environment and cause major damage to the life of the residents and cause impacts on their livelihood. The quality of water was affected by its pollution and water shortage was also faced by the local residents. The local people were facing health issues like breathing problem, eye irritation, vomiting sensation, and headache issue. The health condition of the people feels that the proposed scientific landfill will also add the health impact. The main concern of the stakeholders was to protect and conserve the environment. Some of the people also migrating from the concerned area due to the pollution faced by the local residents due to various other industrial plants. This issue was discussed in the meeting proceedings.

The participants were expressing their views on the basic amenities, major area required for the project, and their socio-economic issues. The common people were expressed their views on building check dams, medical, educational, electricity, water and transportation facilities, employment opportunities, environmental protection and conservation, and safety precautionary measures. The opinion of the people was documented to meet their demands and expectations.

The local residents expressed that they are facing water shortage during peak summer. The surrounding industries emissions are polluting the ground water and reduces its availability also one of their observation. The urbanization of the Ambalamedu area were affecting the availability of water and causes water shortage in the concerned area and affect the fertility of the agricultural land and its production is also their concern. The demands of the local people was to build check dams for fulfilling their water requirements. They also in opinion that if the check dams are built, it will increase the ground water level and availability of surface water level to meet their domestic needs. The immediate requirement of preventing the water pollution and protecting the purity of water against its pollution and conserving and preserving for the requirement of the future generation. The people also opined that the

solid waste management project must cover the required pollution control measures as per norms. The concerned government authorities must check and monitor the rules and regulations of solid waste management whether it is properly followed by the nearby industries.

The participants expressed their opinion on conducting medical camps for them because of the presence of major industries nearby the residential area. The major concern of the participants was their health problem. The people were facing major health issues due to the pollution in respect to air, water and land. They feel the water contamination affects the health condition of the people. The water borne disease may lead to causing fever and new viral infection among the people. The participants were discussed on post-covid impact on the livelihood of the local people. They also expressed that covid and post-covid situation affected their day-to-day business of the people and made economic loss to them.

The people demanded more educational institutions in their local area for addressing the skill gap among the younger generation. The significance of education was expressed in the meeting proceedings. The educational institutions can meet the skill demands of the young graduates and make them employable in the industrial job market and boost the GDP level of the state.

The participants expressed their opinion on the availability of the electricity facility in their local area. The major portion of electricity was consumed by the various industries rather than the household needs. The transportation facility was also one of the main concern of the local people. The participants also expressed their opinion on increasing the transportation facility in the local area for their residents. The roads must be well constructed and maintained by the concerned authorities. The rash driving of goods vehicles or container vehicles was affecting the movement of local residents. The road damages can be monitored on a regular basis by the concerned authority to prevent the road accidents. Sometimes, fire accidents broke out in the solid waste disposal site which affect the environment and cause air pollution to the residential area. People were facing breathing issues and eye irritation due to the fire smoke. One major fire accident was also occurred in the Brahmapuram and the fire smoke was prolonged for two weeks in the nearby residential area. Still now, the people were recalling the fire accident. The government authority must monitor whether any untoward incident like fire damage or water stagnation/contamination in the proposed site.

The environmental protection and conservation was discussed in the public meetings. The safety precautionary measures must be followed in the industries to prevent the fire accidents. The wastages of the industries must be properly segregated and separated to avoid any major leakage by its hazardous waste which may lead to gas leakage and affect the quality of air and might lead to air pollution. The participants made their opinion on conservation, preservation and protection of the environment for achieving the sustainable development goals (SDG). Sustainability was one of the main concern among the local residents due to the presence of major industries in the local area.

The participants were expressed their opinion on air quality, water quality, soil quality, and preventing the pollutions, eco-friendly environment, sustainability, and conservation and preservation of environment. The focus group discussion were conducted to record and document the people's opinion and views on the major issues faced by them nearby the project site. The valid points and suggestions would help the organizers, the government authorities and the stakeholders to conserve and protect the environment.

Socio-Economic Study

As the part of Socio economic study the Focus Group Discussion (FGD) were conducted on Vadavucode Puthencruz, Grama Panchayat (Ambalamedu), Ernakulam district, Kerala. Total participant of FGD is 23 in which 12 male and 11 female.

Site Selection



Within 3 km radius from the project area is chosen for conducting FGD. Accordingly, Ambalamedu (Vadavucode Puthencruz, Grama Panchat) exist within 3 km radius from the project location. Therefore, FGD conducted at the above mentioned site.

A total number of ten transfer stations are proposed for the transportation of the process rejects and inert from TS to Scientific landfill proposed at Ambalamedu Site. These Transfer Stations will receive process rejects and inert from various MSW processing facilities/ MCF/RRF

The below figure shows the distance from TS to the Ambalamedu SLF site and coordinates of the Transfer station along with google image of the site.

Ambalamedu (Vadavucode Puthencruz, Grama Panchayat) Profile

Vadavukode village is located in Kunnathunad Taluk of Ernakulam district in Kerala, India. The total geographical area of Ernakulam is 3,05,826. The total forest land in Ernakulam is 70,617. The forest area (Hectare) is 82383.02. The forest covers in Ernakulam (Area in sq.km) is 385 open forest, 12 dense forest and 298 moderate dense forest. It is situated 14km away from sub-district headquarter Perumbavoor and 16km away from district headquarter Kakkanad. As per 2009 stats, Vadavucode Puthen Cruz is the gram panchayat of Vadavukode village. The total geographical area of village is 250 hectares. Vadavukode has a total population of 2,377 peoples. There are about 624 houses in Vadavukode village. Thrippunithura is nearest town to Vadavukode which is approximately 18km away. The population density of Ernakulam district is 1,072 people per square kilometer.

The population growth rate of Ernakulam district between 2001 and 2011 was 5.69%. Vadavucode Puthen Cruz Gram Panchayat is a Rural Local Body in Vadavucode Panchayat Samiti part of Ernakulam Zila Parishad. There are total 2 Villages under Vadavucode Puthen Cruz Gram Panchayat jurisdiction. Gram Panchayat Vadavucode is further divided into 17 Wards. Gram Panchayat Vadavucode has total 17 elected members by people. Gram Panchayat Vadavucode has total 12 schools. The proposed project location falls at Ambalamedu ward no. 14, Karimugal South Ward no.12, Puthencruz ward no.8 and Vadavacode ward no.7.Vadavucode-Puthencruz Panchayat is situated in Ernakulam District. Agriculture is the main profession of this village. Still this village is waiting for Industrial development.

Education, Drinking water, Road and Electricity are the main concern of this village. Medical and health services has to be improved.

Demographic Details

Demographic Details of the site

S.No	Name of Settlement	Rural / Urban	No. of House Holds	Population			Schedule Caste		Schedule Tribe		Literate	
				Total	M	F	M	F	M	F	M	F
1	Vadavucode puthencruz panchayath	Rural	5638	22378	11014	11364	2348	2385	331	360	70061	68749

Sources: ernakulam.nic.in/en/census

The Vadavucode Puthencruz Panchayath is one of the rural panchayath in which the total number of households is 5,638. The total number of population is 22,378 in which the male population is 11,014 and the female population is 11,364. The scheduled caste population of male is 2,348 and the female population of SC is 2,385. The scheduled tribe population of male is 331 and the female scheduled tribe population is 360. The total number of male literate population is 70,061 and the female literate population is 68,749.

Occupational Pattern

The Vadavucode Puthencruz Panchayath in which the occupational pattern comprises the total number of male and female workers are 6,234 and 2,529. The total number of male and female main workers are 5,301 and 1,817. The male and female cultivators are 126 and 17. The total number of male and female agricultural labourers are 138 and 35. The other male and female workers 4,962 and 1,736. The male and female marginal workers are 933 and 712. The male and female non-workers are 4,780 and 8,835.

Occupational Pattern of the site

Sn	Name of Settlement	Total Workers		Main Workers		Cultivators		Agricultural Labor		Other Workers		Marginal Workers		Non-Workers	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F
1	Vadavucode puthencruz panchayath	6234	2529	5301	1817	126	17	138	35	4962	1736	933	712	4780	8835

Sources: ernakulam.nic.in/en/census

During the FGD, people proposed their basic requirement and feedback.

Focus Group Discussion at Thirupunithura Municipality, Ernakulam District, Kerala State

Project: Environmental & Social Impact Assessment for Proposed Scientific Landfills at Ambalamedu, Ernakulam District of Kerala

Project	:	Environmental & Social Impact Assessment for Proposed Scientific Landfills at Ambalamedu, Ernakulam District of Kerala
Date & Time	:	14.05.24 @10.00 Am
Venue	:	Irumbanam Community Hall, Thirupunithura Municipality, Ernakulam District, Kerala.
Organized by	:	KSWM – DPIU & ABC Techno Labs India Private limited
FGD Participant	:	Thirupunithura Municipality People, Elected Members, NGO's, SHG's and Volunteers etc.

Site Selection

Within 3 km radius from the project area is chosen for conducting FGD. Accordingly, Thirupunithura Municipality exist within 3 km radius from the project location. Therefore, FGD conducted at the above mentioned site.

Chittethukara, Thrikakkara Municipality Profile

Demographic Details of the Study Area within 10km radius

S. No	Name of Settlement	Rural/ Urban	No. of House Holds	Population			Schedule Cast		Schedule Tribe		Literate	
				Total	M	F	M	F	M	F	M	F
1	Thrikkakara municipality	Urban	19348	77319	38035	39284	3487	3636	188	192	33348	33353

Sources: ernakulam.nic.in/en/census

The Thrikkakkara municipality is one of the urban area in which the total number of households are 19,348. The total population is 77,319 in which the male and female population is 38,035 and 39,284. The male and female scheduled caste population is 3,487 and 3,636. The male and female scheduled tribe population is 188 and 192. The male and female literate population is 33,348 and 33,353.

Occupational Pattern of the Study Area

S. No	Name of Settlement	Total Workers		Main Workers		Cultivators		Agricultural Labor		Other Workers		Marginal Workers		Non-Workers	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F
1	Thrikkakara municipality	20753	8214	18853	6623	81	23	132	51	18367	6445	1900	1591	17282	31070

Sources: ernakulam.nic.in/en/census

The Thrikkakara municipality in which the occupational pattern is mentioned above. The total number of male and female workers are 20,753 and 8,214. The male and female main workers are 18,853 and

6,623. The male and female cultivators are 81 and 23. The male and female agricultural labourers are 132 and 51. The male and female other workers are 18,367 and 6,445. The male and female marginal workers are 1,900 and 1,591. The male and female non-workers are 17,282 and 31,070.

Focus Group Discussion at Chittethukara, Thrikkakkara Municipality, Ernakulam District, Kerala State

Project: Environmental & Social Impact Assessment for Proposed Scientific Landfills at Ambalamedu, Ernakulam District of Kerala

Date & Time: 14.05.24 @3.00 Pm

Venue: Chitetukara, Thrikakara Municipality, Ernakulam District, Kerala

Organized by: KSWM – DPIU & ABC Techno Labs India Private limited

FGD Participants: Chitetukara, Thrikakara Municipality People, Elected Members, NGO's, SHG's and Volunteers etc.

ANNEXURE - V

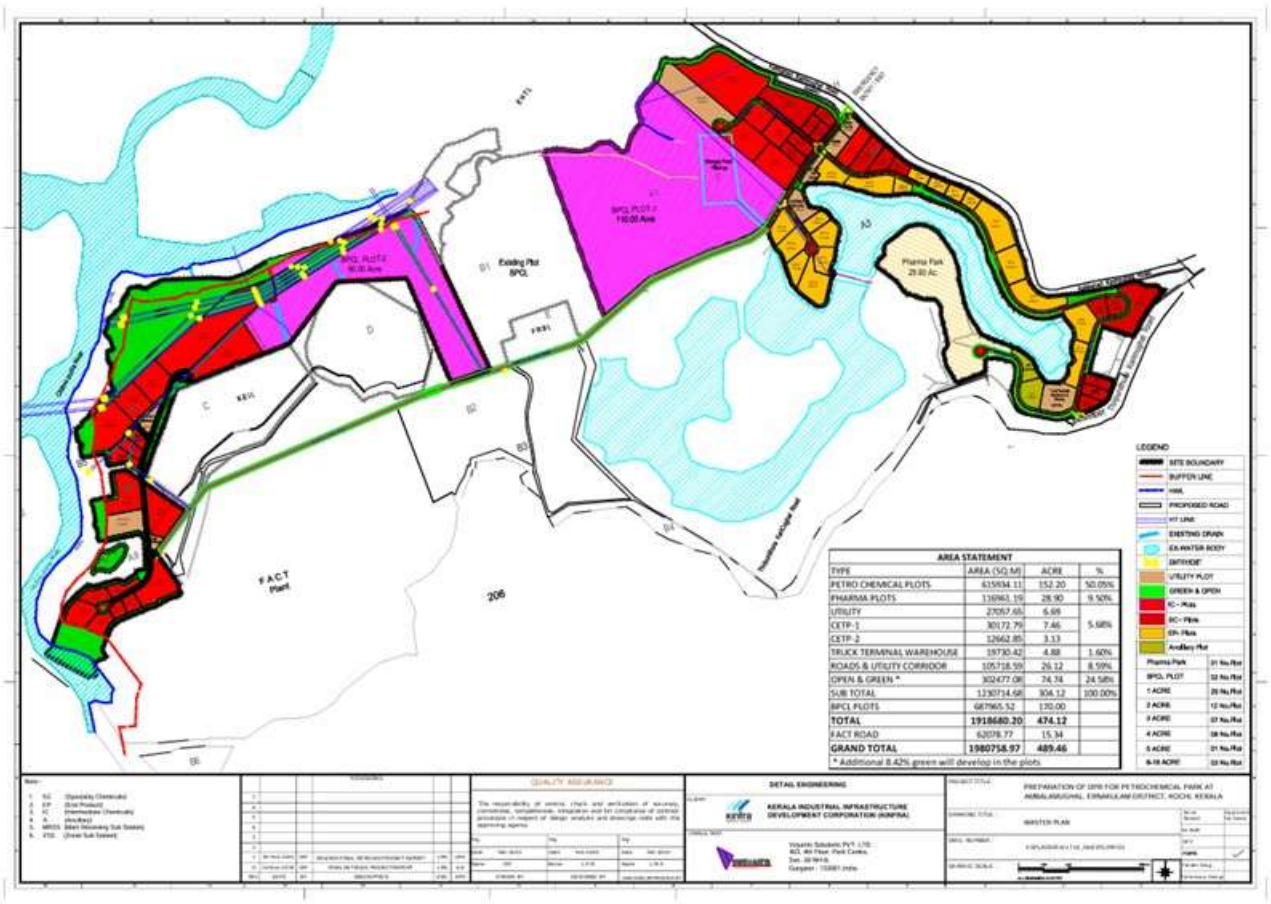
Stepwise Procedure for Shifting of 110 kV Extra High Tension (EHT) Line by KSEB

Phase	Task	Domain	Location	Agency
1.	Planning and Survey			
1.1.	Preliminary Survey: Conduct an initial survey to identify the general route and potential challenges such as marshy land, wetlands, and social impacts.	Reconnaissance	Office	KSEB
1.2.	Detailed Profile Survey: Create a detailed topographical profile along the route, including elevation and obstacles such as trees, buildings, and water bodies. Develop two to three alternate EHT alignment	Field Study	Site	Survey Contractor
1.3.	Tentative Tower Locations: Mark tentative tower locations based on the survey results and clearance norms specified for EHT cables.	Desk Study	Office	KSEB
1.4.	Conduct Geotechnical Investigation: Validate the alignment with detailed geotechnical testing of soil conditions at proposed tower locations to understand bearing capacity and other properties.Modify the alignment if necessary.	Field Study	Site	Geotech lab
2.	Design and Approvals			
2.1.	Sag Analysis and Profile Drawing: Conduct sag-tension analysis for the transmission line to ensure the new line meets technical and safety standards.	Desk Study	Office	KSEB
2.2.	Design Foundation, Towers, and Transmission Line: Design the foundations for different soil conditions, towers to support 110 kV conductors, and the transmission line layout.	Design	Office	KSEB
2.3.	Development of Line Estimate: Calculate the material, manpower, and machinery costs to create a comprehensive project budget.	Design	Office	KSEB
2.4.	Preparation of Detailed Estimate: Develop a detailed estimate incorporating the line estimate and contingencies for unforeseen challenges.	Design	Office	KSEB
2.5.	Preparation of Tender Documents: Prepare tender documents, including technical specifications and safety criteria complying to Chief Electrical Inspectorate General (CEIG), timelines, and financial aspects.	Procurement	Office	KSEB
2.6.	Award of Contract to L1 Bidder: Evaluate the bids received and award the contract to the lowest technically qualified bidder (L1).	Procurement	Office	KSEB
3.	Site Preparation			
3.1.	Mobilization of Contractor: Allow the contractor to mobilize resources, including labor, equipment, and materials, while managing any social	Construction	Site	Licensed Contractor

	concerns due to labor influx.			
3.2.	Clearing Shrubs in Wetland: Clear shrubs and vegetation along the marked alignment route, ensuring minimal environmental impact.	Construction	Site	Licensed Contractor
3.3.	Implement Access Roads and Platforms: Construct temporary access roads and work platforms to enable material and equipment movement in the marshy terrain.	Construction	Site	Licensed Contractor
4.	Foundation Works			
4.1.	Sheet Piling in Marshy Land: Perform sheet piling to confine/stabilize the wet and marshy soil before further excavation work begins	Construction	Site	Licensed Contractor
4.2.	Construction of Suitable Foundation: Carry out works for tower foundations, ensuring stability and load-bearing capacity for EHT towers.	Construction	Site	Licensed Contractor
5.	Tower Erection			
5.1.	Construction of Superstructure: Assemble and erect the steel members of the towers, ensuring compliance with safety standards	Construction	Site	Licensed Contractor
5.2.	Stringing of Transmission Line: Install the conductors between towers using tensioners and pullers, following the sag-tension profile.	Construction	Site	Licensed Contractor
6.	Testing and Commissioning			
6.1.	Testing of New Line: Test the newly installed transmission line for insulation, conductivity, and load capacity. Obtain permission to charge from the Authority(CEIG).	Safety	Site	CEIG, GoK
6.2.	Rerouting Power: Obtain line shutdown by informing the consumers and providing alternate emergency power. Disconnect the existing 110 kV line and reroute power to the newly constructed alignment	Commissioning	Site	KSEB
7.	Decommissioning and Cleanup			
7.1.	Removal of Old Infrastructure: Dismantle the old line and towers, ensuring proper disposal or recycling of materials.	Construction	Site	Licensed Contractor
7.2.	Site Restoration: Restore the site to its original condition, addressing any environmental concerns and legal compliance requirements.	Construction	Site	Licensed Contractor

Annexure VI

KINFRA PARK LAYOUT



Annexure VII

Application of the World Bank Environmental Safeguard Policies to KSWMP

1. Since KSWMP is funded under the IPF instrument of the World Bank, its Safeguards Policies are applicable for the project. Project Concept Note Review for the KSWMP program was before 01 October 2018 (the cutoff date1 for application of the World Bank's new Environmental and Social Framework (ESF)). Hence the World Bank Safeguard policies apply to this project, rather than the new ESF.

2. Considering the large project interventions at regional levels such as regional / cluster level landfill facilities, safeguards category for the KSWMP Project is determined as 'A' according to the World Bank's Safeguards Policy OP/BP 4.01 (Environmental Assessment), while the overall environmental risk is assessed as Significant. The World Bank's Safeguards Policy OP 4.01 (Environmental Assessment) is triggered for the project, necessitating the preparation of an ESMF for the project to guide subproject preparation. Some of the project activities including the development of treatment and disposal facilities and existing municipal waste dumping sites may be near natural habitat areas considering the geography of the State. Though overall impacts on these would be positive; as a precautionary measure OP/BP 4.04 (Natural Habitats) and OP 4.09 (Pest Management) are triggered, and suitable mechanisms to screen and manage subprojects near-natural habitats and manage the use of pesticides are planned. Though there will be no direct impact on physical cultural resources, such impacts and chance-finds may not be ruled out during excavation works involved in civil construction, dumpsite improvements, and landfill development works. Hence, OP/BP 4.11 (Physical Cultural Resources) has been triggered.

3. Impact assessment of the proposed subprojects reveals that most of the likely adverse impacts could be minimized or eliminated by following regulations, guidelines, and adopting standard mitigation measures. Also, there is ample scope to enhance some of the beneficial impacts to be generated from the proposed project. The ESMF prepared for the KSWMP program acknowledges these impacts, and integrates measures for assessing, mitigating/managing these during preplanning, planning, implementation including construction, and O&M and handover.

4. At the subproject level, Regional Infrastructure such as Sanitary Landfill is categorised as E1 as per the Subproject Categorization in EMF for KSWMP (Table 8, 9 of KSWMP ESMF: Volume II A, EMF; disclosed at https://kswmp.org/?p=1425). Subprojects with significant negative impacts including those which require EIA / CRZ clearance as per national regulations (Category A or B as per EIA notification and those which need CRZ clearance at National Level), and those which

might impact sensitive environmental components including natural habitats. In such cases Subproject-specific detailed EA preferably by an independent agency. For such assessment, national/state laws and regulations and the World Bank Environmental Safeguards policies such as OP 4.01 Environmental Assessment, OP 4.04 Natural Habitats, OP 4.09 Pest Management, OP 4.11 Physical Cultural Resources (PCR) are applicable. Screening, and Environmental Impact Assessment has been carried out in line with the above. A Tabular EMP prepared based on the assessments has been presented in the EIA report. EMP & EMoP will be incorporated into the Bid documents to enable the bidders to consider the resources (manpower & costs) for its implementation. Based on the final design, EMP will be updated by the selected contractor/s, before any activity on ground. EMP for linked activities such as Collection & Transportation of ejects and Inerts and for Shifting of EHT lines are also presented here. WB General EHS guidelines on Environmental, Occupational Health & Safety and Community Health and Safety will be applicable to all phases of the proposed SLF development, operation, and closure. WB Industry sector guidelines on Waste Management facilities are also applicable to this SLF. In this case, SLF is designed only for inert/rejects as suggested in WB EHS. SWM Rules 2016, and CPHEEO Guidelines are evaluated viz a viz the landfill siting criteria in WB EHS, and found to be more stringent in terms of distances required from sensitive receptors. All other management and monitoring measures for gas, leachate etc. have been subsumed in the design for SLF. In addition, leachate is proposed to be recirculated and reused rather than disposing. The best environmentally suitable option will be given due weightage in Bid selection considering Leachate management & recirculation, Gas capture and reuse, minimal need for soil for filling etc. The Contractor is expected to prepare C-EMPs adopting the WB EHS also in case of Occupational Health & Safety and Community Health and Safety, Disaster and Emergency Response etc. These will be included in the Bid Documents for DBOT contract.

Annexure VIII

Environmental Screening Checklist

Project Details

Name of Subproject:	Proposed Scientific Landfill at Ambalamedu, Ernakulam District of Kerala.
Subproject Components:	Development of Sanitary Landfill Facilities for inerts. The project consists of ground clearing, ground improvement, ground raising, consolidation, sub grade preparation, preparing base sealing/liner system, leachate drainage layer, pipeline system, erosion control system, leachate management, and allied infrastructures like green belt and tyre washing system..
Subproject Location (City / Town/ Village with ward numbers):	S.F. Nos. 23/4, 23/3, 23/5, 7/5, 7/4, 6/4, 23/2pt, 22/4pt, 22/3pt, 7/3pt, 5/3pt, 6/2pt, 6/3pt, 6/1pt, 6/7pt of Ambalamedu Village, Kochi.

Stage 1: Exclusion List

Is the Project Excluded from Consideration due to the following:

Sl No:	Non-permissible Activities	Remarks
1	Projects in sites/locations which should be excluded as per prevailing Rules / Laws, near Natural Habitats and Forests: (i) any construction in demarcated Forest areas or protected areas or their study area, (ii) landfills, not confirming to siting criteria as per SWM Rules 2016, or (iii) treatment facilities for Solid Waste, Biomedical Wastes and C&D Wastes not conforming to Pollution Control Boards siting criteria for specific industry (various types of treatment plants) types (where mitigation measures are not possible).	The proposed project involves (i) no construction in demarcated Forest areas or protected areas or their study area, (ii) no construction of landfills, not confirming to siting criteria as per SWM Rules 2016, or (iii) no treatment facilities for Solid Waste, Biomedical Wastes and C&D Wastes not conforming to Pollution Control Boards siting criteria for specific industry (various types of treatment plants) types (where mitigation measures are not possible).
2	Projects which would involve decontamination of hazardous waste dumpsites or those would potentially result in further pollution of sensitive areas	No activities which would involve decontamination of hazardous waste dumpsites or those would potentially result in further pollution of sensitive areas
3	Projects involving (i) any impact on or due to Dams or embankments or (ii) purchase, storage and use of Banned Pesticides	No activities with (i) any impact on or due to Dams or embankments (ii) and projects The Project will not purchase, store and use Banned Pesticides.

Proceeding to Stage 2 Screening: Environmental Screening Checklist

Project Details			
Sl. No	**Components**	**Details**	**Remarks**
1	Project components	Development of Scientific Landfill Facilities for Cluster- 4 at Ambalamedu	–
2	Details of Components (main components including collection and transportation, decentralized household solid waste management, community-level solid waste management, centralized non-biodegradable waste management facilities, centralized biodegradable waste management facilities, sanitary landfills, biomining of dumpsites, including for Linked activities / associated facilities)	SLF for Rejects /Inerts (development of disposal facilities (sanitary landfill) and associated infrastructure (base sealing, landfill phasing, drainage layers, and leachate management, waste placement, peripheral infrastructure like access, roads, leachate collection, gas venting and collection, reuse)	The inerts & rejects are collected and planned to be transported from ULBs to Transfer locations to SLF. From these locations, the inerts & rejects are lifted by hook loaders or refuse compactors.
3	Location of the Project Sites &Current Landuse (Provide information for all sites involved in the project; including for Linked activities / Associated facilities), any historic land use (related to heritage, or contamination) Site Survey No:/s (attach map) with ownership details, Geographical co-ordinates of the site location [including any off-site sub-components (attach map) Also, mention disaster zones. (Earthquake, Cyclone, etc.)	S.F. Nos. 23/4, 23/3, 23/5, 7/5, 7/4, 6/4, 23/2pt, 22/4pt, 22/3pt, 7/3pt, 5/3pt, 6/2pt, 6/3pt, 6/1pt, 6/7pt of Ambalamedu Village, Kochi. Current land use is grass. The geo co-ordinates are 9°59'12.32"N & 76°21'46.76"E. There is no earlier record of historic land use or related to historic land use. Similarly, contamination of the are by the competent authority also not reported. The land belongs to Govt. of Kerala. There is no off-site subcomponents are expected for the project. Project site is not prone to earthquake as per IS 1983	The land is yet to be transferred from KINFRA to KSWMP.

		Rev. 2002 it fall in least active zone. Since the project site located on the western coast occasional cyclonic storms are expected are anticipated.	
4	Land Area proposed to be used: Location wise (in sq km / sq m)	1,01,123 m^2 (25 acre)	Land owned by KINFRA
5	Quantity of Water Required for Construction and Annual Operations with Details of Source/s	Construction requires 35 KLD Operation period requires 3 KLD	During the operation phase, the required amount of water is planned to be sourced from KWA. During construction phase, the estimated water requirement is 35 KLD which will be sourced from KWA by prior permission by the contractors.
6	Power Required and Source of Power	Power requirement at SLF would be 88.52 kW.	Sourced from KSEB

Baseline Environmental conditions

Sl. No	Environmental Aspects	Yes	No	Details (include distance in Km, info on its importance)
1	Is the project site located on or adjacent to any of the following (Provide Distance to these features in meters/kilometers)			
(i)	Critically Vulnerable Coastal Areas (CVCAs), Eco-sensitive Areas (ESAs)		✓	Site is not located in CRZ zone as evidenced from the PARIVESH (MoEF&CC) site.
(ii)	Cultural Heritage site, Protected monuments - listed by ASI/State		✓	Cultural Heritage site, Protected monuments are not falling within the site selected SLF.
				Kochi fort is located at about 14 km in West direction Mattancherry palace is located at about 12 km in West direction
(iii)	Natural Forests / Protected Areas / Bio- Reserves Is the subproject in an eco- sensitive or adjoining an eco-sensitive area, with any schedule 1 species? If Yes, which is the area?		✓	
(iv)	Other Wetlands/ Mangrove/ Estuarine Region		✓	
	Natural Habitat areas, roosting / nesting areas,		✓	

(v)	spawning areas, breeding areas; areas with natural features like waterfalls, sacred groves			
(vi)	Other Sensitive Environmental Components listed in EMF	✓		Low Sensitivity Levels can be controlled with mitigation measures
(vii)	Drinking water source, upstream and downstream uses of rivers, etc		✓	The drinking water for the proposed project is sourced from KWA.
(viii)	Low-lying areas/areas of Tidal Influence (provide CRZ details)		✓	Project area is not located in CRZ as per notification
(ix)	Sensitive Receptors – a) Habitations / Households / Hostels, other special areas, etc. b) School c) Religious Places d) Tourist Areas	✓		Nearest Kakkanad habitation and Rajagiri School of Engineering located at 1km (N) and 0.5 km (NNW) directions respectively.
2	Is the site in Critical / Over Exploited Ground Water Block. Provide the level of the groundwater table		✓	The category generally identified by CGWB report and State Ground Water Department as on march 2009, as per the guidelines of the Ground water estimation Methodology 1997. As per the report the Taluk falls under Safe category.
3	Is the site vulnerable to major natural or induced hazards such as Landslides, Flooding, Storm surge, Severe wind damage, Earthquakes, Fire, Explosion, Other (specify)			Natural Hazards like landslide, storm surge, earthquake are not experienced regarding earthquake it falls in moderate zone. The site avg. ground elevation 21.332 m with respect to MSL. High Flood level is expected at 22.95 MSL. The site is planned to raise at 24.95m.
4	Describe the type of soil and vegetation on site	✓		Laterite soil as per CGWB with wild shrubs and local species like neem
5	Is the site present in the flood plains as recorded in the last 100 years? Provide the HFL level of the site/region		✓	Flood map of 1 in 100-year return period is obtained from KSDMA, and superimposed on google map. It is observed that the distance from the 100- year flood plain to proposed site is about 2.5 km.
6	Existing pollution/contamination or degradation on site		✓	

7	Any other remark on baseline condition		✓	The site located in Industrial area mainly surrounded by oil and fertilizer industries

Anticipated Environmental Impacts: Impacts on Air, Noise, Land, Geology, and Soils

Sl. No	Impacts on Land / Soil Environment	Yes	No	Remarks
8	Total extend of land to be covered/built	✓		About 18 acres will be covered by SLF footprints
9	Total extend of land where the waste will be dumped openly / or expected to get contaminated by waste or leachate/material storage	✓		About 18 acres will be covered by SLF
10	Extend of Land to be remediated		✓	
11	Extend of land expected to be under green belt	✓		The greenbelt will be developed over an area of approximately 13,155 square meters.
12	Will the proposed project cause the following on Land / Soil:			
(i)	Impact on Surrounding Environmental Conditions including Occupation on Low lying lands/flood plains	✓		Site will be raised and this may impact natural flow. Hence Dykes & drainage designed to prevent any impact on the river or nearby TSDF facility
(ii)	Substantial removal of Top Soil (mention area in sqm)	✓		The area of active SLF involves about 18 acres Substantial removal of Top Soil is not expected as the land is slushy
(iii)	Any degradation of land / eco-systems expected due to the project?		✓	
(iv)	Loss or impacts on Cultural/heritage areas/properties		✓	
(v)	Does the project activity involve cutting and filling/ blasting etc?	✓		Yes site will be raised to ensure that it is 2m above ground water level. Total fill material required is 954657 cubic meter. Material will be sourced from nearest borrow areas with Environmental Clearance

(vi)	Will the project cause physical changes in the project area (e.g., changes to the topography) due to excavation, earthwork, or any other activity?	✓		The project site will undergo significant changes in profile. It will be filled to the height of 23m from GL with inert. About 18 acres of the land will be covered by MSW inerts. The area also will have associated infrastructure developments like LTP, Admin block, Sanitary facilities etc.
(vii)	Will the project involve any quarrying/ mining etc?		✓	
(viii)	Will the project / any of its component contaminate or pollute the Land?		✓	As Scientific method of inert disposal with leachate collection & treatment system is planned, contamination is not expected.
(ix)	Will the project contribute to any long term significant adverse (negative), large scale, irreversible, sensitive impact at a regional scale or area broader than the project sites?		✓	
(x)	Will the Project or related activities cause negative impacts on the land in combination with other anticipated / existing projects in the region?		✓	
Impacts on Air and Noise Environment				
13	Will the project cause or increase air pollution due to dust and / or vehicle emissions?	✓		Air pollution is expected due to vehicle that are engaged for transport of Inert and spreading and consolidating the inert at site. Plying of vehicles during filling may cause fugitive dust emission. All Suitable control measures will be provided.
14	Will the project cause or increase pollution due to GHG emissions?		✓	Methane emissions are expected from the inert
15	Will the project cause or increase odor nuisance?		✓	

16	Is there a potential for release of toxic gases or accident risks (eg: potential fire outbreaks)	✓		There is no Potential fire out breaks expected from the inert waste as Methane venting are provided at equal distance. Other toxic gases are not expected
17	Will the project generate or increase noise levels which will impact surrounding biodiversity or communities?		✓	From the disposal site, continuous noise generation is not expected. The operation of vehicle will be intermittent. The
				increased noise level generated due to movement and operation of vehicle at site will be contained within 500m and thereby effect on biodiversity or community is not expected
Impacts on Water Environment				
18	Will the activities proposed at the site(s) impact water quality (surface or ground) – leachate, runoff, wastes deposition, erosion?	✓		Leachate Collection systems are provided to protect the ground water, surface water drains are provided to control the runoff as well as the erosion from the disposal site.
19	Will the activities proposed at the site(s) impact water resource availability and use - leachate, runoff, wastes deposition, erosion?		✓	No impact in the water resources is expected as Scientific method of Leachate collection system is provided. Runoff will be controlled by storm water collection system.
20	Chances of Pollution of Water bodies/groundwater wells, nearby or downstream		✓	Suitable mitigation measures are proposed for surface run off
21	Will the activities proposed at the site(s) hinder natural drainage		✓	
22	Will the activities proposed at the site(s) decrease permeability/rainwater percolation	✓		About 18 acres of the total land is covered under disposal site which will be having impermeable layer. The impermeability 1 x 10^{-7} cm/sec. An impermeable layer will be provided to collect the leachate
Impacts on Biodiversity and Host Communities				
23	Will the project necessitates cutting of Trees / Loss of Vegetation		✓	Barren land with wild bushes

24	Will the project necessitate substantial removal of Top Soil (mention area in sqm)	✓		About 18 acres of top soil will be excavated and utilized for greenbelt development
25	Any degradation of land / eco-systems expected due to the project?		✓	
26	Will the project result in Health & Safety Risks in the neighborhood including the release of toxic gases, leachate, accident risks		✓	
27	Potential Noise, Light Pollution/movements causing disturbance to nearby habitats/communities		✓	Located in industrial area, Surrounded by industries. Educational & residential areas are away from the site. Works will be planned to avoid disturbances Transport of materials & wastes will be managed so as not to creae disturbances
28	Potential disruption to common property, accessibility, traffic disruptions, conflicts, or disruption to the local community within the subproject area?		✓	

Provide maps with the geographical location of the project; and an appropriately- scaled map clearly showing the project area and project sites with land use, existing buildings, infrastructure, vegetation, adjacent land use, utility lines, access roads, and any planned construction, and any other information to describe the project, locations and possible impact as required. The above details are appended in this report.

Project Categorisation and Need for Safeguards Instruments, Oversight

Project Category	Remarks
Key Reasons (for categorisation)	Required EC under EIA notification 2006 under 7 (i) (Common Municipal Solid Waste Management facilities) as B1 requiring EIA study. This does not require CRZ clearance as the site is located away from Coastal Regulation Zone as evidenced from PARIVESH portal information.
Safeguards Instruments Required	a) Project-specific EIA (impact assessment considering the project details & location) by Independent Consultant
Additional Responsibilities Expected (such as, i) Specialists to be hired for Physical/Cultural resources, Natural Habitats/others, etc for EIA preparation, and/or supervision), ii) Consultations, iii) any other aspect	

ANNEXURE IX: ENVIRONMENT MANAGEMENT PLAN

A. EMP for Sanitary Landfill for Disposal of Rejects and Inerts

This EMP is presented for three phases, Planning / Detailed Design & Pre-construction Phase, Construction Phase, and O&M Phase considering that the Proposed Bidding is for detailed design, construction, and O&M by Selected Bidder.

Table A: EMP for Sanitary Landfill for Disposal of Rejects and Inerts

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
A		**Planning/Detailed Design & Pre-Construction/Activity (to be followed for Design by the DBOT Contractor)**		
1	***Planning for Sanitary Landfill***			
1	Sustainability & Operational Efficiency, Environmental upkeep	▪ Best Practicable Environmental Option: The SLF contractor will be selected considering the environmentally most acceptable design & operation option. The evaluation shall consider OHS for Ground Improvement, recirculation and management of leachate, gas extraction and reuse, minimal impacts on drainage and erosion and sediment management, Pollution incident & Emergency response plan ▪ SLF and related infrastructure shall be part of the Solid Waste management plan (under preparation in each of the participating ULBs as part of KSWMP) and planned and implemented in a mutually supportive and integrated manner. ▪ Design & implementation Plan shall consider safety, operations and all conditions suggested in various clearances & permits by authorities ▪ Update EIA in case of significant design changes or else update EMP comprehensively in line with Proposed Design. Include various plans as in this EMP in detail along with EMP	Contractor	ULB, SPMU
2	Siting Considerations – Buffer & No development Zone	▪ 30m buffer zone from the SLF footprint area boundary is provided as per KSPCB order vide letter no. PCB/SO/SEE2/Model city/Kozhikode corporation/2019 dated 09.09.2021 and circular vide KSPCB/1249/2024-SEE-1 dated 25.01.2025 ▪ In addition, 100m buffer will be maintained as No development Zone as per SWM Rules, 2016. ▪ Take permits & approvals from KINFRA on the allotted land & buffer	SPMU	GoK

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
3	Updating of EMP based on design	▪ Update EMP based on finalized design & drawings after the DBOT contractor finalizes the design for SLF	Contractor	SPMU
4	Groundwater contamination- Plan for Leachate Monitoring Program	▪ Any leachate to be disposed will need to comply with the Disposal Standards for Treated Leachate as specified in the SWM Rules 2016, Annexure-II or any other acceptable to the regulators	Contractor	ULB, SPMU
5	Risk of fire, explosion, and contribution to greenhouse gases	▪ Design Landfill Gas Management System including vents ▪ Fire Safety Plan & Emergency Plan to be prepared (with (but not limited to) the below details) and followed - Fireline and Control procedures to be finalized in consultation with Local Fire & Rescue Services Banning smoking in all areas of the sanitary landfill - Handling material on fire as well as setting fire to materials nearby are strictly forbidden - Waste that has been unloaded in the filling area has to be examined visually for potential fire sources (glowing ash or glowing burning remains). If fire sources are located, these have to be neutralized with cover material immediately. - All mobile equipment or vehicles should be furnished with a fire extinguisher. - All employees to have multi-gas detectors / analyzers & appropriate PPEs - Prepare special SOPs for gas management & EHS for all activities including hazardous cleaning of covered drains, enclosed spaces including PPE procedure, gas detecting systems, analysers	Contractor	ULB, SPMU
6	Impacts of Substandard construction operation and closeout	▪ Prepare Construction and O&M Manual for Landfill with detailed allocation and responsibilities and procedures for Construction, O&M, EMP & EMoP implementation ▪ Prepare Waste Acceptance and Screening Procedure and signages ▪ (i) Prepare closure and post-closure plan following the CHPEEO Manual and internationally recognized good practices on closure and post-closure of landfills	Contractor	ULB, SPMU
7	Requirements for Preliminary site and water Assessments	▪ Preliminary site investigations shall be conducted as required by regulations and technical design ▪ Ensure structural stability on the soil (mostly marshy at site), considering lineaments, and fractures and any impacts on the surrounding like induced soil piping. Structural stability shall be checked at design & pre-construction / construction and operation & closure phases to ensure no burst or failure of the structure	Contractor	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		▪ A comprehensive hydrological investigation of both the site and the surrounding surface water and groundwater regime needs to be conducted. The investigation should identify the groundwater flow pathways for all aquifers on-site, assess the vulnerability of the groundwater underneath and adjacent to the facility, and establish whether systems to prevent groundwater pollution need to be set up. ▪ A water pollution remediation plan should be developed if pollution of groundwater, surface water, or the subsoil is confirmed in the preliminary water assessment of the site or is identified thus by external monitoring ▪ Site development plan shall be inclusive of **Erosion and Sediment Control Plan for Construction** & Operation Phases (also considering erosion from GoK Phase & of surcharge soil): to prevent marsh & river sedimentation during rains & subsequent water rising nearby. ▪		
8	Absence / Delay in Permissions for Developing the Landfill and associated works as per National regulations	▪ Required permissions for Land, setting up the Landfill and assessments conducted for Landfill development as per existing Laws, Regulations; including those applicable for associated infrastructure, DG Sets, Consent to Establish; and other licenses including those as per Labour Laws, before the start of works on site	Contractor	ULB, SPMU, PCB
9	Dust impacts due to Site Preparation (*Air Pollution) and Visual Blight* due to heavy construction	▪ Secure the site upon possession with gated compound wall and manned security ▪ Plan to Provide temporary high screen around the site before the start of work to curtail dust emissions from impacting surrounding including dust settling in the River	Contractor	ULB, SPMU
10	Material sourcing, transport, and stacking of construction materials before construction	▪ Prior intimation to neighboring landuses on proposed construction activities, timings, emergency contacts, grievance mechanism ▪ Prior intimation to nearby Primary Health Centre & arrangement with nearby hospitals on work activities need for medical support, emergency support needs, type of laborers on-site and labor camp if any ▪ Prepare Plan for Material sourcing & transport including (but not limited to):	Contractor	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
	(Occupational Health and Safety issues and Air noise pollution)	- Materials shall be sourced only from approved suppliers, quarries & borrow areas with permit/license from applicable authorities, and with Environmental Clearance as applicable - Testing of soil, and In case contaminated land or material (buried/in sacks, or drums etc) is encountered anywhere during the material sourcing or works, appropriate measures to be taken to stop sourcing and informing authorities on required corrective action. Borrow soil will be certified pest and contaminant free - Material shall be transported only in closed trucks with PUC certificates, with water sprinkling if required to curtail dust emissions. - The driver should have the required license and follow speed regulations - Considering multiple Transporters & source borrow areas, the Contractor has to develop a Logistics (Soil Transport) Management System for use by his Transporters/Subcontractors. (This will help plan no: and routes, and quantities moving to site from the sources time-wise, how much space is available in nearby roads & areas to park these (as site is swampy), no: of vehicles that can be accommodated on site phase wise, tipping area for the soil, cut-fill balances, storage of excess soil each day (depending on work plan), Plan for movement based on weather conditions & stoppage of sourcing & tipping during inclement weather etc.) - Contractor/Transporters shall arrange required facilities (water, sanitation) for transport workers so that they would not venture into the river, or the marsh. - The contractor and borrow owners shall implement Borrow Area management Plans during & after sourcing to prevent Community Health & safety issues & Environmental Protection. - Materials shall be transported preferably through well-surfaced roads. Developing & surfacing of approach roads shall be part of the subproject. If any road used for transport of materials is *kuchcha*, water sprinkling shall be done to prevent dust emission before and after truck passes - Material transport and unloading activities should not result in noise disturbance to neighbours and should preferably be carried out during day time unless permitted by authorities - Materials shall not be spread around on site. It shall be properly stored/stacked following good housekeeping practices (labeling, properly arranged); in covered sheds to prevent loss of strength and loss of material. Material storage shall not result in any harm to workers or visitors. Stockpile height & width shall be limited,		

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		and the need to adopt batter slopes and protective covers & drainage shall be in line with sediment and erosion control plan - Approved Herbicides (no banned chemical to be used) shall be used to prevent weed growth and visual inspection shall be made to avoid all root growth to ensure integrity of base & linings - Provide vehicle wheel wash area on-site (with wash water reuse) - Workers to be provided with Personnel Protection Equipment (PPE) including safety boots, jackets, ear muffs, gloves. - Proper rest area on site shall be provided with water, first aid, toilets		
11	Layout of Labour camp *(Impacts on Air, Water, Land, Fauna/Flora, Socio-economic)*	▪ Labour camp layout, design and material/fire safety plan shall be approved by supervision engineer approved by SPMU Environmental Expert in charge before start of construction of the camp. The camp layout shall ensure: - Nearby health center & Fire & Rescue Services shall be informed about the labor camp & guidance shall be incorporated in the design - Materials used for the camp shall be safe (from corrosion, fire/flood/other manmade and natural disasters) - Camp should not be provided on-site if the area is seen prone to Hazards - Camp should be adequately at higher plinth levels to prevent water intrusion during flooding or other construction stage issues - Rooms shall be of appropriate sizes with adequate ventilation and livable temperature/other conditions and facilities like proper beds, storage areas, common kitchen when the wood is not used as a fuel (better to use LPG) - Proper facilities shall be provided at the camp including food and common entertainment facilities, crèche, toilets with proper septic tanks, washing area, wastewater, fuel for cooking and waste collection/management systems, etc - The camp shall be planned to be maintained in good clean hygienic conditions and shall have outdoor seating areas, greenery, security	Contractor	Site engineer of ULB, SPMU with guidance/support of Labour Commissioner, PCB, Fire & Rescue
12	Loss of tree cover *(Impacts on flora, Fauna)*	▪ Clearing and grubbing to be done only on the required surface & just before the start of activity on that section. In the case of the time gap, water should be sprinkled regularly until the start of the next activity. ▪ Avoid tree felling as much as possible. Follow national regulation / applicable procedures for the replanting of trees if replanting is essential. Tree felling permission shall be obtained from the forest department / local body under applicable Acts. Take care of fauna, nests in case of large trees as per good practices and community ethos	DPR consultants Design Contractor	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		▪ Compensatory plantation shall be planned to be undertaken at prescribed rates (or preferably 10 times of the number of trees cut) ▪ Plan to use native species in consultation with the communities, Forest Department, Local Bodies ▪ Design mechanisms / barriers / bird divertors to prevent birds from getting attracted to EHT lines, Leachate Retention Pond, storage area of material/inerts, food sources near worker facilities & others etc. installing Bird Diverters, shall : a) meet quality and standards of CEA's 'Technical Specifications for Bird Flight Diverter, b) are installed following the method in Wildlife Institute of India's 'Powerline mitigation to conserve bustards' and CEA's 'Technical Specifications for Bird Flight Diverters', i.e., diverters on all cables with one unit at every 5 m interval of the powerline, c) are maintained through the life of the Project		
13	Nearness/disturbance to sensitive areas such as forests, wildlife habitations, etc especially in case of laying any support facilities *(Impacts on Flora, Fauna, communities)*	▪ Follow mitigation hierarchy – Avoid, Minimise, Mitigate, Reduce. Obtain requisite permissions from respective authorities such as Department of Environment and Forests, Pollution Control Board, other regulators	PIU	ULB, SPMU
14	Contamination of groundwater due to leaching *(Impacts on water and land)*	▪ Ensure appropriate design provisions (based on hydrogeological aspects as well) are made for liners, line drains, leachate collection and treatment facilities to prevent percolation of leachate ▪ Additional Leachate storage and recirculation facility considering wet inerts.& rejects during rains	Contractor	ULB, SPMU
15	Nuisance hazards to neighboring areas	▪ Ensure proper design and adequate compound wall; high screen during construction, buffer zones and thick green belt to comply with SWM Rules, 2016, Clearance Conditions and other PCB requirements	Contractor	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
	(Dust emissions, Visual blight, other disturbances)			
16	Reduced land values in nearby areas and impacts aesthetics affected *(Socio-economic impacts, visual blight)*	▪ Adequate buffer zones shall be planned and beautification scheme shall be prepared & implemented ▪ Discuss with town Planning Department and Local Body for demarcating a no-development zone around the facility	ULB along with the town planning	GoK, SPMU
17	Flooding of the landfill site during excessive rainfall *(Land, water environment, Health)*	▪ Design of the facility shall ensure that it is constructed above the HFL levels and as suggested by SWM Rules 2016 ▪ Design shall include flood protection measures. Plan not to leave any depths/excavations open during construction. All trenches must be closed or provided with proper drainage so that floodwater does not fill in ▪ Plan to provide cut off drain around the facility and proper stormwater management (including reuse, recharge) for the area nearby to prevent flooding of nearby properties ▪ Flood water should not mix with any site drainage or leachate ▪ Prepare emergency response plan	Contractor	ULB, SPMU
18	***Storm Water Drainage:*** Inappropriate site drainage & its impacts on the River (sedimentation & Pollution)	▪ Site Drainage Plan shall be prepared in discussion with river users, KINFRA, PWD/Water Resources and other applicable authorities, while updating EMP with: - Considerations to channel and effectively discharge storm water into the river, without impacts on river - Micro watershed Development & Implementation Plan (as suggested in FR) also considering the impacts on / due to EHT lines shifted near the area - Adopting appropriate stormwater discharge into the River to prevent disturbance to soil deposited to raise the ground above HFL & the sediment deposition in river (washout from soil deposited to raise the ground, and soil and other material stored for construction & O&M – daily cover), slope from raised ground to ultimate disposal point, mechanisms to install pipelines from different phases of the landfill to the marshy area upto the River & final disposal into the River - Permits for disposal and laying the lines for ultimate disposal (from KINFRA, A	Contractor, KINFRA	ULBs, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		- Cut off drains for storm water, Silt traps/Sedimentation basins, with agreed SOP for periodic clearing and O&M - Drain to carry water from site through buffer to the river - Develop EMoP including periodic testing of drainage for any contaminants		
19	***EHT lines passing through the Proposed Site:*** Health & Safety issues of EHT line shifting & its proposed layout neighboring the landfill	▪ Develop comprehensive Management Plan for EHT line shifting including Procedures for Health & Safety Management - Detail out the Shifting procedure including timeline - Comparison of the EHS clauses in the applicable Electricity Regulations, National Regulations, & World Bank EHS & prepare SOP adopting the best practices (discussions on going with KSEB, GoK on the processes) - Permits for shifting from & to new location from landowner (KINFRA), KSEB etc. Permit from other agencies if any – such as GAIL, FACT othersurrounding activities - Identify & plan housekeeping & safety of material storage & construction - Prepare SOP for ensuring safety of EHT & SLF during shifting of EHT, - Prepare EHS clauses / EMP for SLF construction, material transport (including soil for raising, other material), SLF Operation also considering rains, seepage, flooding, Gas, Fire, incidents/breakage, safe works (on Leachate Pond, berms, soil filling etc) under existing lines under GoK phase that might not be shifted currently	Supervision Consultant, Contractor for Shifting EHT, Contractor for SLF	KSEB, GAIL, KINFRA, SPMU, Others
20	***Leachate Management***	▪ Prepare Leachate Management Plan including Leachate collection & recirculation system, LTP, retention Ponds and all other associated infrastructure, Disposal mechanism for treated leachate while updating EMP including: - Permits for construction & O&M of Pond, including from KSEB (as a pond may be under EHT) - Area, System inputs & Outputs (incl. evaporation loss), Leachate Generation Modelling & Water Balance Assessment designed to account for monthly inputs and outputs to demonstrate that the system will be able to operate in a satisfactory manner throughout the year. Cumulative leachate storage over multiple years of operation under average and wet conditions (at least two consecutive years) should also be factored in should also be factored in.; and Operational Management and Monitoring Strategy), Design & Treatment Mechanism of LTP & Ponds, Disposal of treated leachate, Sludge management after drying, Guidelines & standards incl. on quality; Pollution & quantity dispersal capacity of receiving water body during emergency disposal		

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		- Leachate Ponds: pond dimensions and volumetric capacity, pond liner system: configuration of pond liner, statement of intended performance (overall permeability and containment features), associated leachate conveyance infrastructure and equipment and connection points at the leachate pond(s), liner construction and/or installation & construction quality assurance (CQA) measures to be employed; leachate pond management, including details on operational freeboard, mechanical aeration equipment (if required), and pond level alarms, proposed leachate quality monitoring program, contingency plans for leachate management in the event of breakdown / emergencies (such as High level sensors, Float switches) - Quantity of earth to be scooped & redeposition management plan for additional leachate pond construction - Odour Management mechanism - Pumping system all use energy efficient pumps and appurtenances - Health & safety impacts of LTP & Retention Ponds including pollution due to overflow & non-retention, scooping of sludge, management of sediments and foreign bodies, prevention of slip, trip falls, impacts due to gas built up, side protection measures & housekeeping, specific impacts of repair/maintenance & alternate mechanisms, quality assessment and online monitoring - Reuse & Disposal mechanism and standards and its online monitoring in case of normal & emergency situations. Plans & permits for collection and transport of - Sludge generated after centrifuge & screw type conveyor to the nearest TSDF's as per hazardous waste management Rules, if tested hazardous. - Plan for fully mechanized LTP operations with no manual intervention		
21	***Development of Monitoring Program***	▪ A comprehensive monitoring program should be developed to support the ongoing operation of a landfill facility. Aspects that should be included in the program (as a minimum) include structural safety, leachate, landfill gas, surface water and groundwater; Odour monitoring should also be considered, Fly & Pests monitoring, closure safety ▪ A Pest management Plan & monitoring program shall be prepared and approved for Operations & post closure stages. Banned chemicals, insecticides & pesticides shall not be used.		

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
	Disaster, Climate Risk & Emergency Response	▪ Prepare detailed Disaster Management Plan, Climate Risk Management & Emergency Response Plan including responsibilities and time plan for implementation & reporting. Plan shall cover all on site & nearby infra including mitigating / responding to impacts of GAIL pipeline and EHT lines during all phases. Design shall subsume safety and climate resilience by planning facilities away from hazardous neighboring uses, and incorporating mitigation and response in plan and design. ▪ During the process of maintenance, the operation unit shall conduct regular inspection for timely detection and treatment.	Contractor	ULBs-PIUs/SPMU, PCB
22	Post closure monitoring & Maintenance	▪ Operator shall prepare detailed written Closure Plan (that describes the steps necessary to close SLF units at any point during their active life in accordance with the cover design requirements). This shall at the minimum include notification to initiate closure, marking the area to receive final cover, developing closure schedule, Contract documents including Environmental expertise, EHS, monitoring SLF and surrounding environment during & post closure, hiring of independent engineer to observe closure & submit certificate, securing borrow material (detailed as is plan), constructing cover system, and other details ▪ Post closure Management and Monitoring Plan (as per regulations) including inert containment, Final cover system, Leachate collection system, Groundwater monitoring system, Gas monitoring system, cleaning leachate collection and retention systems, planting and fertilization schedule, planned future use & SOPs, time & schedule of repairs & maintenance, routine inspection schedule, (including use of tools like site walk over, aerial photography) to prevent polluting the surrounding environment & health and safety impacts ▪ Prepare Emergency Response Plan for Post closure stage ▪ Ensure that detailed EMP is prepared for Final cover design to ensure Minimize infiltration of precipitation into the waste; Promote good surface drainage; Resist erosion; Control landfill gas migration and/or enhance recovery; separate waste from vectors (e.g., animals and insects); Improve aesthetics; minimize long-term maintenance; Protect human health and the environment; and considering final use.	Contractor	ULBs-PIUs/SPMU, PCB
B	**Construction / Implementation stage**			
	Site Development			

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
1	Vegetation clearance for site development *(Impacts on flora, fauna)*	▪ Clearing and grubbing should be avoided beyond that which is directly required for development activities. ▪ The next activity to be planned/started immediately, to avoid dust generation and soil erosion during monsoon. ▪ Turfing/ re-vegetation to be started soon after completion of embankment	Contractor	ULB, SPMU
2	Soil Erosion from site leveling due to the loose earth being left out from construction before the onset of monsoon *(impact on-air environment and noise environment)*	▪ Plan the activities so that no bare/loose earth surface is left out before the onset of monsoon. For minimizing soil erosion, the following preventive measures in Erosion Control Plan (to be prepared by the Contractor) are to be taken: o Next layer/activity to be planned, soon after completion of, clearing and grubbing, laying of sub-base layer, scarification, etc. o Topsoil from borrow area, debris disposal sites, construction site to be protected /covered for soil erosion. o Debris due to excavation for foundations, dismantling of existing cross drainage structure shall be removed from the watercourse immediately. When stockpiled, debris should be covered and with a garland drain.	Contractor	ULB, SPMU
3	Soil erosion at the Borrow areas	▪ Soil shall be sourced from borrow areas in permissible areas/sites (not in sensitive areas); which shall get Environmental Clearance and applicable permits/clearances. ▪ The Borrows shall be audited to check conformity with EC and Mines and Minerals (Development and Regulation) Amendment Act, 2015 & Minor Mineral and concession Rules, 2015 as applicable; including Chance Find Procedures. Arrangements shall be made with landowners on redevelopment of the borrows ▪ Borrow area management plan shall be prepared & followed, in line with SOP published by MoEFCC, WB EHS and other good industry practices. This shall focus on its effective use, revegetation and rehabilitation including preventing stagnant water pools (and mosquito menace) due to borrowing/quarrying, disturbances to nearby areas due to borrowing, discussion with stakeholders around, stripping & storage of topsoil (15cm depth) & its restoration, drainage alteration, noise, loss of biomass, dust and runoff prevention, stability of the area/region around, etc.	Contractor	ULB, SPMU
3	Alteration of drainage during site development	▪ Diversions should be constructed during the dry season, with adequate drainage facility, and will be completely removed before the onset of monsoon ▪ Debris generated due to the excavation of foundation or due to the dismantling of the existing structure should be removed from the watercourse	Contractor	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
	(impact on the water environment)	▪ Appropriate silt fencing to be provided on the mouth of discharge into natural streams ▪ Continuous drain (lined/unlined) to be provided. Obstruction if any, to be removed immediately.		
4	Runoff and drainage *(Water environment)*	▪ Minimal site works during monsoon & if there are works adequate precautions shall be taken to prevent any type of erosion or flooding ▪ Throughout monsoon uninterrupted continuous drain to be functional. ▪ Lined drain to be provided at build-up locations for quick drainage. ▪ Increased runoff due to increased impervious surface is countered through the increased pervious surface area through rainwater recharge. A series of rainwater recharge facilities are provided along with storm water drain network. ▪ All pipelines for disposal of drainage shall discourage return flow and shall have sediment traps/basins. Periodic cleaning and disposal of waste mater and sediments need to be ensured through a fool-proof mechanism & SOPs ▪ Required permits / clearances shall be availed for all pipelines / appurtenances, and activities outside project land including final disposal pipe & point ▪ Contractor will rehabilitate the borrow areas as soon as borrowing of soil is over from a particular borrow area in accordance with the approved borrow area Redevelopment Plan.	Contractor	ULB, SPMU
5	Impacts due to material transport, vehicle movement, storage and use from Borrow areas and other sources	▪ The unpaved surfaces used for the haulage of borrow materials, if passing through the settlement areas or habitations; will be maintained dust free by the Contractor. Sprinkling of water will be carried out twice a day to control dust along such roads during their period of use. ▪ During dry seasons (winter and summer) frequency of water sprinkling will be increased in the settlement areas and Engineer in charge along with environmental expert of DPMU will guide the sprinkling time depending on the local requirements. ▪ Contractor will maintain all roads, which are used for transporting construction materials, equipment and machineries. ▪ All vehicles delivering fine materials like aggregate, cement, earth, sand, etc, to the site will be covered by Tarpaulin or similar to avoid spillage of materials and windblown dust from the top of vehicles. ▪ Existing road used by vehicles of the contractor or any of his subcontractor or suppliers of materials will be kept clear of all dust/mud or other extraneous materials dropped by such vehicles. ▪ The contractor will make effort to transport materials to the site in nonpeak hours	Contractor	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		▪ Material transport plan & app based monitoring shall be prepared to monitor no:of trucks arriving the landfill site during the filling / raising activity, location of areas where this shall be offloaded / or vehicles to be parked till such time tipping is done, mechanism of transfer of materials from vehicles to the site, schedule for raising in conformity to material logistics, ample space for appropriate storage to prevent impacts due to dust, floods, slippage of piles, mechanism for screening foreign bodies/inappropriate material from borrowed earth and proper disposal of such material, and other required details. ▪ The activities shall be well synchronized & ensure no borrowing or filling / raising during inclement weather. ▪ Stable ground and access shall be ensured for construction of dykes and filling the earth. ▪ Alternate entry to site to be ensured to prevent heavy vehicle movement above GAIL pipeline without protection against such movement and its impacts ▪ Inspection to be arranged with GAIL at appropriate intervals		
6	Material Sourcing	▪ Environmental Assessment in line with ESMF for all associated facilities including Borrow areas once known; but before initiating any activity there ▪ Borrow areas / Quarries shall get required permits & clearances ▪ Landfill Site, borrow sites and all related activity areas shall have requisite runoff, dust, noise, material management and storage, safety precautions, and other measures ▪ Borrow Area management Plan to be implemented to prevent impacts on surround areas including sedimentation & water stagnation, slippage and other impacts, Community Health & Safety, with Consultations	Contractor, Borrow Area Owners	ULB, SPMU
7	Ground Improvement as part of land development	▪ The ground needs to be improved by suitable method such as Prefabricated Vertical drains (PVD) & Preloading/ Stone Columns/any other accepted method in accordance with Indian Standards /MORTH Specifications for Road and Bridge Works /FHWA Guidelines. ▪ The design scheme shall be submitted by successful Bidder and vetted by Institute of Repute (IIT/NIT/Engineering College) & environmental management plan shall be updated considering the final approved methodology. The Work Plan, EMP and EMoP shall be submitted for Engineers Approval prior to beginning work	Contractor	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		▪ The method of installation shall be based on site specific Geotechnical report and as per applicable codes / Industry recognized standards or design methods specific to the installer's equipment and construction methods shall be used. In order to ensure this, it is required to conduct geotechnical verification tests as per IS-15284 (Part-1/2) /MORTH /IRC as applicable. For other methods acceptable codes such as FHWA / International Codes shall be adopted. This work shall include all testing and observations by qualified personnel employed by the agency or an independent Geotechnical testing laboratory. ▪ Before start of works site shall be ensured safe for the works by supervision consultant ▪ Movement routes shall be planned & safe access measured ▪ Construct working pad, as necessary, to access job site and work area. ▪ Furnish all equipment, power, water, air, and other necessary items required for installation of scheme including granular blanket. ▪ Once the ground is prepared, Remove surplus materials, equipment and any waste products from the site and restore site grade to the satisfaction of the Engineer.]		
Construction of Landfill (including cells, LFG extraction, leachate collection, and treatment system)				
1	Impacts due to the loss of topsoil *(Land environment)*	All areas of cutting and all areas to be permanently covered will be stripped to a depth of 150mm and stored in the stockpile. Topsoil shall be safeguarded from erosion and will be reused as follows. a) Covering all borrow areas after the excavation is over a) Development of greenery	Contractor	PMU
2	Impacts due to the vehicular movement *(Air and noise environment)*	▪ Vehicles and machinery are to be maintained so that emission conforms to National Ambient air quality standards. ▪ All vehicles and machinery should obtain Pollution Under Control Certificates ▪ HORN PROHIBITION signpost to be erected. ▪ Rumble strips/speed breaker to be provided.	Contractor	ULB, SPMU
3	Impact due to the use of construction equipment	▪ Mixing equipment should be well sealed and be equipped with a dust-removal device. ▪ Operators should wear dust masks, ear protection, and hard hats.	Contractor	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
	(air and noise environment)	▪ Vehicles delivering materials should be covered to reduce spills and dust blowing off the load. ▪ Labor to be provided masks / PPEs. ▪ Construction site prone to dust generation shall have fencing to arrest dust spreading into neighboring sensitive land uses ▪ Noise standards at construction machines are to be strictly monitored to prevent exceeding of GOI noise standards. ▪ Workers in the vicinity of strong noise to wear protectors and their working time should be limited as a safety measure. ▪ In construction sites within 150 m of sensitive receptors and settlement areas construction to be stopped from 22:00 to 06:00. ▪ Machinery and vehicles should be maintained to keep their noise to a minimum. ▪ Noise barrier shall be constructed at all noise-sensitive locations.		
4	Soil contamination and groundwater contamination from Leachate (Land and Water Environments, Health impacts)	▪ Install a drainage layer underneath the processing area to provide adequate leachate drainage. This may consist of a bed of coarse material such as wood chips, or the processing platform such as a concrete pad ▪ Permanently incorporate a drainage layer designed to withstand the loading, working, and removal of material. ▪ The storage areas of the facility should have a leachate barrier system that forms a secure barrier between the groundwater, soil, and substrata ▪ Design and maintain the slope and orientation of leachate drains such that free drainage of leachate to a collection drain is facilitated and ponding of leachate is avoided; maximize runoff and hence reduce infiltration	Contractor	ULB, SPMU
5	Impacts on River during construction activities *(Water environment)*	▪ Construction work close to water bodies should be avoided during monsoon ▪ Labour camps are to be located away from water bodies. ▪ Vehicle washing/workshops near water bodies are to be avoided. ▪ Contaminated water from construction activities carrying soil, cement wash, etc shall not be allowed to flow out of the site. It shall be contained and treated on site. ▪ Raised platform shall be able to withstand the loads due to wastes, movement of men and material & vehicle on the same. Dead and live loads shall be considered & validated in design through third party supervision contractors. This is important to prevent further settlement / shear and related impacts on the river ▪ Drainage systems shall be well checked very frequently for any blockages (once every week or less as required) ▪	Contractor	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
6	Occupational health and safety impacts of the workers and communities during the construction of landfill and support facilities: • Ground improvement • Health impacts of exposure to a variety of harmful materials of waste-related pollutants. • Accidental spillage by moving vehicles. • Cut & Bruises during handling of materials/rejects • Allergies from pathogen and airborne dust *(Air environment, Health impacts)*	▪ For Ground improvement, A detailed Safety program shall be submitted so as to ensure that job-site personnel work safely and existing utilities / properties (including those adjacent) if any are safe. The safety program shall address the methods for protecting on-site personnel, and all structures. The safety program shall be provided to the Engineer before the start of the work. As work involves heavy construction, GI contractor shall deploy on site a qualified Safety Engineer. Civil Site in-charge shall not be designated as Safety Engineer and shall be responsible for Civil works and its quality control alone. ▪ All centers of labor contact points shall be provided with First Aid and other related activities. ▪ Emergency Preparedness plans shall be prepared and implemented for all manpower working centers and its field extension centers. ▪ An Environment Health & Safety policy shall be prepared and implemented throughout in all project & associated activity areas ▪ Adequate manpower shall be arranged, and manager shall listen and act upon the manpower related grievances through Worker Grievance Management, including on EHS issues such as availability of safe working condition ▪ Detailed PPE procedure will be developed, and Workers will be provided with PPE such as face mask, gloves, shoes, nose masks & goggles ▪ Provide non-slippery work areas ▪ Proper training will be provided regarding the maintenance of Health ▪ Workers shall be provided with rest areas, toilet facilities (with septic tanks), food, and water in a hygienic environment (with proper handwash). Provide clean eating areas where workers are not exposed to hazardous or noxious substances; ▪ First aid facilities will be available at accessible places. More than one first aid station if the site is large ▪ Tie-up with the local hospital / Primary Health Centre (or responsible JHI) will be arranged to provide an ambulance to handle emergency cases if required and for regular health checkups. Arrange daily health checkup for workers working on waste heaps ▪ Routine inspections, housekeeping, and maintenance will be carried out at regular intervals ▪ Measures such as deferred timings and stretch break to be adopted ▪ Secure all installations from unauthorized intrusion and accident risks; ▪ Provide H&S orientation training to all new workers to ensure that they are apprised	Facility operator	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		of the basic site rules of work at the site, personal protective protection, and preventing injuring to fellow workers; ▪ Provide visitor orientation if visitors to the site can gain access to areas where hazardous conditions or substances may be present. Ensure also that visitor/s do not enter hazard areas unescorted ▪ Ensure the visibility of workers through their use of high visibility vests when working in or walking through heavy equipment operating areas; ▪ Ensure moving equipment is outfitted with audible back -up alarms; ▪ Mark and provide signboards for hazardous areas such as energized electrical devices and lines, service rooms housing high voltage equipment, and areas for storage and disposal. Signage shall follow international standards and be well known to, and easily understood by workers, visitors, and the general public as appropriate; ▪ Disallow worker exposure to noise level greater than 85 dBA for more than 8 hours a day without hearing protection ▪ All workers shall be registered as per prevalent labor laws (including a workforce of subcontractors) and provided insurance cover ▪ Workers and their kith and kin shall be suitably informed about the registration, other details of workers, and insurance details and provide contact details of contractors person/insurance agent ▪ While using heavy machinery like JCB, cranes, landfill compactors, etc, inform workers on possible dangers and prevent going near operating / movement areas. Flagmen should be arranged on-site with a whistle. ▪ While using heavy machinery like JCB, cranes, landfill compactors, etc, inform communities to prevent children and others from going near operating / movement areas. ▪ Flagmen shall be arranged if work is near schools, hospitals, major roads, and traffic control is required with the support of police. ▪ A work permit system will be implemented for all works related to working at heights (typically when working over 2m and above), excavations, special works, dangerous works including electrical and hot jobs; ▪ All works related to working at heights will be undertaken only during the daytime when sufficient sunlight is available; and with proper Harness ▪ Use of temporary fall protection measures in scaffolds and out edges of elevated work surfaces, such as handrails and toe boards to prevent materials from being		

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		dislodged will be done; ▪ All excavation activities will be conducted in supervision of the site contractor; ▪ Proper signage and lights will be provided in places of excavated areas. ▪ No types/variations of Manual Scavenging shall be allowed in the proposed Project during any stage. ▪ Work in excavations & cells shall be clearly monitored & provided with direct supervision while work happens. No worker shall be left to carry out the duties all by himself without support. ▪ Work permit system shall be in place & monitored closely by supervising consultant ▪ Multi-gas analyzers, Gas detectors, alarms, shall be used in all parts during construction, including near GAIL pipeline, EHT lines & landfill parts where Gas may be encountered etc. ▪ Barricade the proposed SLF land under EHT lines-RoW, so that works do not happen before shifting and appropriate permits & Procedures are in place. Exercise appropriate physical and warning controls on the piece of land below other EHT lines that would not be shifted presently ▪ Works – such as spread of soil to raise the ground, and construction of Retention Pond under the existing EHT line shall be well detailed out & permission for works shall be sought from KSEB & other agencies; so that there is no adverse effect on the lines, workers or any others ▪ During construction appropriate seepage preventing mechanism shall be constructed on both sides of shifted EHT ▪ The transmission line shall be designed to withstand long standing water periods from flooding & other disasters and to allow maintenance in case of emergencies.		
C	**Operation & Maintenance Phase**			
1	Waste leakage from Loading waste rejects and inerts *(Air, water, land, Fauna/Flora, Health impacts)*	▪ Ensure proper record keeping of waste collected and transported ▪ Weighbridge level record keeping and monitoring at the tipping point ▪ Padded reject collection area or unloading platform with lined drains to collect leachate if any	Landfill operator	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
2	Pest and Vector Menace	▪ Implement the Rodent, Other pests and Fly Control Plan ▪ Banned (WHO, Government of India, Government of Kerala) Pesticides or Insecticides shall **not be** purchased or used	Landfill operator	ULB, SPMU
3	Impacts due to vehicle movement *(Air, Water environment, Health)*	▪ The movement route shall be scheduled for each vehicle. ▪ Enforce speed limits applicable and make drivers aware of this ▪ Vehicles movement shall be tracked by Health Supervisors to ensure keeping up to schedule; preferably using GPS (GIS linked) ▪ Clean fuel shall be used in vehicles. Any adulterated fuel shall be avoided. There shall be periodic emission tests for vehicles ▪ Provision of Personal Protective Equipment such as face mask, gloves, nose masks & goggles to all workers in C&T vehicles, Maintenance yards ▪ Proper lubrication shall be provided to minimize squeaking noise due to friction ▪ Honking shall be minimized to eliminate any possible discomfort to the nearby people. ▪ The most optimum route is planned with minimum no. of vehicles with the help of GIS mapping and apps for the general public ▪ Traffic will be managed at the site by providing adequate space for parking of vehicles ▪ Timely processing & disposal of rejects/inerts shall be carried out by vehicles and should transfer inert only in the specified area. No material shall be disposed of in any place other than the designated area; including water bodies, coasts/forests or sensitive areas.	Landfill operator	ULB, SPMU
4	Transportation of rejects/inerts in overloaded and open vehicles *(Air, Odour nuisances; spills and littering impacts on Air, Water, Land)*	▪ All vehicles shall carry only approved load of weight as per SOP ▪ Regular cleaning of roads & drains and removal of any spillovers. ▪ All Transport vehicles shall be covered. ▪ Ensure provisions of SWM Rules 2016 for all collection and Transportation activities ▪ RCV/ITL locations have been identified ▪ Inert will be collected from various areas by small vehicle which will be transferred to respective RCV locations	Landfill Operator, PCB	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
5	Plying of vehicles through kutcha / unsurfaced roads and idling (air pollution: SPM, CO, CO2)	Vehicle movement shall be well planned – through topped roads. In case of necessity to move through Kutcha roads, ensure sprinkling of water to suppress dust before and after the movement of the vehicle	Landfill Operator, PCB	ULB, SPMU
6	Nuisance due to odor and influx of insects, rodents, flying birds	▪ Provide adequate buffer zone around the landfill site/treatment site and other facilities with thick vegetative cover. ▪ No waste shall be allowed to be landfilled. ▪ Rejects/inerts shall be deposited at the designated place and waste shall not be allowed to accumulate near the reception pad or area. ▪ Odor management measures including odor filters, aromatic buffers/ other buffers for preventing fly menace, PPEs for workers ▪ Regular cleaning and approved pest control measures to be adopted: Biopesticides / biological control shall be adopted. Banned pesticides/insecticides shall not be used. ▪ Workers shall be made aware of storage and use of pest control measures and PPEs to be used ▪ The nearest Rajagiri school, Metro water station and KEIL landfill may have some impact due to odour emination from the site. However the above mitigation measures would minimize the impact to the greater extent.	Landfill operator	ULB, SPMU
7	Bird menace at the waste disposal facility.	▪ Avoid open dumping of waste or rejects / inerts including in and around the site premises. Provision for safe storage of rejects and inerts (for at least one week) on sites in case of emergencies to be arranged. ▪ In case of breakdown or maintenance, intake shall be stopped and be diverted to the emergency containment area	Landfill operator	ULB, SPMU
8	Air emission of toxic gases from the landfill site *(Air environment, the health of communities and workers)*	▪ Placing of gas vents and construction of the gas compression station or similar arrangements with adequate capacity to receive the maximum flow of gas. Use of multi gas analysers and other mechanisms to identify gas built up before undertaking any activity ▪ Performing trials to collect the gas early during the landfill operation and before the cell is filled. This can significantly reduce odor impact. ▪ Keeping the integrity of the system by lining system and final cover of the landfill properly by ensuring adequate placing, adhering to waste filling plan, avoid overloading landfill cells, and regular evacuation of leachate and gas.	Landfill operator	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		▪ The strict maintenance schedule for the degassing system should be prepared and followed by the project operator		
9	Dust emissions during the operation- PM_{10} *(Air environment, Health)*	▪ During operations, sprinkle water regularly wherever there is a possibility of generation of dust. ▪ Vehicles within the landfill to be restricted to a speed limit of say 20km/hr or as per Design considering disturbance to cells, and safety ▪ Dust control within the Landfill Footprint (Active Areas) – temporary access roads within the landfill footprint will be watered, as required, to prevent dust problems; ▪ Dust control outside landfill footprint – permanent concrete or asphalt and gravel or rock-surfaced roads outside the landfill footprint will be watered periodically to mitigate dust. Soil surfaced roads will require more frequent watering; and ▪ Using Leachate for Dust Control – treated leachate and harvested rainwater may be used for dust control depending on its quality. However, treated leachate will only be reused used within the landfill footprint	Landfill operator	ULB, SPMU
10	Exhaust emissions *(Air environment)*	▪ No idling of vehicles on site. Regular maintenance of heavy equipment used at the site and inert hauling vehicles to ensure their exhaust emissions meet the emissions standards prescribed	Landfill operator	ULB, SPMU
11	Odor generation during operations *(Air, a nuisance to communities and workers)*	▪ Daily soil covers to compacted material or rejects to manage odors. Rejects with a strong odor to be covered immediately they are emptied from delivery vehicles ▪ Control and manage leachate treatment plants to minimize odor. ▪ Adhere to air quality regulations with quarterly air quality monitoring Maintenance of the buffer zone, green belt, and protective berms	Landfill operator	ULB, SPMU
12	Noise generation during operations *(Impacts on Noise environment, Nuisance to workers, communities)*	▪ Strictly adhering to designated working hours (day time); Sensitizing construction truck drivers and equipment operators to switch off idle engines; ▪ Using modern, well-maintained and regularly serviced vehicles; ▪ Ensuring that all generators and heavy-duty equipment be insulated or placed in enclosures to minimize ambient noise levels. ▪ Provision of earmuffs and ear protection to workers and employees in high noise areas	Landfill operator	ULB, SPMU
13	Leachate and Runoff from activities	- The storage areas of the facility should have a leachate barrier system that forms a secure barrier between the groundwater, soil, and substrata	Landfill operator	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
	(Soil contamination and groundwater contamination)	- Design and maintain adequate slope and orientation such that free drainage of leachate to a collection drain is facilitated and ponding of leachate is avoided; reduce infiltration – all surfaces prone to leachate accumulation shall be lined or suitably protected against percolation - Store leachate with contingency storage provision in aboveground storage tanks; suitably sloped & protected against flooding or leaks; provide addition emergency containment or storage - The filling and capping of the Site's landfill cells shall be undertaken in a phased approach, which will ensure leachate generation is minimised. - Technology shall ensure arrangements such as: - drainage layer underneath the processing area to provide adequate leachate drainage. This may consist of a bed of coarse material such as wood chips, or the processing platform such as a concrete pad. Permanently incorporate a drainage layer designed to withstand the loading, working, and removal of material. - The evaporation pond must be able to manage the maximum leachate volumes potentially generated and extracted from the landfill as well as any rainfall into the ponds during consecutive wet years. A 0.5m freeboard or similar must also be maintained as per the Best Practice Landfill Guidelines. During particularly wet weather periods, leachate can be recirculated back through the waste of the operational landfill. The pond crest shall be engineered to be a minimum of 0.5m or as appropriate above the natural topographic ground levels to prevent surface water runoff from the Site entering the ponds. - High-Level sensors / float switches will be installed within each leachate evaporation pond to switch off the extraction pumps when the pond reaches operational freeboard. The signal from the float switch will override the signal from the submersible pumps to prevent accidental overfilling or overflowing of the pond. ▪ The leachate collection system shall be regularly inspected, maintained, and repaired when necessary. Leachate monitoring shall be undertaken on a regular basis to ensure the leachate collection and extraction system is operating effectively, to determine the head and quality of leachate, and to ensure compliance with assessment criteria and compliance limits		

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
14	Occupational health and safety impacts of the workers during operations: • Health impacts of exposure to a variety of harmful materials of waste-related pollutants. • Accidental spillage by moving vehicles. • Cut & Bruises during handling of materials/rejects • Allergies from pathogen and airborne dust *(Air environment, Health impacts)*	▪ All centers of labor contact points shall be provided with First Aid and other related activities. ▪ Emergency Preparedness plans shall be prepared and implemented for all manpower working centers and its field extension centers. ▪ An Environment Health & Safety policy shall be prepared and implemented throughout the activities area. ▪ Adequate manpower manager staff shall listen and act upon the manpower related grievances. ▪ Workers will be provided with PPE such as face mask, gloves, shoes, nose masks & goggles ▪ Provide non-slippery work areas ▪ Proper training will be provided regarding the maintenance of Health ▪ Workers shall be provided with rest areas, toilet facilities (with septic tanks), food, and water in a hygienic environment (with proper handwash). Provide clean eating areas where workers are not exposed to hazardous or noxious substances; ▪ First aid facilities will be available at accessible places. More than one first aid station if the site is large ▪ Tie-up with the local hospital / Primary Health Centre (or responsible JHI) will be arranged to provide an ambulance to handle emergency cases if required and for regular health checkups. Arrange daily health checkup for workers working on waste heaps ▪ Routine inspections, housekeeping, and maintenance will be carried out at regular intervals ▪ Measures such as deferred timings and stretch break to be adopted ▪ Secure all installations from unauthorized intrusion and accident risks; ▪ Provide H&S orientation training to all new workers to ensure that they are apprised of the basic site rules of work at the site, personal protective protection, and preventing injuring to fellow workers; ▪ Provide visitor orientation if visitors to the site can gain access to areas where hazardous conditions or substances may be present. Ensure also that visitor/s do not enter hazard areas unescorted ▪ Ensure the visibility of workers through their use of high visibility vests when working in or walking through heavy equipment operating areas; ▪ Ensure moving equipment is outfitted with audible back -up alarms; ▪ Mark and provide signboards for hazardous areas such as energized electrical	Facility operator	ULB, SPMU

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		devices and lines, service rooms housing high voltage equipment, and areas for storage and disposal. Signage shall follow international standards and be well known to, and easily understood by workers, visitors, and the general public as appropriate; ▪ Disallow worker exposure to noise level greater than 85 dBA for more than 8 hours a day without hearing protection ▪ All workers shall be registered as per prevalent labor laws (including a workforce of subcontractors) and provided insurance cover ▪ Workers and their kith and kin shall be suitably informed about the registration, other details of workers, and insurance details and provide contact details of contractors person/insurance agent ▪ While using heavy machinery like JCB, cranes, etc, inform workers and communities on possible dangers and prevent going near operating / movement areas. Flagmen should be arranged on-site with a whistle. ▪ Flagmen shall be arranged if work is near schools, hospitals, major roads, and traffic control is required with the support of police. ▪ A work permit system will be implemented for all works related to working at heights (typically when working over 2m and above) and for hot jobs; · ▪ All works related to working at heights will be undertaken only during the daytime when sufficient sunlight is available; ▪ Use of temporary fall protection measures in scaffolds and out edges of elevated work surfaces, such as handrails and toe boards to prevent materials from being dislodged will be done; ▪ All excavation activities will be conducted in supervision of the site contractor; ▪ Proper signage and lights will be provided in places of excavated areas. ▪ No types/variations of Manual Scavenging or hazardous cleaning shall be allowed in the proposed Project during any stage in any part/activity. ▪ All sludge related work and working on leachate (LTP, Leachate Ponds, Sludge scooping, repairs of ponds) shall be preferably done by machines, with minimal direct work by people on SW sludge & leachate. All precautions shall be taken to prevent any type of hazards that may result in injury, ill health or severe/serious incidents of the workers ▪ Work in excavations & cells shall be clearly monitored & provided with direct supervision while work happens. No worker shall be left to carry out the duties all by himself without support.		

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		▪ Work permit system shall be in place & monitored closely by supervising consultant ▪ Multi-gas analyzers & other mechanisms shall be used in all parts during O&M, including in & near landfill cells, inert storage areas, sludge storage areas, LTP & leachate ponds, GAIL pipeline, EHT lines and similar areas always during any work. In addition, periodic gas inspection shall be undertaken as per schedule. ▪ There will also be height restrictions for machinery or especially high vehicles, such as loaders, JCB and other equipment, near overhead lines for safety reasons. Hence activities in GOKL Phase & retention pond shall follow SOP for safe work ▪ Leachate Pond: o The pond system shall also be securely fenced to prevent unauthorized access, and as a health and safety precaution, safety netting will be installed on the interior face of each evaporation pond to provide an egress point.		
15	Pest / Vermin Control (Odour, flies, rodent / other pest menaces)	▪ Pest management Plan to be prepared, focusing on integrated Pest Management ▪ Regular cleaning and approved pest control measures to be adopted ▪ Biopesticides / biological control shall be followed. ▪ Banned pesticides/insecticides shall not be used. ▪ Workers shall be made aware of storage and use of pest control measures and PPEs to be used	Contractor	PIU
D	**Closure & Post Closure Phase**			
1	Landfill Closure	▪ A vegetative cover shall be provided over the completed SLF in accordance with the specifications in line with regulations such as : (a) Selection of locally adopted non-edible perennial plants that are resistant to drought and extreme temperatures shall be allowed to grow; (b) The plants grown be such that their roots do not penetrate more than 30 cms. This condition shall apply till the landfill is stabilised; (c) Selected plants shall have ability to thrive on low-nutrient soil with minimum nutrient addition; (d) Plantation to be made in sufficient density to minimize soil erosion. ▪ Leachate & Gas management mechanisms shall be maintained in good condition for the post closure period ▪ The Best landscaped / visual impact shall be ensured while keeping the cover intact		

Sl No	Probable Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
2	Post Closure safety	▪ Before closure contractor shall Update Post Closure Care Plan & Implement Post closure Maintenance, Monitoring, & reporting. The owner/operator of a closed SLF must prepare a written post-closure care plan that provides: - A description of all required monitoring and maintenance activities, including the frequency with which each activity will be performed. - The name, address, and telephone number of the person to contact during the post-closure care period. - A description of planned uses of the land during the post-closure care period. - Even minor maintenance or such use of the land during this period must not disturb the integrity or operation of any of the waste containment systems or the monitoring systems. At the end of the post-closure care period, the owner/operator must certify that the post-closure care has been completed in accordance with the official post-closure care plan. This certification must be signed by an independent, registered professional engineer or the state director. Once signed, the certification is placed in the facility's operating record. - Follow National Regulations on Post closure care and guidance on protection of the area & allowed activities - The post-closure care of landfill site shall be conducted for the number of years as per regulations and long term monitoring or care plan shall consist of the following, namely :- - (a) Maintaining the integrity and effectiveness of final cover, making repairs and preventing run-on and run-off from eroding or otherwise damaging the final cover; - (b) Monitoring leachate collection system in accordance with the requirement; - (c) Monitoring of ground water in accordance with requirements and maintaining ground water quality; - (d) Maintaining and operating the landfill gas collection system to meet the standards. - Use of closed landfill sites after fifteen years of post-closure monitoring can be considered for human settlement or otherwise only after ensuring that gaseous and leachate analysis comply with the specified standards. - Environmental Monitoring shall be performed & data shared with stakeholders; All Consent Conditions shall be followed - Future Use shall be carefully Planned considering safety and pollution aspects	Facility Operator and or other Contractors involved	PIU/ULB, PCB

Detailed Environmental Monitoring Program will be prepared in line with the EMoP in Chapter 6, and EMoP of EMF Guidance Manual, depending on the design proposed by the Contractor. Contractor will report to KSWMP DPMU monthly on EMP & EMoP implementation, Incidents and status of Corrective Action Plan if any. This requirement will be made part of the Bid documents and the Contract document. KSWMP will report these to the World Bank as part of the Quarterly Monitoring Reports, in line with KSWMP ESMF.

SECTION 2: Linked Activity – EHT Line Shifting

(Shifting of EHT activity will be carried out by Kerala State Electricity Board (KSEB) before start of land development works for the proposed SLF. However funding source for this activity is unclear currently, and GoK decision is awaited. This activity as such do not need Environmental Clearance. Hence this is presented in the Annexure. Please note that H&S impacts of the presence of EHT lines near the landfill and mitigation measures are presented in the EMP for SLF.)

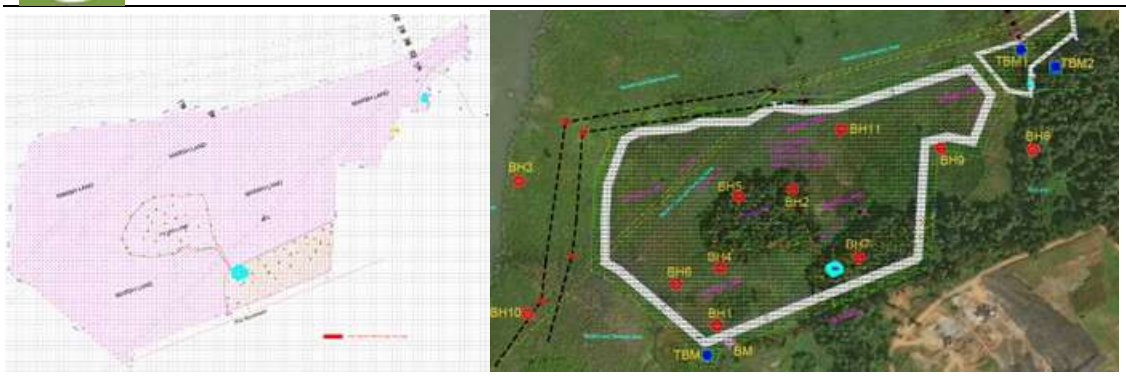
EHT line shifting: There are two EHT lines passing through the Proposed site. One is through the Proposed parcel under KSWMP phase of the landfill. The next is through the GOK part of the SLF. DPR Proposes additional Leachate Retention Pond beneath this.

EHT lines are laid and maintained by Kerala State Electricity Board. They have the mandate to shift the EHT lines through their empanelled contractors, who follows the safety regulations in line with Central Electricity Authority & other guidances. The first EHT line under the KSWMP phase will be shifted as overhead EHT to the land parcel (in KINFRA Complex) between proposed SLF and existing TSDF before land clearance for construction of sanitary landfill. The line under the GOK Phase will be shifted only once GOK decides to develop that Phase. The procedure for shifting and EMP are presented here.

Stepwise Procedure for Shifting of 110 kV Extra High Tension (EHT) Line by KSEB. Detailed stepwise procedure is presented in Annexure V,

Phase 1: Planning and Survey including preliminary survey, detailed topo profile survey and alternate alignments, conduct geotechnical investigation, and identification of probable hazards. Phase 2 is design and approvals including sag analysis and profile drawing design operation of estimates tender documents bid process management and award of tender to selected bidder. Phase three includes site preparation by the mobilized contractors team including clearing of shrubs. Page 4 and phase 5 o include providing support mechanisms, construction and laying off transmission lines. This is followed by phase six of testing and commissioning and rerouting of power. Phase seven on decommissioning and cleanup follows this phase. At this stage old infrastructure is removed and recycled, and the sites are restored to our original conditions.

Shifting of one EHT line that runs through KSWMP Phase is planned to be carried out before site preparation once there is agreement with KSEB. The remaining lines will be shifted only when GOK decides to construct their Phase.



Environmental Impacts of Shifting a 110 kV EHT Line in the site under consideration

Shifting a 110 kV Extra High Tension (EHT) line involves a complex interplay of engineering, logistics, and regulatory compliance. Beyond the technical aspects, such projects have significant environmental impacts that must be carefully assessed and managed. In addition to the **general impacts, the marshy condition of the site, and access requirements for the complex operation determines the risk levels including:**

- **Vegetation Clearing and Habitat Loss:** The site has many trees, shrubs and herbs through no critical or vulnerable habitats as per the site studies. Shifting the EHT line requires clearing trees, vegetation to access the existing infrastructure, and near & on the new route, leading to Disruption and **Loss of Biodiversity. Vegetation must be cleared along and to the sides of proposed alignment to allow for construction and associated access for vehicles.** Removal of shrubs, trees, and other flora can destroy habitats for birds, insects, and other wildlife. However, there will be disruption and loss to the terrestrial biodiversity (without any nesting, foraging grounds or migration corridors). Impacts on riverine biodiversity is minimal for majority of the shifting activities. Since access to river is limited, it is not expected that workers would each the river for uses. Absence of sanitation facilities and liquid and solid waste management for site office and labour facilities may increase impact river biodiversity, and increase in existing eutrophication, due to liquid and solid wastes. Shifting of OHT at both river edges of allotted area is important as there may be disturbance to water body.
- **Impacts on land and drainage:** As the existing & new alignment passes through marshy areas near the river, it may:
  - **Disrupt Hydrology**: Alteration of water flow patterns can affect local ecosystems. Flow patterns are not largely expected to be affected by this alignment change, as there are multiple flow channels to the river, and the overall SLF will lead to large scale change in pattern. For this proper drainage planning and implementation with support of stakeholders and nearby landuses is considered under the ambit of the subproject. Natural flow of Chithrapuzha is not expected by the proposed activities.

- **Increase Soil Erosion**: Clearing vegetation may destabilize soil specifically topsoil, increasing erosion and sedimentation in nearby water bodies/river. Excavation can compact soil and affect marshy land. Soil protection measures shall be developed for restoring of soil structure.
- **Result in loss of Ecosystem Services**: services like water purification, flood control, and carbon sequestration, may be compromised.
- **Seepage**: Ensure works to prevent seepage of water to both sides of cable anchors/layout (TSDF & SLF sides) in discussion with KSEB

- **Health and safety: (i) impacts on workers and nearby landuses of shifting & relaying in between SLF and existing TSDF including such as heavy loads, works on marsh, works involving trenching/excavation, work on electricity**, cables and wires (electrocution, flash over, fall of person from height, fall of objects from height, failure of Tools & Plants, fire, etc., that may be encountered while carrying out the work or testing near charged area)**, (ii)** electromagnetic field exposure and its potential health effects, (iii) impacts of gas discharge during operation of SLF/TSDF, (iii) emergencies including accidental contacts with electricity, fires, and disasters.
  - Decision on Shifting and Construction of Pond & other features beneath EHT line shall be based on latest Decisions & Guidance of KSEB on any construction beneath EHV lines. Applicable Clearance and H&S requirements shall be ascertained before design
  - Impacts of shifting EHT above GOK phase on the SLF (that may be in construction or operation phase) need detailed study. As the land near it is the marsh between proposed SLF and the river; access to those EHT lines & transfer of materials need to be week developed. Additional retention pond for leachate may be under construction and operation then. Impacts on and due to the leachate pond on the work plan, safety (possible High Energy Hazards) and pollution need careful analysis.
  - Prevent access of contractor / workers and machineries below EHT line RoW by installing barricades till such time it is shifted fully (in case KSEB delays in shifting before mobilization of contractor). Appropriate lighting, PPEs and barricading to be ensured.
- Transport and storage of Material & equipment for the works: Large amount of material need to be transferred from and to the site for demolishing existing infrastructure, construct new for laying. Storage of these material in or around the site may impact drainage, safety, ecology, Construction activities, including transportation of materials and equipment, can damage existing roads, disrupt normal traffic flow, causing delays and inconveniences for the public.
- Water & Soil Pollution due to materials, fuel spills and storage risks (from heavy machinery, DG sets, etc.), wastes from works including C&D wastes of Pylons, Wires and other appurtenances, electronic waste, hazardous wastes including cement, soil, recyclable metals, PCBs, Batteries, Plastics and general solid wastes and liquid wastes from site facilities and camps.

- Soil Contamination: Spillage of fuels, lubricants, or concrete mix used for laying can degrade soil quality and may run off to river if not contained.
- Water Pollution: Runoff from excavations and disturbed soil carrying debris or chemicals may contaminate nearby river. Many workers are expected to be in site for shifting and relaying. Absence of worker facilities may lead to use of the river. The liquid and solid wastes if not well managed may find its way naturally from the marshy riverside land to the river.

- Disposal of spoils: In case of excavations, disposal of spoils is important. It may be added to the soil sourced for raising of SLF land or other uses if not contaminated.
- Noise, Vibration and Air Pollution Noise and dust generation is expected from activities like:
  - Excavation: Excavations for removing existing infrastructure and for laying new cables or associated activities may involve digging, cutting, scooping, piling and drilling, which produce noise and dust. Site works during night may impact overall noise levels. Cumulative noise impacts will be high considering the location in industrial area, separated from most habitations by the river, but need to be mitigated.
  - Transportation: Movement of heavy equipment and materials generates vehicular emissions and noise. Vehicular access is important for the Cable for its repairs & maintenance. This shall be ensured, in a safe manner without disrupting the normal landfill operations
  - Steel Assembly: Welding, cutting activities when required may generate fumes and noise.
  - Power lines: Corona discharge from power lines may produce audible noise, particularly during wet conditions, disturbing nearby communities.

  In addition, gas emitted & escaped from SLF & nearby TSDF during operations may cause risks of fire if not prevented, works (during construction & O&M) supervised and monitored well by Health & Safety experts of the PIUs, DPMU, SPMU, Contractors, with continuous support of KSEB, Fire & Rescue Services, KINFRA, TSDF Operators (KEIL) and other stakeholders. Check gases daily and before working around cables.
- *Concerns related to Electric and Magnetic Fields*
  - Although scientifically inconclusive, prolonged exposure to EMFs generated by EHT lines is often perceived as a potential environmental issue, particularly for flora and fauna in the area.
- *Impact on other industries and landuses in the area*
  - Impacts of shifting, relaying & functioning of EHT lines on other industries, TSDF and SLF shall be avoided, monitored and mitigated by proper safety measures. Alternate arrangement for power supply shall be made by KSEB on consultation with the industries and other landuse served by the EHT lines proposed to be shifted.

- Proposed micro watershed area near which EHT lines are proposed to be shifted, need careful planning and management of any activity here

- *Chance finds*: Chance find procedures to be followed

Table B: EMP for EHT Line Shifting

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
A		**Pre-Construction/Activity or Planning Stage**		
1	***Planning the Shifting of (3) EHT Lines and its relaying***			
a)	Loss of precious ecological values/ damage to precious species – for all (3) EHT Lines (Line above KSWMP Phase initially and then the lines above GoK Phase)	▪ Careful selection of route alignment to avoid natural habitats; including Riverine faunal/floral habitats specially along river edges ▪ Safe Access required for full shifting of remaining EHT lines above GoK Phase to be ensured while designing the Layout. Detailed plan and schedule for shifting of all EHT lines to be prepared	KSEB Contractor, KSEB	PMU, GoK
b)	Deforestation and loss of biodiversity edge effect	▪ Avoid transmission line/ tower along sensitive environment ▪ If avoidance is not possible, minimize impacts ▪ Obtain permits from all authorities and agencies concerned & implement all guidance associated with Permits	KSEB Contractor, KSEB	PMU, GoK
c)	Tree felling permission	▪ Permission for felling of trees to be obtained from landowner, and other concerned authorities before tree felling	KSEB Contractor, KSEB	PMU, GoK
d)	Selection of routes for relaying EHT line through identified migratory bird path and bird habitats and near water bodies	▪ Careful selection of a route avoiding nesting grounds, foraging grounds, migration corridors, etc. ▪ Plan to provide bird guards and markers [as per the specification provided in IS-5613 (Part-II) or similar & good practices when passing through/near nesting grounds, foraging grounds, migration corridors, etc.	KSEB Contractor, KSEB	PMU, GoK
e)	Exposure to safety-related risks	▪ The transmission line will be designed as per IS 5613 (Par 2) and guidance's from Central Electricity Authority and other agencies, Departments including KSEB Fire & Rescue Services to provide setbacks from nearby landuses	KSEB Contractor, KSEB	PMU, GoK
f)	Exposure to electromagnetic interference	▪ The transmission line would be designed considering National & international guidelines including such as Central Electricity Authority and other agencies, Departments including KSEB Fire & Rescue Services	KSEB Contractor, KSEB	PMU, GoK

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
g)	Damage to private property	▪ There are no settlements in the proposed RoW. However, all activities in and around shall be marked and mitigation and safety measures planned. ▪ Design modification and special towers, tower extension and adequate electrical Clearance will be maintained, etc have been used to reduce the impacts zone of the transmission line	KSEB Contractor, KSEB	PMU, GoK
h)	Proposed micro-watershed, and Alternate Leachate Pond	▪ Proposed micro watershed area near EHT planned, need careful planning and management of any activity here ▪ Alternate Pond for Leachate construction shall be reviewed in detail & all impacts to be avoided by design	KSEB Contractor, KSEB	PMU, GoK
i)	Impact on Cultural Heritage	▪ Careful selection of route alignment to avoid socially, culturally and archaeologically sensitive areas (i.e. sacred groves, graveyard, religious place, monuments, etc.); and ▪ Maintain distance from archaeological monuments as per AMASR Act or other applicable regulations	KSEB Contractor, KSEB	PMU, GoK
B		**Work on shifting**		
1	***Shifting of Existing Elevated High Tension (EHT) Line***			
a)	Disturbance to Land, Water, Air while demolishing, decommissioning	▪ Careful planning to minimise impact on land, water ▪ Avoid spilling out of activities, towers, or people to the river sides or nearby other land uses ▪ Ambient air quality monitoring and noise monitoring shall be conducted during demotion and excavation works to conform the standards applicable to industrial area.	KSEB Contractor, KSEB	PMU, GoK
b)	Health and safety impacts	▪ Proper scheduling to ensure that EHT lines are shifted before start of any SLF activity on site ▪ Ensure barricading of site area where EHT lines are being shifted, provide appropriate awareness and notice boards, with emergency contact details & ambulance service ▪ Exercise appropriate physical and warning controls on the piece of land below other EHT lines that would not be shifted presently ▪ Works – such as spread of soil to raise the ground, and construction of Retention Pond under the existing EHT line shall be well detailed out & permission for works shall be sought from	KSEB Contractor, KSEB	PMU, GoK

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		KSEB & other agencies; so that there is no adverse effect on the lines, workers or any others ▪ During construction appropriate seepage preventing mechanism shall be constructed on both sides of Cable laid (by shifting EHT). ▪ The transmission line shall be designed to withstand impacts of long standing water periods from overland flooding and for safe works. ▪ Accessing HT lines through marshy land need proper planning & tools/platforms to work on marsh). PPEs, safety shall be prioritized considering the marshy nature & river nearby ▪ Improve Drainage before works: Implement proper drainage systems (e.g., ditches, pipes) to reduce water accumulation. ▪ Surface Water Control before works: Ensure that surface water runoff is directed away from the work site. ▪ Stack material from demolition activities, Tools, materials, properly on the designated parts of the site, ensure proper cordoning of such area and activities and ensure safe shifting ▪ List out the high energy hazards, prepare critical controls, train workers and all others on site & other areas if any associated with this work, and implement (Welding, Demolition, working on heights, with heavy parts, working on electric parts etc. and other High Energy activities) ▪ Ensure work permit system is in place ▪ Alert nearby land uses and industries/premises depending on this infrastructure on the possible impacts		
c)	Disturbance to Flora, Fauna	▪ Minimize tree cutting, and compensate each tree cut as per rules. Carefully manage the existing flora on site / trees while cutting the trees	KSEB Contractor, KSEB	PMU, GoK
d)	Noise and vibrations	▪ Provide noise barriers to prevent noise affecting sensitive land uses ▪ All equipment/machineries to be regularly maintained to ensure efficient operation. ▪ DG sets with acoustic enclosure should be used. ▪ Construction work during the night-time (10 pm to 6 am) to be prohibited. In case of work at night approval of Local Body & by other industries in industrial area is mandatory.	KSEB Contractor, KSEB	PMU, GoK

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
e)	Access to EHT lines	Proper safe access shall be ensured to all the remaining EHT lines for operations, emergencies and shifting when required	KSEB Contractor, KSEB	PMU, GoK
f)	Traffic impacts	Proper Transport Plan to be prepared for material storage, transport from & to the site especially of large equipments and members	KSEB Contractor, KSEB	PMU, GoK
2	***Relaying as EHT Cable***			
a)	Loss of topsoil	▪ Topsoil from the entire tower footing area (approx. sq. m.) will be stripped (10 to 15 cm) before the commencement of excavation work ▪ Topsoil will be stored in a dedicated topsoil storage site, having adequate mitigation measures for preventing erosion due to runoff; ▪ Activities will be scheduled (as far as possible) to avoid extreme weather events, such as heavy rainfall; ▪ After work is over, topsoil will be reinstated at the site.	KSEB Contractor, KSEB	PMU, GoK
b)	Noise and vibrations	▪ All equipment/machineries to be regularly maintained to ensure efficient operation. ▪ DG sets with acoustic enclosure should be used. ▪ Construction work during the night-time (10 pm to 6 am) to be prohibited. In case of emergency work at night approval of Municipality is mandatory.	KSEB Contractor, KSEB	PMU, GoK
c)	Air Pollution	▪ Water sprinkling to be carried out twice a day during the dry season on the exposed surface area. ▪ Vehicles transporting loose construction/excavated materials shall be covered with tarpaulin sheets. ▪ Loose construction material/ excavated material shall be kept covered with a tarpaulin sheet or with nets arounds depending on its nature ▪ All vehicles utilized in the transportation of raw materials and personnel will have valid Pollution under Control Certificate (PUCC). ▪ Regular maintenance of machines, equipment, and vehicles that will be used for construction activities of substation/tower construction.	KSEB Contractor, KSEB	PMU, GoK

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		▪ Ambient air quality monitoring and noise monitoring shall be conducted during demotion and excavation works to conform the standards applicable to industrial area.		
d)	Water/Soil pollution	▪ Soak pits/modular bio-toilets would be provided at all construction camp, laydown area and labor camp	KSEB Contractor, KSEB	PMU, GoK
e)	Impacts on drainage channels	▪ Materials shall be stored without affecting natural drainage ▪ Works during floods & rains will be difficult with excessive drainage, and hence shall be undertaken during non-rainy seasons	KSEB Contractor, KSEB	PMU, GoK
f)	Injury and sickness of workers	▪ Provide safety equipment's (PPEs) for workers; ▪ Prevent entry of all unauthorized persons to sites; ▪ Provide training on health and safety to all the supervisors and workers.	KSEB Contractor, KSEB	PMU, GoK
g)	Loss of Vegetation	▪ Avoid felling of trees during stringing unless it becomes necessary. ▪ After completion of stringing, natural regeneration dwarf tree/medicinal tree plantation would be allowed to heights as per the standards mentioned in IS: 5613 and Government of India Circular 7-25/2012-FC dated 5th May 2014 and other applicable regulations and standards. ▪ Proper scheduled pruning also following the EHS aspects	KSEB Contractor, KSEB	PMU, GoK
h)	Injury and sickness of local people	▪ Coordination with local communities for construction schedules etc; ▪ Barricading construction area; ▪ Placing hard barricading with reflectors & lighting as required on the boundary of the construction area; ▪ Undertaking regular health check-ups of the workforce and reporting any major illnesses at the earliest to health officer of nearby Local Body for disease control and surveillance. ▪ Creating mass and labour awareness on HIV and STDs;	KSEB Contractor, KSEB	PMU, GoK
i)	Traffic Plan	▪ Prepare and follow proper Transport plan to prevent disturbances to nearby areas	KSEB Contractor, KSEB	PMU, GoK
j)	Labour camp-related EHS and Hygiene Issues	▪ Facilities would be provided at the labour camp. Some of the relevant provisions to comply are as follows: ▪ Worker's accommodation; ▪ Provision of safe drinking water, sanitation & drainage;	KSEB Contractor, KSEB	PMU, GoK

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		▪ Appropriate arrangement for cooking; ▪ Availability of medical facility (first aid) including ready ambulance		
k)	Housekeeping	▪ Proper storage of materials, and wastes in separate receptacles to ensure no impacts on people, drainage etc. ▪ Fuels, wastes, tools, equipment, and materials to be safe stored in high platform without risk of fire or flooding	KSEB Contractor, KSEB	PMU, GoK
a)	Chance finds	▪ Chance find procedures to be followed; including - Cordoning off the work site without any disturbance to it - Contacting relevant authority and inform on chance find - Informing the authorities at the earliest and Following the directions of authorities	KSEB Contractor, KSEB	PMU, GoK
C		**Operation and Maintenance Phase of EHT**		
3	***Operation Phase of (re-laid) High-Tension Cable (& other EHT lines that are not shifted, but above GoK Phase)***			
b)	Loss of vegetation	▪ Periodic pruning of vegetation to maintain a minimum clearance as per regulations between conductor and trees	KSEB Contractor, KSEB	PMU, GoK
c)	Vegetation re-growth	▪ Scheduled overstory clearing shall be ensured.	KSEB Contractor, KSEB	PMU, GoK
d)	Injury/ mortality to staff during O&M work	▪ During the testing and charging of the electrical line, electricity insulating protective equipment like footwear (ISO 20345: 2004 Part-2), rubber gloves (IS 4770: 1991) would be provided to workers. In addition, provisions of the “Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations” and other guidance shall be adhered to. Induction training for the entire new employee and six-monthly refresher training for substation O&M staff would be organized.	KSEB Contractor, KSEB	PMU, GoK
e)	Injury/ mortality from emergency situation	▪ Preparation of fire emergency action plan and training given to staff on implementing emergency action plan. ▪ Site workers shall be trained to inform KSEB and other agencies on the other (not shifted) EHT lines if any issues they may face on these during operations	KSEB Contractor, KSEB	PMU, GoK

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
f)	Flooding & Water / Leachate Seepage	▪ Ensure works to prevent seepage of water & electric hazards	KSEB Contractor, Other agencies like KINFRA – the land owner	PMU, GoK
g)	Health and safety impacts	▪ Exercise appropriate physical and warning controls on the piece of land below other EHT lines that would not be shifted presently ▪ Works – such as spread of soil to raise the ground, and construction of Retention Pond under the existing EHT line shall be well detailed out & permission for works shall be sought from KSEB & other agencies; so that there is no adverse effect on the lines, workers or any others ▪ Prepare SOP for all activities (such as raising the ground of GoK Phase, construction of alternate leachate pond) beneath EHT lines (that are not shifted) considering impacts during works, and operational impacts such as gas release from Pond, use of machineries etc. ▪ Accessing EHT lines through marshy land need proper planning & tools. PPEs, safety shall be ensured for repair works considering the chances of subsidence ▪ List out the high energy hazards, prepare critical controls, train workers and all others on site & other areas if any associated with this work, and implement ▪ Ensure work permit system is in place ▪ Alert nearby land uses and industries/premises depending on this infrastructure on the possible impacts	KSEB Contractor, KSEB, SLF Contractor	PMU, GoK
g)	Impacts due to GAS	▪ during construction & O&M Gas emission to be supervised and monitored well ▪ Check gases daily as required and before working around cables.	KSEB Contractor, KSEB	PMU, GoK
h)	Housekeeping	▪ Proper storage of materials, and wastes in separate receptacles to ensure no impacts on people, drainage etc. ▪ Fuels, wastes, tools, equipment, and materials to be safe stored in high platform without risk of fire or flooding	KSEB Contractor, KSEB	PMU, GoK

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
i)	Access	▪ Vehicular access is important for repairs & maintenance. This shall be ensured	KSEB Contractor, KSEB	PMU, GoK
j)	Chance finds during maintenance & repairs	▪ Chance find procedures to be followed; including - Cordoning off the work site without any disturbance to it - Contacting relevant authority and inform on chance find - Follow the directions of authorities	KSEB Contractor, KSEB	PMU, GoK

Section 3: Linked Activity: Transfer Locations

Feasibility Study suggests that inert material shall be transferred from the ULBs large refuse compactor vehicles (RCV). Inerts from material collection facilities (MCFs) and other locations in each ULB will be transferred to the transfer locations in small vehicles. These would be tipped into the RCVs. FR presents details on Intermediate Inert Transfer Locations. These locations are currently identified in the MCFs in dumping yards of ULBs (most under biomining and bioremediation). The transfer stations reduce the cost of transporting inert to disposal facilities. Consolidating smaller loads from collection vehicles into larger transfer vehicles reduces hauling costs by enabling collection crews to spend less time traveling to and from distant disposal sites and more time collecting waste. This also reduces fuel consumption and collection vehicle maintenance costs, plus produces less overall traffic, air emissions, and road wear. In addition, a transfer station also provides an opportunity to screen waste prior to disposal. For example, biowaste shall not be allowed into the transfer vehicles as there is no biowaste management facility at SLF as it is only for inert waste. In case biowaste enters SLF, odour, leachate and gases will be high. Hazardous wastes also shall not be directed to SLF. They shall be disposed at TSDF considering the hazardous content. Facilities for storing such wastes shall be provided at the transfer locations. Schedule. Responsibilities and monitoring mechanisms shall be worked out to ensure that inert wastes are transported to the SLF whereas others are disposed in other facilities without polluting the environment.

A generic (and standalone) EMP for these activities is presented in ***Table* C** below, as this may be performed by contractors / staff different from SLF construction & O&M contractor. This shall be updated in line with locational and process risks based on the ultimate plan for Transfer Locations and Transfer arrangements.

In case the project plans to design and construct full-fledged transfer stations instead of using existing MCFs, detailed environmental impact assessment (including cumulative impacts) will be conducted and the EMP will be updated based on this.

Table C: EMP for Collection Transportation of wastes in ULBs, and transfer of inerts to SLF

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
A		**Pre-Construction/Activity or Planning Stage**		
1	***Planning for Primary and Secondary Storage, Collection, Transport of Waste***			
1	Pollution and health and safety risks due to mixed/unsegregated waste *(Air, Water, Land Pollution, impacts on flora/fauna/humans and visual blight)*	▪ Include infrastructure, service, management of Waste Segregation at Source, Storage, Collection, Transport, Treatment, and Disposal of only rejects & inerts (including mechanisms to plan for surge) in the SWM plan for the ULBs in the service area and implement before initiating the SLF Operations – all in line with SWM Rules, 2016 and other applicable regulations, WB EHS and good practices. Follow ESMF exclusion criteria, access requirements and update EIA/EMP for Collection & Transport of inerts including Transfer Locations Include Noise, Leachate, Odour, Dust, Traffic and other Pollution Management Plans in detail in EMP All permits and clearances applicable at Transfer Locations, for Collection, Transport and Disposal shall be in place before initiating the operations ▪ Plan for suitable sizes, materials, type and placement of storage bins, Collection schedule and mechanism for all areas, Eco-sensitive areas, special conditions like events, disasters, festivals and tourism at each category of premises / each locality so that activities do not result in pollution ▪ Closed type containers for wet waste; distinctive bins for wet & dry waste should be used for storage and collection of waste. ▪ In areas prone to flooding, suitable high plinths/platform shall be arranged for keeping bins ▪ As per SWM Rules, 2016, there should be three bins at each household / property for the storage of wet (covered), dry and domestic hazardous waste. Domestic Biomedical Waste to be collected or disposed-off as per guidance from the State or agreed with ULB.	ULBs/PIUs; Contractors	PMU, PCB

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		▪ Household garden waste and Food and C&D waste from bulk generators will be separately stored at source and transported once a week or as appropriate & agreed in consultation with communities ▪ Plan to Accommodate Separate receptacles at MCFs, MRFs Compost facilities and other waste management facilities for storage of segregated inerts and rejects		
to 2	Lack of awareness to communities on proper waste storage, collection, transportation *(Socio-economic)*	▪ Arrange awareness generation attempts for communities through Ward Sabhas, Pamphlets, media/ other means ▪ Include CBOs / NGOs, institutions (schools, other agencies) for awareness generation	ULBs/PIUs; Contractors	PMU, PCB
B	**Implementation Stage and Operation/ Maintenance Stages**			
1	***Storage of Wastes***			
1	Pollution and health and safety risks due to overflowing, inappropriate, improperly placed and poorly maintained bins *(Air, Water, Land Pollution, impacts on flora/fauna/humans and visual blight)*	▪ Awareness to communities on usage and maintenance of appropriate bins ▪ Standard Operating Protocols for the collection agency and C&T workers on flagging inappropriate bins/usage ▪ Ensure proper daily collection of wet waste, once a week collection of dry wastes and hazardous wastes, drop off centers for e-waste, bulk dry recyclable wastes ▪ Support by making available suitable receptacles (closed bins of required size) for deserving communities ▪ Instructions to provide bins (preferably in such a way as to prevent visual blight) in high platforms above flood level and to secure them to prevent bins getting washed away during floods, rains ▪ Spot checks on placement, use, cleanliness of bins to avoid water accumulation during non-use periods ▪ Arrange Grievance mechanisms ▪ Ensure special storage of inerts and rejects at MCFs. Plan to Accommodate Separate receptacles shall be ensured at MCFs, MRFs Compost facilities and other waste management facilities for storage of segregated inerts and rejects	PIU, PCB	DPMU
2	• Operational difficulties and use of more resources for segregation after collection *(Socio-economic)*	▪ Enforce waste segregation through awareness drives, media campaigns, other measures ▪ Provide three bins in collection cart: for Wet waste, dry waste, and unsegregated wastes or schedule collection timings separately	ULBs/PIUs; Contractors	PMU, PCB

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
	• The low value for recyclables due to mixing up with wet waste and difficulties for ragpickers to collect recyclable fraction *(Socio-economic)* • Odor and leachate from putrescible material affecting the entire waste *(Air and Soil) and* • Visual blight *(Socio-economic)*	▪ Arrange mechanical segregation of wastes at the treatment point in case the treatment mechanism requires segregated waste ▪ Sensitize communities to reduce reuse and recycle wastes		
3	• Multiple handling of waste after collection resulting in health impacts for community and workers *(Health and safety)* • Impacts on Health and safety of Workers due to sharps like glass, needles, broken tools, etc *(Health and safety)*	▪ Avoid secondary storage of wet waste. It shall be directly transported to a treatment facility and not allowed to mix with inerts. Else closed containers of dry waste shall be offloaded at designated areas from where it can be directly lifted by suitable vehicles (without tipping on land) and transferred to the treatment facility. ▪ No waste shall be allowed on ground. Separate storage areas & receptacles shall be provided to avoid people dumping wastes & scooping up (double handling of wastes) ▪ Dry waste and inerts may be stored in approved MCFs / RRFs as per SWM plan. Inerts shall be separated out at MCFs and other WM units, or collected separately from large generators ▪ Awareness of Health impacts on workers ▪ Health insurance coverage for workers ▪ Enforce the use of Personal Protective Equipment by workers/CBOs, drivers and others engaged in collection and transportation ▪ Ensure inert acceptance criteria is followed ▪ No hazardous or solid waste or other waste shall be allowed in inert transfer vehicles. There shall be strict monitoring including surprise Third party checks.	ULBs/PIUs; Contractors	PMU, PCB
4	Waste accumulation at premises due to Hartals, operating agency-related issues, disasters, emergencies	▪ Provide facilities to store wastes for a week in case of emergencies. These areas shall be covered, without chance of climate or pests affecting this ▪ Prepare alternate Disaster Waste Management Plan (DWMP) for each town and make provisions to implement in case of emergencies	ULBs/PIUs; Contractors	PMU, PCB

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
	(Air, Water, Land pollution; Odour, Fly nuisances creating health impacts, visual blight)			
2	***Collection and Transportation activities***			
1	Waste leakage from collection system resulting in open burning, dumping *(Air, water, land, Fauna/Flora, Health impacts)*	▪ Ensure proper record keeping of waste collected and transported ▪ Weighbridge level record keeping and monitoring at the Transfer Locations and tipping point ▪ Scheduled checks while loading, and third-party surprise audits	ULBs/PIUs; Contractors	PMU, PCB
2	Impacts due to vehicle movement (*Health and safety of workers, communities)*	▪ The movement route shall be scheduled for each vehicle. ▪ Enforce speed limits applicable and make drivers aware of this ▪ Vehicles movement (both collection trucks/three wheelers and RCVs) shall be tracked by Health Supervisors to ensure keeping up to schedule; preferably using GPS linked to GIS ▪ Clean fuel shall be used in vehicles. Any adulterated fuel shall be avoided. There shall be periodic emission tests for vehicles ▪ Provision of Personal Protective Equipment such as face mask, gloves, nose masks & goggles to all workers in C&T vehicles, Maintenance yards ▪ Proper lubrication shall be provided to minimize squeaking noise due to friction ▪ Honking shall be minimized to eliminate any possible discomfort to the nearby people. ▪ The most optimum route is planned with minimum no. of vehicles with the help of GIS mapping and apps for the general public ▪ Traffic will be managed at the site by providing adequate space for parking of vehicles ▪ Timely processing & disposal of waste shall be carried out by vehicles and should transfer waste only in the specified Secondary Collection Point or secondary collection vehicle or treatment disposal yards planned. No waste shall be disposed of in any place other than the designated area; including water bodies, coasts/forests, or sensitive areas.	ULBs/PIUs; Contractors	PMU, PCB

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
3	Accidents and breakdown of collection and vehicles *(Air, water, land, Fauna/Flora, Health impacts)*	▪ Ensure Critical Controls for all High Energy Hazards expected ▪ Include mechanisms/protocols for Waste transfer and transport in case of accidents/emergencies in DWMP for the town, including direct transfer (without double handling; no waste on the ground), use of PPEs by personnel, cleaning protocols, etc. ▪ Drivers shall have a valid driving license, and shall be well trained on defensive driving ▪ All vehicles to carry First Aid kit and driver to be trained for the same ▪ Vehicles shall carry information to contact authorities in case of any mishaps / fast driving, transport of wastes without cover, etc. ▪ Fit vehicles with highly audible reversing alarms and mirrors and check at least daily and maintained in good working order. ▪ Allow only authorized and competent workers to operate the vehicles; ▪ Plan collection routes to avoid times of high-pedestrian activities	ULBs/PIUs; Contractors	PMU, PCB
4	Inaccessibility of collection and transport vehicles to some waste storage areas / during certain occasions or emergencies causing its accumulation and pollution *(Air, water, land, Fauna/Flora, Health impacts)*	▪ Arrange proper vehicles based on road widths, appropriateness, slopes, eco-sensitivity at each location (such as hand carts for narrow roads, auto three-wheelers for most areas accessible; direct collection by picking (using appropriate tools) wastes on beaches, etc. without disturbance of flora, fauna)	ULBs/PIUs; Contractors	PMU, PCB
5	Information to property owners/occupiers on collection schedule to prevent waste accumulation in premises *(Air, water, land, Fauna/Flora, Health impacts)*	▪ Premises & MCFs/RRFs & treatment facilities etc. shall be informed about the collection schedule ▪ Premises & MCFs/RRFs & treatment facilities etc. shall be instructed to make the inerts & rejects available at the right time without delay ▪ Collection vehicles shall be well maintained with PUC certifications and periodic checks ▪ Avoid leachate & mixing of other wastes with inerts	ULBs/PIUs; Contractors	PMU, PCB

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
	Idling of collection vehicles in front of houses/collection areas result in emissions *(Air emissions: CO, CH4)*			
6	Poor cleaning and maintenance of vehicles and bins *(Odour and fly menace; Air impacts: PM2.5, PM10, SO2, NOx, & CO)*	▪ All vehicles/containers used for collection, transportation shall be cleaned every day ▪ There shall be proper maintenance and cleaning workshop/yard for collection and transport vehicles (and bins) with cut off drains and mechanism (package unit) to treat wastewater; greenbelt of 3-6m around with layered canopy trees ▪ All vehicles used for C&T shall be checked for pollution norms (PUC) and only those within approved norms shall be used ▪ No leakage of leachate is allowed from any waste carrying vehicles. All vehicles shall have a leachate collection tank or other arrangements, irrespective of its type and carrying capacity. ▪ Leachate shall be treated at leachate treatment plant ▪ Regular cleaning and approved pest control measures to be adopted: Biopesticides / biological control shall be adopted. Banned pesticides/insecticides shall not be used. ▪ Workers shall be made aware of storage and use of pest control measures and PPEs to be used	ULBs/PIUs; Contractors	PMU, PCB
7	Collection and Transportation of wastes in overloaded and open vehicles *(Air, Odour nuisances; spills and littering impacts on Air, Water, Land)*	▪ All C&T vehicles shall carry only approved a load of weight as per SOP ▪ Regular cleaning of roads & drains and removal of collected waste. ▪ All Collection / Transport vehicles shall be covered & with mechanism to collect leachate (if required, from drain silt and similar inerts) without dripping ▪ Ensure provisions of SWM Rules 2016 for all collection Transportation activities ▪ All Transfer of inert shall occur facilities that have proper floor and roof in a such manner, so as not to let waste on to ground, or rains / winds affect the transfer operations & impact the nature of inerts	ULBs/PIUs; Contractors	PMU, PCB
8	Plying of vehicles through kutcha / unsurfaced roads and idling *(Air pollution: SPM, CO, CO2)*	▪ Vehicle movement shall be well planned – through topped roads. ▪ In case of necessity to move through Kutcha roads, ensure sprinkling of water to suppress dust before and after the movement of the vehicle	ULBs/PIUs; Contractors	PMU, PCB

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
9	Impacts of operation and maintenance *(Community and Worker Health and Safety)*	▪ Hazard Identification & Risk Assessment analysis shall be prepared for all activities of C&T related activities and mitigation measures shall be implemented for all significant risks identified. ▪ All centers of labor contact points shall be provided with First Aid and other related activities. ▪ Emergency Preparedness plans shall be prepared and implemented for all manpower working centers and its field extension centers. ▪ An Environment Health & Safety policy shall be prepared and implemented by contractors & facilities ▪ The manager shall listen and act to the manpower related grievances. ▪ Workers shall be provided with PPE such as face mask, gloves, shoes, nose masks & goggles ▪ Proper training shall be provided regarding the maintenance of Health ▪ First aid facility shall be available at an accessible place ▪ Tie-up with the local hospital shall be done to provide an ambulance to handle emergency cases if required ▪ Routine inspections, housekeeping, and maintenance shall be carried out at regular intervals ▪ Measures such as deferred timings and stretch break to be adopted ▪ Provide non-slippery work areas Workers involved in all aspects of C&T shall be provided with proper rest areas, with water, First Aid facilities within quick reach ▪ Appropriate fire and safety standards/facilities/equipment / mock drills and familiarization shall be ensured for all stages of storage, collection, and transportation ▪ DG sets if used for C&T/maintenance etc.; shall have valid consents from pollution control authorities and shall have in-built arrangements to reduce air emissions ▪ Proper handing over procedure shall be prepared and used so that all concerns are taken when the operator changes during/after operations period ▪ A set of workers (Municipal / private / HKS) shall be kept ready for emergencies/contingencies. ▪ Measures such as deferred timings and stretch break to be adopted ▪ All workers shall be registered as per prevalent labor laws (including a workforce of subcontractors) and provided insurance cover	ULBs/PIUs; Contractors	PMU, Labor Commissioner

Sl No	Probable Negative Impacts	Mitigation Measures	Implementation Responsibility	Monitoring Responsibility
		▪ Workers and their kith and kin shall be suitably informed about the registration, other details of workers, and insurance details and provide contact details of contractor's person/insurance agent		
10	Inert waste tipping and storage at SLF	▪ There shall be proper scheduling and planning of transfer operations using GPS based tools ▪ Monitor inert movement using GPS to prevent tipping in any place other than SLF ▪ Monitor compliance to Waste Acceptance Criteria: Before tipping, monitoring composition of inert reaching SLF for tipping. Apply warnings & penalties for non-inerts (unacceptable wases: Certain wastes might be unacceptable at a transfer location & SLF for a variety of reasons: those prohibited by regulations (e.g., PCBs, lead acid batteries, radioactive materials, ash, asbestos, inflammables etc.), those might pose a health or fire hazard, waste to be treated or recycled, large pieces that could damage trucks or equipment during waste loading operations, carcass, sludges, liquids or similar) ▪ Storage area and infrastructure of inerts / waiting of RCV for tipping as per detailed plan with lighting, washing, cleaning, sanitation, drainage facilities ▪ Facilities for workers, and other staff involved ▪ Plan for emergencies (at SLF & ULBs) & urgent repairs ▪ Sustainability Plan for inert reduction, disposal after SLF closure	ULBs/PIUs; Contractors incl. SLF Contractor	PMU, PCB