DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

MINISTRY OF MEGAPOLIS AND WESTERN DEVELOPMENT

Metro Colombo Solid Waste Management Project

ENVIRONMENTAL IMPACT ASSESSMENT REPORT OF THE PROPOSED PROJECT ON METRO COLOMBO SOLID WASTE MANAGEMENT

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Prepared By:

EML Consultants

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Central Environmental Authority,

North Western Provincial Environmental Authority

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Abbreviations

ABOP	Air Blast Over Pressure
ARI	Average Recurrence Interval
ASL	Aruwakkalu Sanitary Landfill
ATS	Aruwakkalu Transfer Station
BCF	Bogie Container Flats
BH	Bore Hole
BOD	Biological Oxygen Demand
CD	Communicable Diseases
CEA	Central Environmental Authority
CEB	Ceylon Electricity Board
CMC	Colombo Municipal Council
CMR	Colombo Metro Region
COD	Chemical Oxygen Demand
CTC	Central Traffic Controller
DDTS	Dry Deciduous Thorn Scrub
DEM	Digital Elevation Model
DMEF	Dry Mixed Evergreen Forest
DR	Department of Railways
DWLC.	Department of Wildlife Conservation
EIAR	Environmental Impact Assessment Report
EPL	Environmental Protection Licence
GEF	Global Environmental Funds
GOSL	Government of Sri Lanka
GSMB.	Geological survey and Mines Bureau
GV	Ground Vibration
HDPE	High Density Poly Ethylene
HH	House Hold
IEE	Initial Environmental Examination
ITI	Industrial Technology Institute
KPS	Kelaniya Pradeshiya Sabah
KTS	Kelaniya Transfer Station
KUC	Kolonnawa Urban Council
LA	Local Authority
LFG	Landfill Gas
MC	Municipal Council
MCR	Metro Colombo Region
MCSWMP	Metro Colombo Solid Waste Management Project
MMC	Moratuwa Municipal Council
MSL	Mean Sea Level
MSW	Municipal Solid Waste

NARA	National Aquatic Research Agency
NBRO	National Building Research Institute
NEA	National Environmental Act
NIRP	National Involuntary Resettlement Policy
NMOC	Non-methane Organic Compounds
NT	Near Threatened
NWP	North Western Province
NWPC	North Western Provincial Council
NWPES	North Western Provincial Environmental Statute
O&M	Operation and Maintenance
PEA	Provincial Environmental Authority
PES	Provincial Environmental Statute
POP	Persistence Organic Pollutant
PPA	Project Approving Agencies
PRDA	Provincial Road Development Authority
PS	Pradeshiya Sabha
RCV	Refuse Receiving Vehicle
RDA,	Road Development Authority
SJKMC	Sri Jayawardenapura Kotte Municipal Council
SLLRDC	Sri Lanka Land Reclamation and Development Corporation
SLR	Sri Lanka Railway
SPM	Suspended Particulate Matter
SPOF	Sparse and Open Forest
SWM.	Solid Waste Management
TCLP	Toxicity Characteristics Leaching Protocol
TDS	Total Dissolved Solids
TL	Tractor Lane
ToR	Terms of Reference
UC	Urban Council
UDA	Urban Development Authority
UNDP	United Nations Development Programmed
VES	Visual Encounter Survey
VOC	Volatile Organic Compound
W2E	Waste to Energy
WMU	Waste Management Unit
WNP	Wilpatu National park

Executive Summary

This Environmental Assessment was prepared by M/s Environmental Management Ltd, at the request of the Ministry of Megapolis and Western Province Development to assess the environmental impacts of the proposed MSW landfill development at Aruwakkalu in the Puttalam District. The said ministry is proposing to develop this landfill as a necessary alternative solution for the MSW disposal problem faced mainly in the CMR and in the Grater Colombo Area largely. Total waste load generated in CMR is about 1200 tons/day. Therefore, the capacity of the proposed landfill is set at 1200 tons/day. However, the landfill is open to other LAs in the Greater Colombo and the LAs in Puttalam. Since other disposal options will be available in few years, the waste generated in the MCR is not expected to arrive at the ASL in full leaving room for waste from other LAs.

This development is long overdue. To establish a sanitary landfill to handle the MSW generates in the Greater Colombo goes three decades back. The technical and siting alternatives considered throughout in this endeavor can reasonably be considered as a substantial consideration of alternatives. Previous proposal for sanitary landfill at Aruwakkalu was not environmentally accepted due to a siting issue. Under the new proposal, the landfill site is moved to a new location at Aruwakkalu, which is not in conflict with the laws of the country. In addition, the transfer station in Colombo was moved to Kelaniya from Meethotamulla. This decision was taken considering the recent disaster at Meethotamulla. Nevertheless, transfer station at Kelaniya is a better choice economically, socially and environmentally.

Waste transfer station in Colombo will be established at Kelaniya. Site is 3 kms from the Colombo City limits and the size is 10 ha. The site adjoins the main railway line and Kandy-Colombo highway. Therefore, from the KTS there is direct access to the ASL by train and has main road access for RCVs to KTS. KTS is in a marshland. Yet, significant ecological impacts were identified. Flood retention and drainage capacity of the marsh is conserved by building the KTS infrastructure on piles. Waste dumping floor takes place inside a secure building and negative pressure will prevent odorous air leaving out. An odor control system is installed. Leachate together with other wastewaters will be treated at site to meet the disposal standard for inland water bodies. Treated effluent will be discharged to a nearby canal (Mudun Ela). Access to the KTS will be through a new access road from Kandy-Colombo highway and the exit is through the Manelgama Road which joins the Kandy-Colombo highway. Around 400 RCV are expected at KTS daily and traffic congestion is anticipated. This is likely the most significant issue. Traffic management plan and road improvements are recommended. The other issue is the odor and vector problem along Manelgama road due to constant movement of RCVs (although empty). Involuntary resettlement is not required due to KTS development.

Waste will be transported to Aruwakkalu from KTS in trains. Two trains are scheduled per day each carrying 600 tons. The distance is 170 kms. Railway track is available from the KTS to all the way up to Aruwakkalu. Access to the KTS from the main line is possible without a problem. Since most of the distance to travel is through single-track, delay in the railway systems is one of the main concerns. Disruptions to railway system is another major concern. It will be necessary to add loops at more stations to avoid delay. The Cement Company also uses rail track between Palavi and Aruwakkalu and they are in charge of maintaining that part of the track. Therefore, tripartite agreements may be necessary among SLR, Cement Company and ASL for the railroad operation. It is recommended to employ people with SLR experience for train operation.

Waste will be received at ATS. The waste filled containers are unloaded to tipping trucks for taking into the landfill. ATS is located about 200 meters from the ASL. ASL has capacity for 10 years. It will be developed in two stages as Phase I and Phase II. Each phase has the capacity for 5 years. Landfill operation is expected to start in 2020 and completes in 2030. The site is a spent limestone quarry currently under reforestation. The proposed project will disturb the ongoing reforestation work and remove the already gained forest cover. Wild elephants roam in the area and electric fence is planned for site protection. ASL is developed as semi aerobic landfill to achieve improved leachate quality and aiming at better environmental outcome. The estimated design quantity of leachate is 600 m^3/day. Leachate is subjected to biological and chemical treatment to meet the quality requirement for disposal to inland water. However, the most of the treated effluent will be reused on site to improve the waste moisture content, dust control, and planting of trees. Waste will be stacked to 40 meter height in cells raised in eight layers of five meter height. There is no plans for energy recovery initially but will be considered in the future. At the end of the filling, the topography will be brought into balance of the surrounding area and reforested. An extensive storm water management plan is proposed to prevent rainwater inflow to the ASL. Neither stormwater nor treated leachate will be directed to the lagoon. Significant environmental impacts are not anticipated due to ATS and ASL development.

In conclusion, the proposed project will not create irreversible negative impacts on the existing physical, ecological, and socioeconomic environment at the KTS and ATS/ASL. The impacts are reversible and transient in nature. Compared to the long term benefits project will be important and viable. Therefore, the Consultants, subjected to the implementation of proposed mitigation measures and monitoring of compliance and effects, recommend the project for the environmental clearance. The developer shall take necessary corrective mitigation measures, if the effect monitoring indicates the need for further countermeasures. Furthermore, considering the nature of the project the environmental study also includes a contingency plan. It is necessary that the developer/ASL operator institutionalize this plan as part of O&M plan. The developer plans to establish an operational company to run the landfill operation. They will be responsible for the implantation of the mitigation plan, monitoring, and contingency management. Operation needs to run beyond landfilling to take care of leachate, LFG management, and closure activities.

CHAPTER I

1 INTRODUCTION

1.1 Background of the project

Disposal of municipal solid waste (MSW) has become a national issue in Sri Lanka, especially in the Colombo Region and in the other urban centers, due to large quantities of municipal solid wastes generated and lack of sustainable waste disposal options. Piling up of solid waste along roads, people resorting to environmentally unacceptable disposal practices and making of filthy urban environment are the consequence of this situation. Due to overloading conditions, the mediocre waste disposal solutions currently available also fail to meet at least the minimum environmental standards. Finding solutions to municipal solid waste problems has often become difficult due to inability to find socially and environmentally acceptable sites, high cost (both capital and operating) and inconsistent approaches adopted by the local authorities and the politicization of the issue.

Solid waste disposal has become a problem to large majority of local authorities, particularly those having large urban centers. In that sense the local authorities representing urban areas such as municipal councils and urban councils the problem is acute. Particular emphasis can be placed in the case of the Greater Colombo Region. This area comprises of the Colombo Municipal Council (CMC) and other peripheral municipalities and urban councils. The Colombo Municipal Council alone generates nearly 1,000 tons of solid waste daily. Municipal Councils such as DMMC, KUC, SJKMC, and MMC collect around 350- 400 tons per day each. The quantity of waste generated in the Western Province is over 3,200 tons per day.

In terms of disposal, the most common method remains to be the open dumping. Open dumping is a not a well accepted practice considering many social, environmental and public health issues associated with that practice. Few negative aspects associated with the practice of open dumping include contamination of soil and groundwater, spread of vectors and rodents, deterioration of public health, loss of quality of the environment in the disposal area, etc. Still there are only a few sites in the Colombo region, which may be developed as open waste dumps.

For a number of years, the Government of Sri Lanka has been seeking with little success, to identify an environmentally acceptable and economically feasible means of disposal of MSW generated in the Greater Colombo Area. International tenders for sanitary landfill facilities to be developed at Welisara (1996) and Alupotha (1998) have failed. In 2009, private sector proposals for waste disposal were entertained through an open tender but not awarded to any party, mainly

due to non- availability of a suitable land for the proposed landfill anywhere near Colombo. In additions to sanitary landfills, other technologies such as Waste to Energy (W2E), composting were also proposed by private parties from time to time. However, none of these projects materialized. As a result, even 20 years later there is no viable solution to the waste problem in the Colombo Region.

After the collapse of the Meethotamulla garbage hill on 14th April 2017 resulting loss of lives, the government agencies are under enormous pressure to find an environmentally acceptable and sustainable solution to the waste disposal in the Colombo Region. Since this incident, the CMC in particular is confronted with an aggravated situation regarding the disposal of waste. Due to lack of immediate solutions, the CMC had resorted to dumping waste in a site close to Muthurajawela Marsh. While it is not a sustainable long-term solution, it's also challenged in the courts. Long-term availability of this site is doubtful.

In summary, the waste disposal in the greater Colombo area is in crisis at present. Colombo being the capital city the biggest challenge is to the CMC to keep the city clean and healthy. Urgent solution is required for disposal of solid waste in a sustainable manner to avoid; piling up of garbage along roads, improper disposal by local authorities, people disposing waste in haphazard manners, avoid unhealthy and unsightly environment. In the absence of a solution, there can be serious direct and indirect health and socio-economic impacts such as the spread of diseases and threat to industries as tourism.

1.2 Objectives and justification of the proposed project

The objective of this project is to develop a sanitary landfill site at Aruwakkalu in the Puttalam District. A feasibility of this project was carried out some time ago and an EIAR was prepared. However, the proposed project was not approved by the CEA. One of the principle reasons for not approval of the project was that the site selected for the sanitary landfill was in the buffer zone of the Wilpattu National Park. Also the potential environmental impacts to Kala-Oya estuary, which is a wetland declared under the RAMSAR convention were considered significant. Therefore, the key factor, which led to the disapproval of the proposal, was the site selected for the sanitary landfill.

However, the basis for choosing Aruwakkalu for the establishment of sanitary landfill was not negated by the disapproval of the first project proposal by the CEA. In fact, there are a number of large depressions suitable for converting to landfills spread out in the area as a result of limestone mining. Some of these depressions are located far from the Wilpattu National Park and Kala Oya estuary to cause any environmental impact on those. Another positive factor regarding the choice

is the availability of rail transport direct to the site area. Therefore, the revised project with the revised site selection was found to be viable and environmentally not compromising.

Therefore, in 2016, the responsibility of pursuing the proposed project was handed over to the Ministry of Megapolis and Western Development. The Ministry of Megapolis and Western Development has re-commissioned the feasibility study and started looking for alternative sites in the same areas. The proposed project will establish a sanitary landfill at Aruwakkalu, about one kilometer from the Siam City Cement active lime quarry site. The new location as stated above is far from the Wilpattu National Park and to the Kala Oya estuary to cause any environmental impact on those. Furthermore, the location of the transfer station in Colombo is changed to Kelaniya from Meethotamulla. The new selection is better in terms of reducing the transport infrastructure complications. The reason to change the transfer station site is the recent disaster at Meethotamulla. However, the change is positive, as the site is located next to the Colombo Main Rail Line and in-use dumping site.

The proposed project will provide a viable alternative to solid waste disposal in the Greater Colombo area. In particular, it is considered as a solution to waste disposal in Colombo City and Colombo Metropolitan Area (CMR). The project is presented as one of the long-term solution to the solid waste disposal problem faced in Colombo Region among other SWM solutions under consideration at present. The proposed project includes a Sanitary Landfill, Waste Transfer Station in Kelaniya and rail transportation improvements. The Government of Sri Lanka will finance the development, which will be implemented on Design & Build basis. The Consultancy Service was awarded to M/s DOHWA Engineering Co., Ltd of the Republic of Korea.

Although the primary purpose of the proposed landfill is to address the large quantity of waste generated in Greater Colombo, the Government in principal has decided to accommodate the waste generated in Puttalam and Wanathawillu local authority areas if such requests come from the respective local authorities. This approach will provide direct benefits of the project to the local community. **Figure 1.1** shows the Local Authority areas in the Greater Colombo and Metropolitan Region (MCR) who will likely to be benefited by the proposed project.

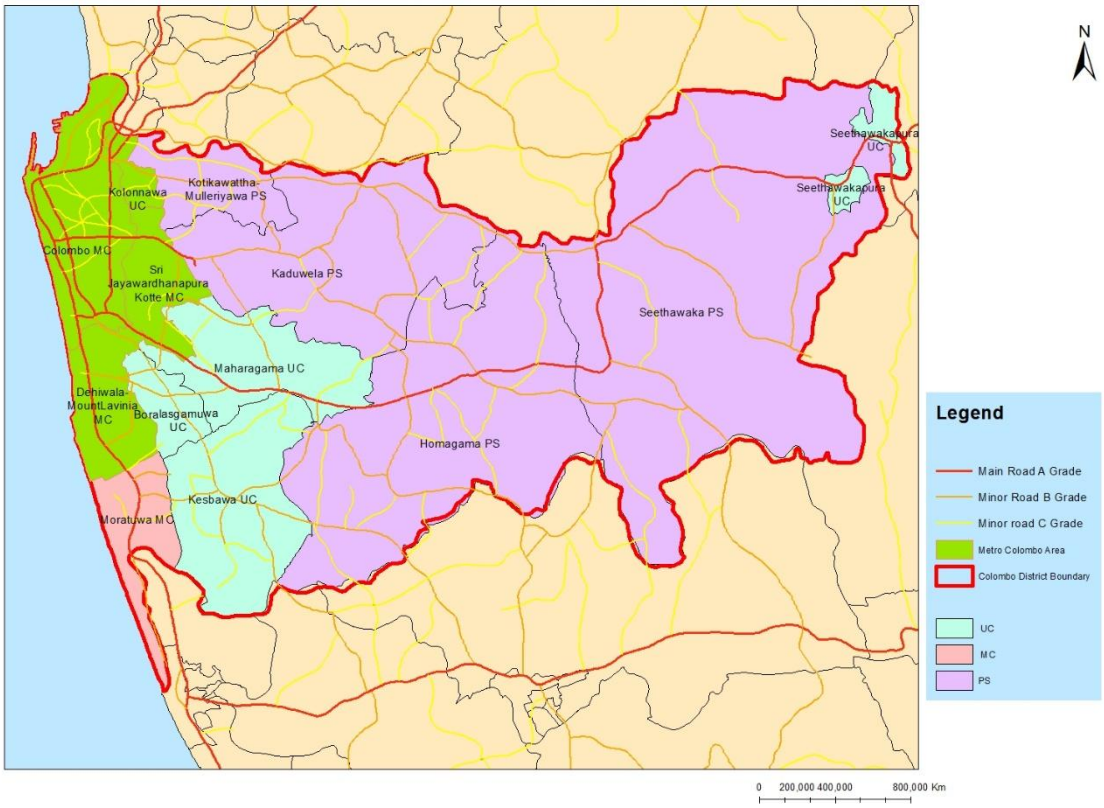


Figure 1.1: Project Area: Metro Colombo Region

According to the National Environmental Act, any project involve in disposal of more than 100 t/day of municipal solid waste, an EIAR/EIAR has to be prepared for the Environmental approval. On the other hand, section 20 of the North Western Province Environmental Statute No 12 of 1990, stipulates conditions prohibiting the discharge, emission or deposit of wastes into the environment.

The proposed project involves in disposal of more 1200 t/day, and an EIAR has to be prepared. In view of the urgency for the project, the GOSL is of the view that an Environmental Impact Assessment (EIA) can be undertaken considering both the national environmental act and the PES of the NWP. The MCSWMP entrusted the task of preparation of EIAR to the EML Consultants (Pvt.) Ltd.

1.3 Objectives of the EIA report

Construction of any solid waste disposal facility having a capacity exceeding 100 tons/day has been prescribed as having to undergo the EIA/IEE procedure. Therefore, this EIAR is required first and foremost to fulfill this legal obligation. The prescribed projects are defined under the Part IV-C of the National Environmental Act No: 47 of 1980 (NEA), amended by Act No. 56 of 1988 and No: 53 of 2000, "Prescribed Projects" (PP). The list of prescribed projects was published under the Gazette Extraordinary No. 772/22 of 24th June 1993 amended by the Gazette Extra Ordinary No. 1104/22 of 05th November 1999, as projects that must undergo the EIA procedure.

In addition to that, the list of projects for which EIA/IEE is required has been stipulated in the Provincial Environmental Statute No. 12 of 1990 as well. This list has been appended to the Extraordinary Gazette Notification dated 27th of March 1998. In terms of the 1st part of the scheduled 1A of the same Gazette Notification IEE/EIA s required for all the projects comes under the afore mentioned part of the Gazette Notification.

Accordingly proposed project becomes a prescribed project as per item 18th, the Solid Waste Disposal facility of the exceeding capacity of 100 tons per day.

The next key objective of the EIA is to provide information and guidance to the decision makers about the environmental consequences that may arise from the implementation of the project. EIAs have gained wide recognition as a useful tool for promoting environmentally sound and sustainable development that helps balance development priorities with Environmental conservation. Therefore, the objectives of the EIA Report are:

- Assist the developer to identify potential environmental and social impacts of the proposed project so that the project design can be modified to accommodate necessary improvements prior to its finalization.
- Assist the regulatory bodies such as the CEA, PEA (NWP) and the Forest Department (FD), Department of Wildlife Conservation ((DWC) to assess potential impacts prior to granting of approval and seek modifications accordingly.
- Enable the public to peruse the project details and report their concerns arising from the project implementation.
- To avoid and remedy the potential environmental and social problems during construction, operation and close out phases of the project

1.4 Brief outline of methodologies and technologies adopted in EIAR preparation

The Terms of Reference (ToR) provided by the Central Environmental Authority (CEA) and the Provincial Environmental Authority of the NWP had been used as the framework for the study and to demarcate the scope of the EIA. The ToRs provided by those two statutory institutions are attached. **Annex 1.1**. Geographic coverage of the study confirms with the ToR requirements of 500 m radius from the boundary of any project site i.e. Aruwakkalu Sanitary Landfill (ASL) and Kelaniya Transfer Station (KTS).

The DOHWA Consultants of South Korea prepared the feasibility report and conceptual designs. Their report was used to explain the project. In describing the project, the EIAR has covered the full process from the point of receiving solid waste at the transfer station to the disposal at the Aruwakkalu sanitary landfill. Information on **biotic and abiotic** components of the existing environment were collected through field visits, field investigations, field surveys, discussions with SIAM City Cement officials and other relevant stakeholders, consultations with informed people, and through literature review. The baseline socio economic information was collected as secondary information and through stakeholder consultation. Consultations included discussions with a very limited number of community members living close proximity to the KTS site and in the Karathivu village in the case of ASL site. However, in both sites, the Grama Niladharis were consulted to obtain information on socioeconomic standing and issues of their respective areas.

There are many examples of EIA/IEER studies for MSW disposal using sanitary landfills. These studies provide valuable information on environmental impacts of landfill projects. These studies/reports were used as a guide for impact identification and determination of their significance and formulation of mitigation measures. However, the consultants used brainstorming (Delphi Method) as a technique to advance the impact identification and selection of mitigation measures so that the issues more important and specific to this project are fully covered.

1.5 Compatibility with other projects/ programmes / plans / developments in the area

Recently the Cabinet of Ministers approved a list of long-term projects and plans to address/manage the solid waste issue. One group of such projects is Waste to Energy (W2E) i.e. to generate electricity from municipal solid wastes. The W2E projects, if come into operation will leave ash (bottom ash and fly ash) for disposal. Ash generated from the three currently proposed W2E projects will be nearly 450 tons per day. Disposal of ash will require a sanitary landfill until

such time ash will be used productively. Therefore, the proposed project is compatible and a necessity for those projects in the pipeline.

The GoSL has undertaken the Western Region Megapolis Planning Project as its major development initiative towards the economic development of the country. Such major infrastructure development and improvement project will result, significant demographic and lifestyle changes (associated with improved economic situations) which will result increase in waste quantities. Therefore, the proposed project is important as a reliable alternative for disposal of MSW generated within the Western Region.

As per the Environmental Protection Licence (EPL) issued by Provincial Environmental Authority to the SIAM City Cement, the company is responsible for restoring the forest cover in the excavated mine sites. At present, the company is painstakingly restoring the forest cover to go in line with natural forest in the area. However, restored area is of the landform after the mining (excavation) and not the original form (depression). On the other hand, the use of the mine site as landfill allows recovering the land from significantly back to its original form. However, the forest cover already gained since the commencement of reforestation will be lost in the process. Reforestation can start only after the landfilling is completed.

The Department of Railways (DR) has a plan to improve the Colombo suburban railway by electrification of lines, which initially focuses on 64 km on Veyangoda / Panadura line. Phase (II) of the railway improvement project has also been pledged with investment funds. Department of Railway plans to improve revenue with the proposed improvements to the railway infrastructure. The proposed project is compatible with the DR plans to improve its earning due to the payments to DR for the use of rail as the mode of waste transport.

The proposed project will eliminate haphazard open waste dumping at the adjoining site by Kelaniya Pradeshiya Sabah (KPS) as the waste generated within the KPS will be handled through the new project. On the other hand, the Sri Lanka Land Reclamation and Development Corporation (SLLRDC) has an ongoing program to protect the low lying areas in Kelaniya. One of the proposed projects in this regard is the rehabilitation of Wedamulla Lake and canals, which are connected to the marshland, selected for the KTS. The effectiveness of the improvement of drainage system will be enhanced by the proposed project. Therefore, the project is compatible with the planned drainage system improvement work by the SLLRDC.

1.6 Policy, legal and administrative framework with reference to the project

1.6.1 National Strategy for Solid Waste Management (SWM)

In May 2000, the Parliament of Sri Lanka passed the National Strategy for Solid Waste Management. This recognized the need to manage Solid Waste from generation to final disposal through a broad range of strategies targeting waste minimization at first, i.e. the 3Rs (reduction, reuse and recycling), and appropriate final disposal. Besides advocating responses by individual urban LAs, the strategy provided for central level actions, such as developing market conditions for the sale of recyclable waste and of the products made from recyclable materials. Enactment of a statutory obligation for waste treatment by MC, UC, and PS, by their statutes, each provincial authority shall be responsible for managing its own waste material without causing any inconvenience to respective residents.

1.6.2 National Policy on Solid Waste Management (2007)

The policies, strategies and legal provisions for SWM currently in place in Sri Lanka provides the necessary basis for action leading to effective and sustainable improvement in the sector. The NEA No 47 of 1980 provides the enabling legislation for the regulation and control of SWM activities. The National Strategy for Solid Waste Management provides guidance for tackling the problem on several different fronts. The National Agenda for Sustainable Development addresses broader policy and guidance issues relating to Environmental improvement and economic development and a number of regulations and directives that set out standards and appropriate provisions for different aspects of SWM.

1.6.3 Hazardous Waste Management

Sri Lanka is a signatory of the Basel Convention on the trans-boundary movement of the hazardous waste. As per the obligations of the convention, all signatory countries should develop and implement necessary legal provisions to ensure proper management of hazardous waste in their respective countries. Considering the requirement of the obligations of the Basel Conventions, the National Regulations for the management of hazardous waste was published in 1996. This regulation covers storage, collection, transportation, recycle, recovery and disposal of hazardous waste.

The hazardous waste regulation was amended in 2008 accommodating a list of waste to be considered as hazardous waste. This is called scheduled waste. According to the National Environmental (Protection) Regulations, No: 1 of 2008, no person shall generate, collect, transport, store, recover, recycle or dispose waste or establish any site or facility for the disposal of any waste specified in the Schedule VIII (herein after referred to as “scheduled waste”) except under the

authority of a license issued by the Authority and in accordance with such standards and other criteria as may be specified by the Authority.

1.6.4 Legal Framework

By the 13th amendment to the constitution of the GOSL, a law came into effect in 1987 by which, the authority for waste management was transferred from the central government to provincial administrations. The 42nd Law of 1987 stipulates provincial responsibility for waste management. The NEA was promulgated as the 47th law in 1980 and amended as the 56th law in 1988. Clause 12 of the NEA allows the CEA to give necessary instructions and guidelines to provincial authorities.

The responsibility for waste control and management in the provinces was included in the ordinance pursuant to the 15th law (1987). It empowers provincial authorities to enact regulations regarding industrial waste control and take punitive measures against violators. Relevant laws and regulations are now fully established both by the central and provincial authorities as listed below:

- The National Environment Act
- Provincial Councils Act
- Local Government Ordinances
- Hazardous Waste Regulations
- Provincial Environmental Statute

Under the provisions of the 13th Amendment, 'protection of the environment' comes under the concurrent list of powers which fall under the purview of both the provincial councils and the government. Thus the Provincial councils too have a mandate to protect and manage environment of Sri Lanka

1.6.4.1 The National Environmental Act No 47 of 1980 (NEA)

NEA No 47 of 1980 was promulgated to protect and manage the environment of Sri Lanka. The NEA was amended by Act No. 56 of 1988 to include a provision relating to Environmental Impact Assessment (EIA) contained in Part IV C of the statute entitled "Approval of Projects". Part IV C of NEA was amended by Act No: 53 of 2000.

The National Environmental Act has identified two types of approval procedures in the EIA processes based on the magnitude and significance of Environmental impacts. The type I – i.e. the Initial Environmental Examination (IEE) is a report where comparatively less impacts are considered and the second type is the Environmental Impact Assessment (EIA) Report is a more comprehensive document whereby alternatives to the proposed project are considered and the option with the least impact on the environment identified and assessed. Mitigation measures for the impacts identified as significant is part of an EIA report.

Under the provisions of Section 23Z of the NEA the EIA (Environmental Impact Assessment) applies only to "Prescribed Projects" which have been specified in Gazette Extraordinary No 772/22 of 24.06.1993 and implemented through designated Project Approving Agencies (PPA).

Environmental Standards

According to the section 23A (2) of the National Environmental Act, no person shall carry on any prescribed activity except-

(a) under the authority of a license issued by the Authority; and

(b) in accordance with such standards and other criteria as may be prescribed under this Act.

In this regard necessary standards are specified in the Section 23 C of the NEA and the relevant regulations. The Environmental standards are already gazette in respect of:

- Water Quality
- Atmospheric Emissions; (Ambient air quality standards and stationery sources
- Noise

1.6.4.2 Provincial Environmental Statute No 12 of 1990 of the NWP

Northwestern Province Environmental Statute No. 12 of 1990 which came into operation with effect of 1st July 1993, implemented through the office of the North Western Provincial Council has jurisdiction over the projects to be approved by the North Western Province Environmental Authority. Section 20 of the statute provides relevant conditions for the disposal of wastes and section 42 and 44 of the statute provides for prescribed projects and submission of EIA for the prescribed projects. According to the statute, this project requires environmental approval from the PEA.

1.6.4.3 Enactment of a statutory obligation for waste treatment by MC, UC, and PS

Legal provisions relating to collection and disposal of solid waste are established by Municipal Councils Ordinance (No. 16 of 1947), Urban Councils Ordinance (No. 61 of 1939) and Pradeshiya Sabhas Act. (No. 15 of 1987).

Local authorities are primarily responsible for collection and disposal of waste in their areas of administration. Therefore, basic legal provisions relating to collection and disposal of solid waste are established by Municipal Councils Ordinance (No. 16 of 1947), Urban Councils Ordinance (No. 61 of 1939) and Pradeshiya Sabhas Act. (No. 15 of 1987). By their statutes, each provincial authority shall be responsible for managing its own waste material without causing any inconvenience to respective residents.

1.6.5 Review of Proposed Project in terms of National Strategy, Policy and Legal; Framework

The proposed project does not interfere the national strategy, policies and legal framework as applicable to solid waste management. The government strategy and policies encourage a 3R approach. In fact, waste reduction and segregation (particularly at the source level) through the local authorities envisaged by the government as the promoter of the project to extend the life of the landfill. These objectives can be achieved through other parallel programs. The proposed project is not the only solid waste management option considered by the government at present with regard to waste disposal and but as an essential component of the integrated solution to SWM. In that sense, while it can be a solution to the disposal of solid waste, it can also accommodate products (or waste) of waste to energy plants, composting plants, etc.

The government strategy and policy while giving significant responsibility to the local level on waste management also recognized the importance of the centralized action. The proposed project is coming in line with that strategy. It is clear that individual local authorities are not I a position (technically and financially) to implement large-scale waste disposal systems. Therefore the central government has stepped in to create such facility which can be shared or used by the participating LAs to address their waste disposal problem.

The proposed sanitary landfill will receive only municipal solid waste. It will not accept any other type of waste. Therefore the proposed project plan is in line with the government policies and practice regarding hazardous waste.

1.7 Approvals needed for the project from other state agencies and any conditions laid down by Governments agencies for implementation of the project.

1.7.1 Central Environmental Authority

Section 23AA (1) Under Part IV C (Approval of Projects) of the NEA stipulates that all prescribed projects that are being undertaken in Sri Lanka by any Government department, corporation, statutory board, local authority, company, firm or an individual, require to obtain approval under this Act. According to the NEA and its amendments, construction of any solid waste disposal facility with a processing capacity exceeding 100 tons per day must undergo the EIA/IEER procedure. Since the proposed project will process 1200 tons of MSW per day, it must follow the EIA/IEER process and the approval of the CEA has to be obtained prior to implementation.

1.7.2 North Western Province – Provincial Environmental Authority

Provincial Environmental protection and management was introduced by the 13th amendment to the constitution in November 1987, in Sri Lanka. So far, only the North Western Provincial Council (NWPC) has enacted legislation on Environmental protection. The National Environmental Act is inoperative within the North Western Province with effect from 10th January 1991. Instead, it is the environmental protection regulations of the North Western Provincial Environmental statute (NWPES) that is applicable in the province. Therefore, environmental clearance from the (NWPES) will be required for the construction, and operation of the landfill and its related activities.

1.7.3 Fauna and Flora Protection Ordinance

Under Act No. 49 of 1993, sections 9 (a) any development activities within a distance of one mile of the boundary of any National Reserve declared under this Act has to obtain prior written approval from the Director, DWLC.

1.7.4 Forest Ordinance

The Forest Ordinance of Sri Lanka (No. 17 of 1907 and subsequent amendments) is the law of conservation, protection, and management of forest and forest resources for the control of felling and transporting of timber and forest related matters. Any activities that fall under the conservation

areas declared under this Act should obtain written approval from the Conservator General of Forests.

1.7.5 Approval of Archeological Department

The areas where the two sites are located have not been identified as areas of archeological importance. There for there will not be a necessity to obtain approval from the archeological department. However, it is recommended to inform the department of the proposed development so that the department can make a determination whether an archeological impact assessment is necessary.

1.7.6 Urban Development Authority

The Urban Development Authority (UDA) was established under Act No. 41 of 1978 to promote integrated planning and implementation of economic, social, and physical development of areas declared under the act by the Minister in-charge of the subject. The proposed land for the KTS is owned by the UDA is in a declared area under the UDA act. Therefore, it is necessary to obtain approval from the UDA for the project.

1.7.7 Approval from the SLLRDC

Since KTS will be built on land within the administrative purview of SLRDC with regard to flood protection and flood control work. Therefore, it is necessary to obtain approval from the SLRDC for any development in the KTS site.

1.7.8 Relevant Local Authority's approval

It is necessary obtain approval from Local Authorities with regard to any development within their jurisdictions. These approvals include building permit, which verifies the conformity with building line and street lines. The KTS comes under the purview of the Kelaniya Pradeshya Sabah (PS). ASL is coming under the Wanathavilluwa PS. Approval from these two LAs are required for the development.

The proposed is developed mainly to address the solid waste issue in Local Authorities in the CMR. These are CMC, SJKMC, DMMC and KUC. However, the other LAs in the Greater Colombo Area are also likely to provide their waste to the ASL. In addition, it was decided to

accept solid waste from LAs in Puttalam District particularly the Puttalam UC and Wanathavillu PS. The delivery of solid waste to the KTS or ASL sites is the responsibility of respective Local Authorities. Furthermore, there will be certain guidelines applicable to the delivery of waste which the LAs must follow. Therefore, agreements between the participating LAs and the project developer are required.

1.7.9 Divisional Secretariats

The project area comes under the purview of the Kelaniya Divisional Secretariat Division (KDSD) in the Colombo District and Wanathavilluwa Divisional Secretariat in Puttalam District. A No objection letter from the Divisional Secretariats shall be obtained.

1.7.10 Other approvals to be obtained

- National Water Supply and Drainage Board/ Water Resource Board
- Department of Railways
- Ministry of Industries

CHAPTER II

2 DESCRIPTION OF THE PROJECT

2.1 Description of the Project

The proposed project will build a 1200 ton/day capacity semi-aerobic sanitary landfill in a 47 ha site at Aruwakkalu (in Puttalam) for the disposal of municipal solid waste mainly coming from the MCR but not limiting to the MCR. In fact, the proposed landfill will accept waste from the LAs in the Puttalam District as a means of proving project benefits to the area. Waste will be collected at Kelaniya and transfer station will be built there. Transportation of waste to Aruwakkalu will be by train. Any waste from Puttalam will be delivered to the ASL site by compactor trucks.

There are several types of landfills. In this case, semi-aerobic landfilling method was selected. After a careful review of different types of waste landfilling methods, the selection of semi-aerobic method is based on following factors.

- Accelerated stabilization of waste is achieved compared to anaerobic methods
- Better quality leachate characteristics is achievable thereby reducing the leachate treatment cost
- Generation of hazardous gases is less compared to anaerobic method
- Not so expensive compared to aerobic landfill method where forced aeration is necessary to keep the fill aerobic
- Possible to construct LFG utilization facility after landfill close
- The potential environmental risks are reduced
- Comparatively easy and less costly to maintain and close the fill

2.1.1 Project Sites (Landfill site and Transfer Stations)

The proposed project will have activities in two locations: Kelaniya and Aruwakkalu. At Kelaniya the Kelaniya Transfer Station (KTS) will be built. The waste will be received at this location before loading and transferring to Aruwakkalu Sanitary Landfill. At Aruwakkalu the project activities are located at two sites. These are the Aruwakkalu Transfer Station (ATS) and Aruwakkalu Sanitary Landfill (ASL). These two sites are very closely located.

2.1.1.1 Transfer Stations

The details of authorities having administrative powers of the respective sites are provided below.

(a) Kelaniya Transfer Station

GN Division:	Wanawasala
Pradeshiya Sabah:	Kelaniya
Divisional Secretariat:	Kelaniya
District Secretariat:	Gampaha

(b) Aruwakkalu Transfer Station

GN Division:	Serakkuliya
Pradeshiya Sabah:	Wanathavilluwa
Divisional Secretariat:	Wanathavilluwa
District Secretariat:	Puttalam

(c) Aruwakkalu Sanitary Landfill

GN Division:	Serakkuliya
Pradeshiya Sabah:	Wanathavilluwa
Divisional Secretariat:	Wanathavilluwa
District Secretariat:	Puttalam

2.1.1.2 Extent of the Project Sites

a) **Kelaniya Transfer Station:** The extent of Kelaniya Transfer Station is 18 hectares approximately.

b) **Aruwakkalu Transfer Station:** The extent of this transfer station site is 1.3 hectares approximately.

c) **Aruwakkalu Landfill Site:** The extent of the proposed ASL is 47 hectares. This is an abandoned limestone quarry located almost 30 kilometer northwards of the Puttalam town. The site area forms roughly a rectangular/elliptical shape with rough dimensions of 700 m (East to West) and 670 m (North to South).

2.1.1.3 Survey Plans of the Project Sites

a) **Kelaniya Transfer Station:** Survey map of the Kelaniya Transfer Station is provided in **Annex 2-1**.

b) Aruwakkalu Sanitary Landfill: Survey map of the Aruwakkalu Landfill site is provided in **Annex 2-2.**

2.1.1.4 Ownership of the Project Sites

a) **Kelaniya Transfer Station:** The KTS site is owned by the SLLRDC

b) **Aruwakkalu Transfer Station:** The ATS site is government owned land leased to the Siam City Cement Company.

c) **Aruwakkalu Landfill Site:** Same as for the ATS

2.1.1.5 Location Maps of Project Sites

As explained above, the project activities are located at two places, namely at Kelaniya and Aruwakkalu. The transportation of waste from the KTS to ASL is by rail. At Aruwakkalu a Transfer Station and the Landfill are located. This section offers descriptions of site locations together with the details of the surrounding environment, developments and infrastructure. It also offers details about the rail transport system.

(a) Kelaniya Transfer Station

The KTS is located next to Colombo Railway Main Line and near the Colombo-Kandy Highway as well as the bypass road connecting the Colombo Puttalam Road with the Colombo-Kandy Highway. It is next to the currently operating dumping site by the Kelaniya Pradeshya Sabah which is called Kelaniya Dumping Site. Location of the site is shown in **Figure 2.1**. (See **Annex 2.3** for large-scale map).

The total area available for the project at the site is about 18 hectares, which includes the existing dumping site. However, the KTS development is restrained to just about 10 hectares excluding the existing dumping site and all encroachments including houses. By way of this approach the propose project will avoid inconvenient for people who are already settled in the area. This includes people living in unauthorized settlements such as railway reservations. The area covered by the KTS is shown in **Figure 2.2.**

The proposed site is a wetland having several waterways linked to each other forming a network. Mudun Ela is located in the site area and it is an important drainage canal. To avoid the loss of the water retention capacity of this wetland and interference with drainage of the waters, all the buildings and other infrastructure such as access roads, parking areas at KTS will be built on a platform(s) built on pile foundations. Design will be carried out so that the platform area will be limited only as essential to allow penetration of sun light to wider as possible area of the wetland.

The road access to the proposed site is through Manelgama Road, which is turning off road from the Colombo-Kandy Highway. This is narrow road where the road width is 6 meters. Manelgama Road links with the Jambuwatta Road that leads to Wanawasala Junction where Wanawasala Railway Station is located. From there access is available to Wanawasala-Waragoda roads under passes the Colombo-Kandy Highway again at the vicinity of the site. Jamubuwatta Road is also a narrow 6 meter wide road. Wanawasala-Waragoda road is a wider two-lane road. However, it is a busy road with traffic. It is proposed to develop a new access road to the site from the Colombo-Kandy highway near the underpass of Waragoda-Wanawasala Road. Manelgama road is proposed as the exit road for empty compactor trucks. Road network in the area is shown in **Figure 2.1** and new access exit road arrangement is in **Figure 2.2**.

The railway of the Colombo Railway Main Line is located to the left of the proposed site. In fact, this is one of the biggest advantages of this site. The closest railway station is Wanawasala. The selected site will allow direct access to the waste carrying trains to the mainline and the trains bringing empty containers to the KTS for loading.

Away from the marsh, the area is extensively developed with residential, commercial, and industrial properties. As stated, there are several illegal settlements around the site. Those will not be disturbed by the proposed development. **Figure 2.3 to 2.7** includes several photographs depicting the views of the site, surrounding area, existing dumping site, etc.

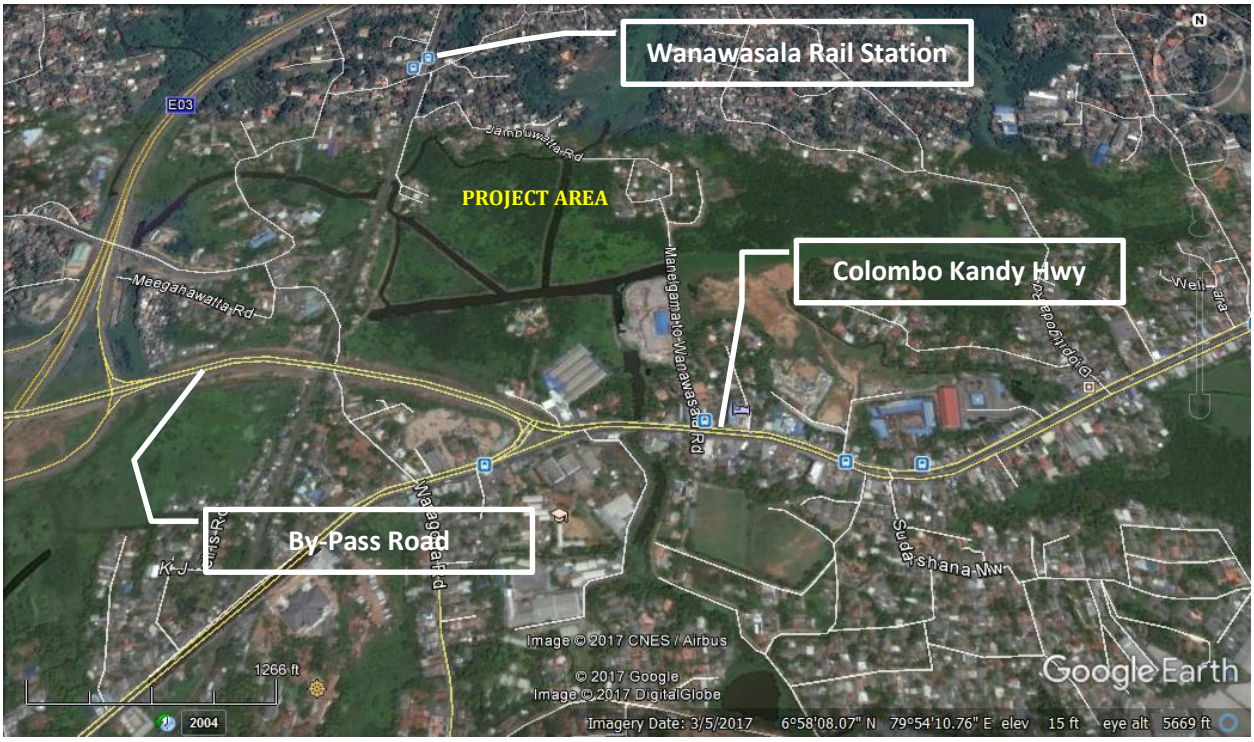


Figure 2.1: Project Area

Figure 2.2: Area Covered by the Kelaniya Transfer Site Area

Figure 2.3: Existing Waste Dump of Kelaniya Pradeshya Sabah

Figure 2.4: Waragoda-Wanawasala and Manelgama Roads

Figure 2.5: Waterways within the Site Area

Figure 2.6: View of the Mail Railway next to the Site

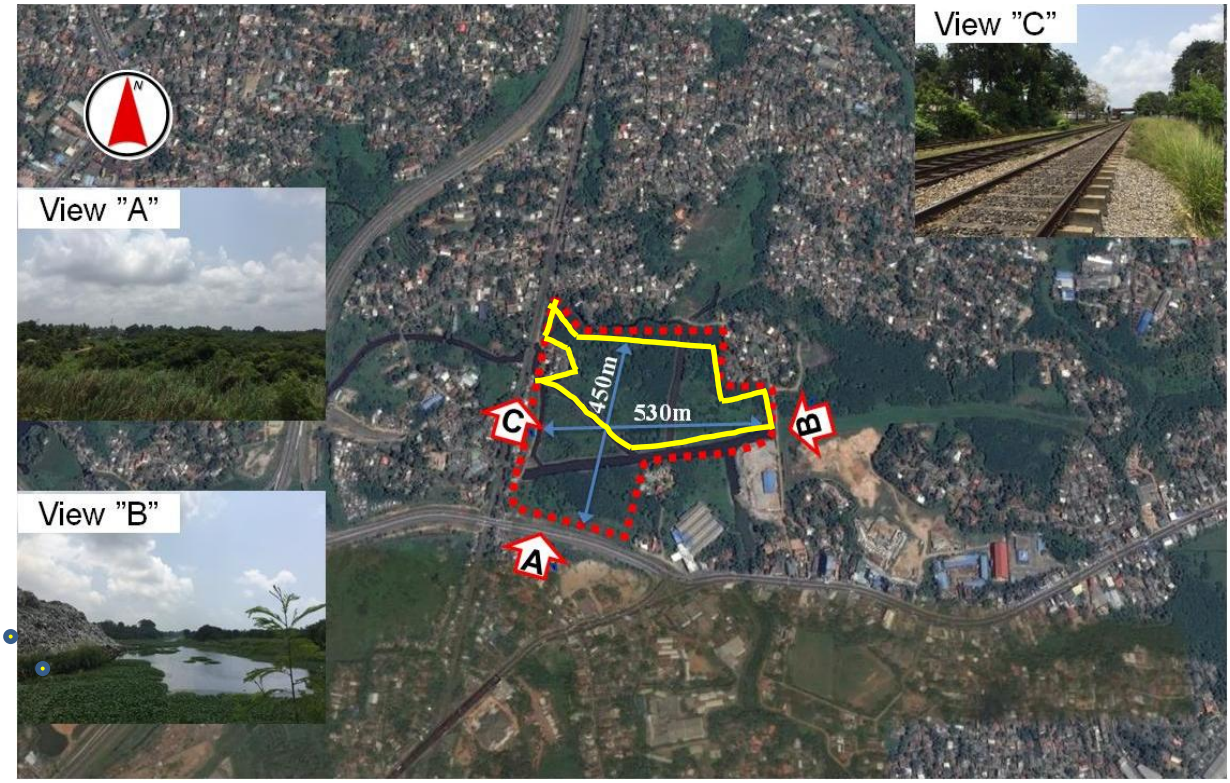


Figure 2.7: Map Showing the Surrounding Developments around KTS

(b) Aruwakkalu Transfer Station

The Aruwakkalu Transfer Station (ATS) is where the waste transported from KTS will be unloaded to be conveyed to the landfill. The proposed location of Transfer Station (ATS) is located near Siam City Cement (which is the successor to Holcim Cement) railhead facility shown in **Figure 2.8**.

Considering the operational requirements of Siam City Cement and the proposed project, it was decided to develop a separate railhead under the proposed project for the ATS. This will be

established by having a separate line branching off from the line to the Siam City Cement loading facility as shown in **Figure 2.9**.

The area identified for ATS is relatively flat land with mild undulations. There is no proper road access to the area presently. Power supply is not available to the site. Presently the area is covered by vegetation typical to the project area (see Chapter 3 for baseline environmental description). **Figure 2.10** includes photographs depicting the outlook of the site and surrounding area.

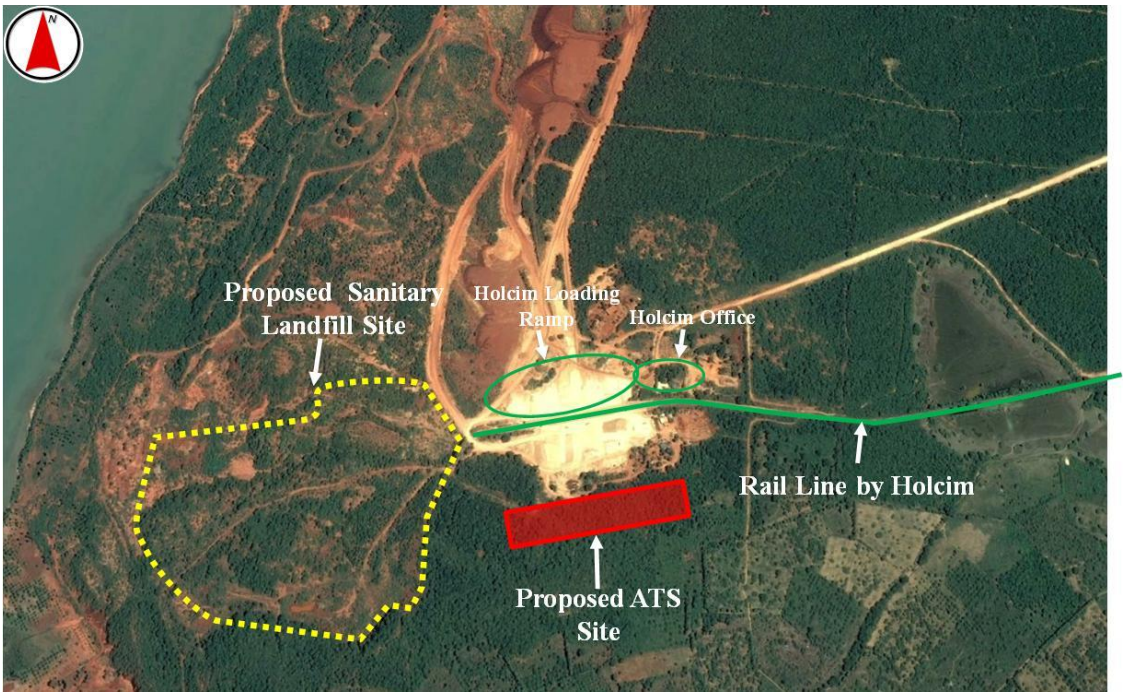


Figure 2.8: Location of Aruwakkalu Transfer Station

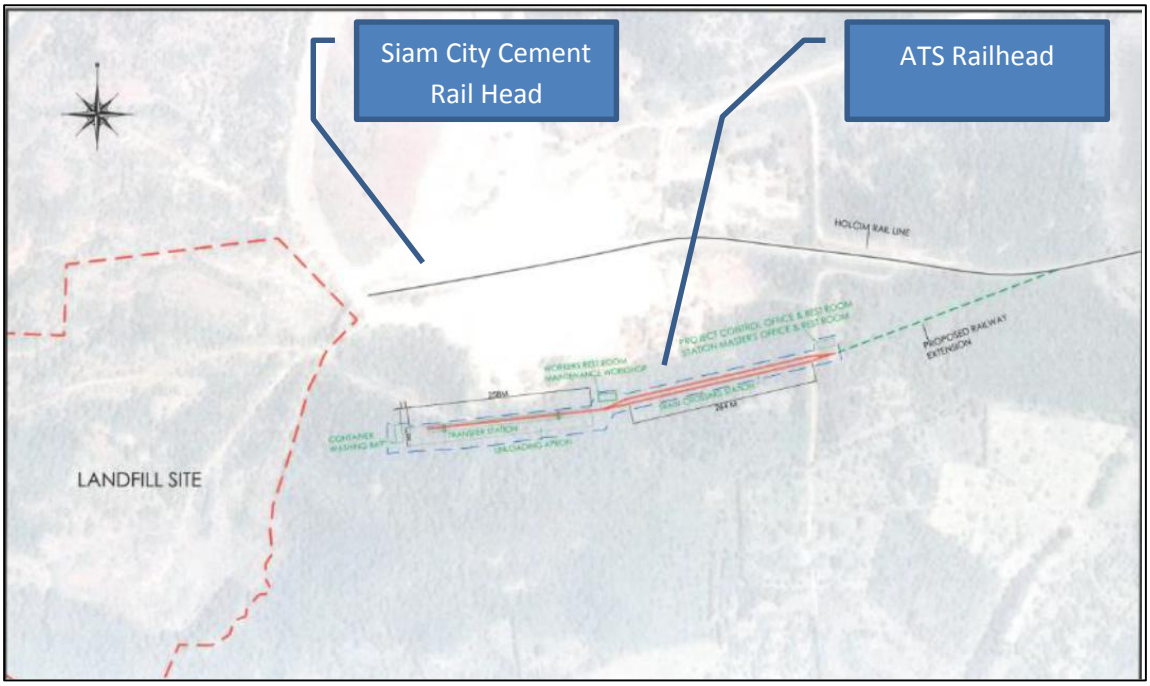


Figure 2.9: Relative Locations of Railhead of Siam City Loading Point and ATS

Figure 2.10: Photographs Illustrating Features of the Site and Surroundings of ATS

(c) Aruwakkalu Sanitary Landfill

The proposed Sanitary Landfill site is situated in the Puttalam District of North Western Province. The site lies west of the office area of the Siam Cement Company and west of the Dutch Bay as indicated in **Figure 2.11**. Extent of the land is 47 has.

The project site is a manmade crater created by excavation for limestone and abandoned over 20 years ago. The quarry operator is now continuing their limestone quarrying business in the northern area of the proposed landfill site (**Figure 2.11**). The project site has forest vegetation formed by reforestation program implemented by the cement company to meet their environmental

obligations. In general, the surrounding area is also having forest vegetation except of the areas that were cleared for roads, etc. **Annex2.4** provides map of the landfill site. **Figure 2.13** includes several photographs depicting the outlook of the site and surrounding area.

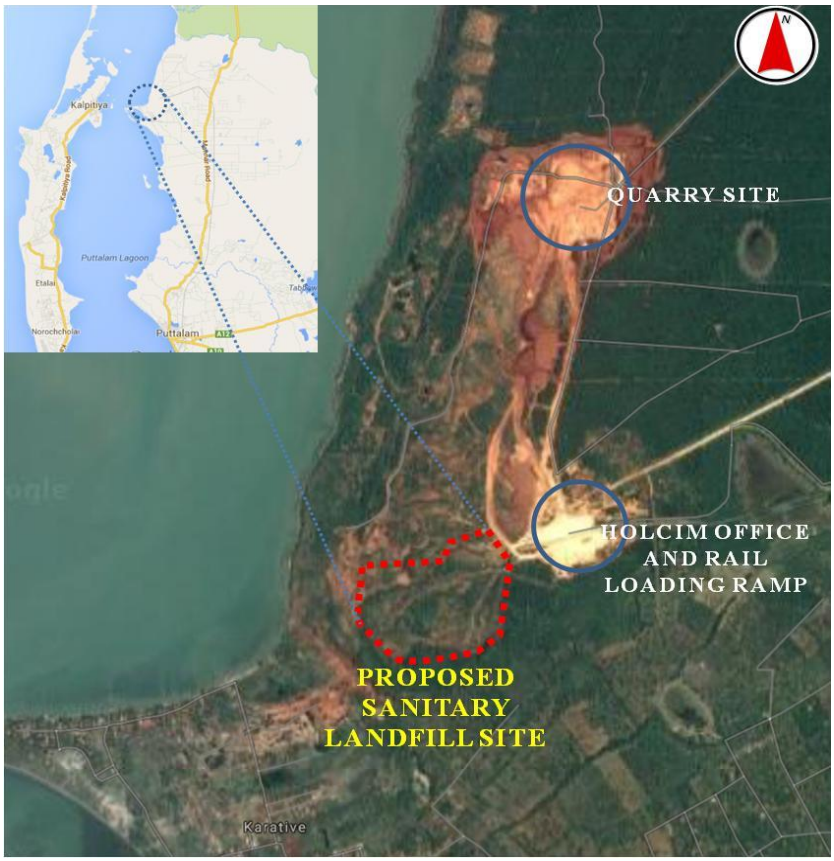


Figure 2.11: Location of Aruwakkalu Landfill Site

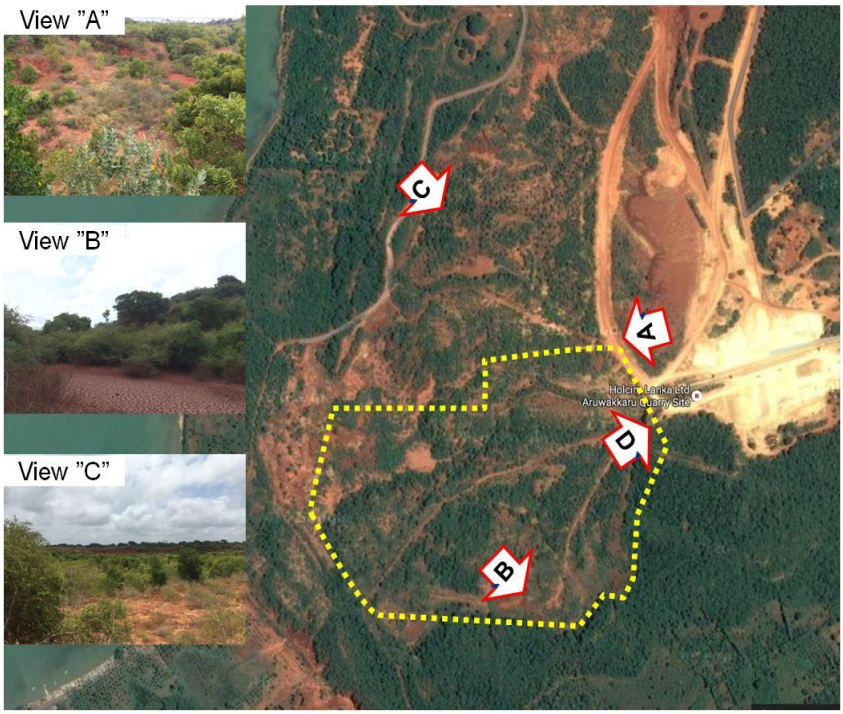


Figure 2.12: Aruwakkalu Landfill Site Map

Figure 2.13: View of Sanitary Landfill Site, Site Roads and Soil

The proposed site is selected for landfilling (sanitary landfill) after careful consideration all the key factors. These include:

- Availability of waste
- Available area
- Surrounding environment / conditions
- Topography and geological conditions
- Transport infrastructure and access
- Post closure land-use plan

As explained earlier, the proposed landfill is designed with the purpose of offering a viable disposal option for municipal solid waste in the Colombo region in particular the CMR. From the point of view of the distance, the waste disposal site is very far from the waste generation region. However, given the fact that non-availability of lands appropriate in terms of societal and environmental acceptance, adequate size, life span, and economics, and so on, around the waste

generation region, Aruwakkalu is very much a coherent choice. ASL site is situated far from human habitats, already having more agreeable landform due to being abandoned quarry. Area has adequate land for the supporting facilities such as the administrative buildings, leachate treatment ponds, access roads, perimeter drains, fencing etc. Demand for land is low and land is available free from encumbrances. Additional area is available for the buffer zones (green belt). Since there are more abandoned quarry sites future expansion is possible. There are other advantages of the chosen area for the landfill as given below.

- There no populated areas and surrounding development, such as housing/residential, institutional commercial, etc., near to the site
- Site is not close to any rivers, watercourses, lakes, ponds, water intakes, etc.
- Site is not in an area where ground water is in demand or extensively used
- Availability of basic utilities such as electric power supply, water supply, telephone
- Meteorological conditions of the area allows untroubled operation at least nine months of the year
- Availability of soil to provide soil for landfill cover
- Areas is not prone to flooding and land slides
- Availability of train service from the KTS to the site making bulk transport of waste possible

The proposed project plan also considered the negatives sides of the choice of the site and has responded appropriately through planning and design to address those such as outlined below.

- High and intense rainfall during rainy period of North-East monsoon. Presently the area gets completely muddy and as explained by informed people would be difficult for vehicular movement (slippery and could get stuck). The ATS and access to the ASL will be provided with internal road network and parking areas that can provide all weather operating conditions

- The site identified for ASL is a depressed area, which is currently acting as storage for surface runoff for upstream catchment by partially converting it to a pond during the rainy period. Stormwater Management Plan will be developed to cut off the inflow of run off to the landfill site. The stromwater management plan will directly benefits the project by controlling the leachate quantity.

- Proposed development will remove the forest cover, which was a result of an arduous reforestation work by the Cement Company. Reforestation is included in the landfill closure plan.

2.1.1.6 Railway Transport Existing Track

The existing railway network will be used to transport solid waste from KTS to ATS. From the unloading facility at ATS the waste will be hauled to the landfill by trucks. The existing railway system from Colombo to Aruwakkalu is 170 kilometers long. **Figure 2.14** depicts the trace of the Railway Line from KTS to Aruwakkalu.

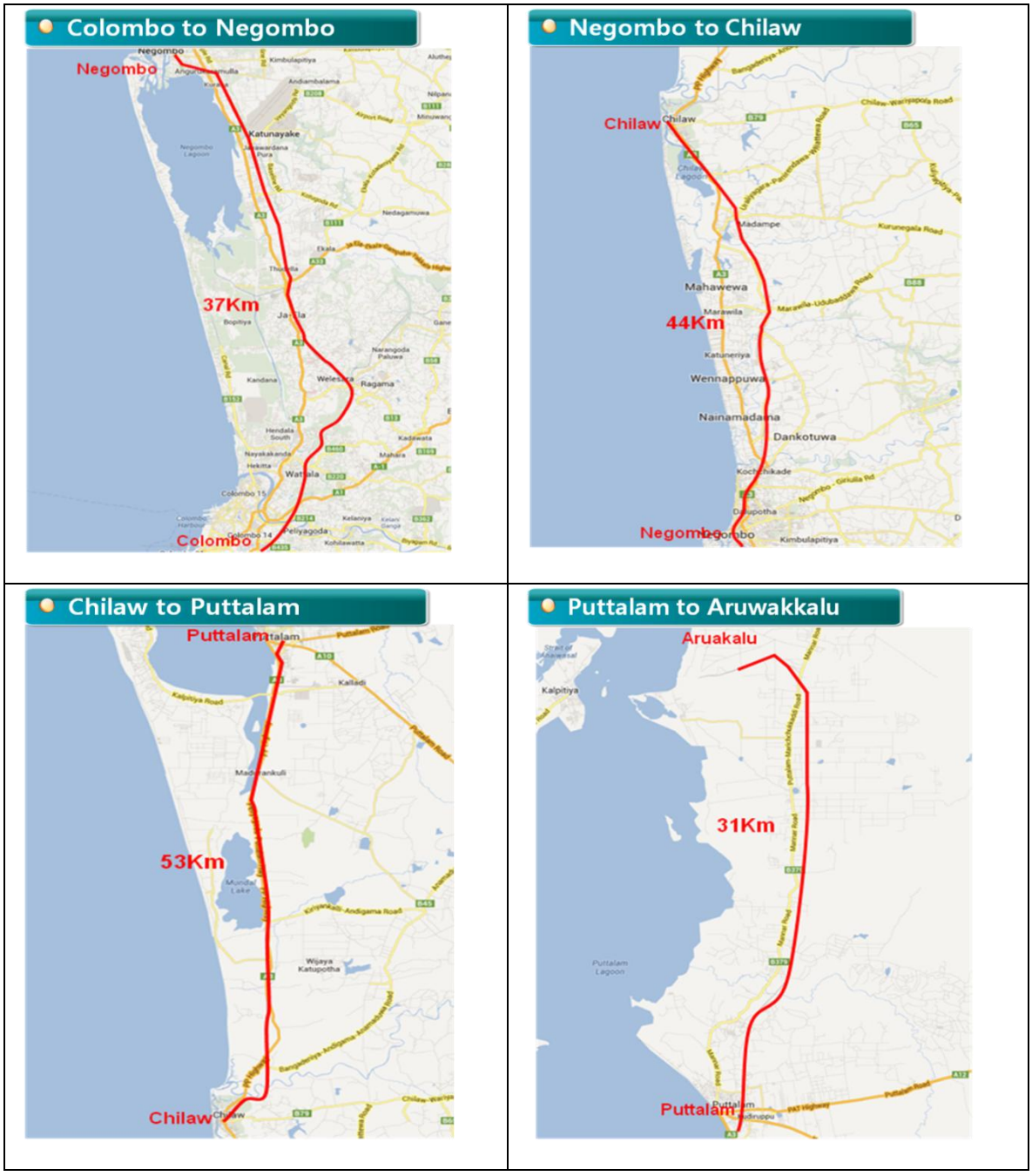


Figure 2.14: Railway Track from Colombo to Aruwakkalu

The total rail track from KTS to Aruwakkalu can be divided into the following segments.

a) **KTS to Ragama** – This is part of the Main Rail Line from Colombo leading to North (Jaffna, Kankesanthurai). On this track the trains travelling to Kandy, Badulla (Up Country Line), Puttalam, Mannar, Trincomalee, Batticoloa also travel. It is the busiest railway segment in the country. At Ragama junction line divides as Main Line and Puttalam Line. The KTS is located in between Kelaniya and Wanawasala stations. Approximately 90 trains pass this section Up and down daily during week days. Between Total length of this segment is nine (09) kms. Between Kelaniya and Ragama there are four (04) stations. Rail line is double tracked up to Ja-Ela.

b) **Ragama to Negombo** – This section of the Puttalam Line is single track. Length of the section is 23 kms. There are nine (09) railway stations in between Ragama and Negombo station (excluding the two stations at BOI Investment Promotion Zone and Colombo Airport, Katnayake). Around 30 passengers and mixed trains operated by the Sri Lanka Railways ply this section daily in both directions.

c) **Negombo to Chilaw** – This section of the Puttalam Line is single track. Length of the section is 44 kms. There are 10 railway stations in between Negombo and Chilaw stations. Around 24 passengers and mixed trains operated by the Sri Lanka Railways ply this section in both directions daily.

d) **Chilaw to Palavi** – This section of the Puttalam Line is single track. Length of the section is 48 kms. There are two (02) railway stations in between Negombo and Chilaw stations. Approximately eight (08) passenger and mixed trains operated by the Sri Lanka Railways ply this section daily in both directions.

e) **Palavi to Puttalam** – This section of the Puttalam Line is single track. Length of the section is 5 kms. There are no railway stations in between Palavi and Puttalam stations. Approximately eight (08) passenger and mixed trains operated by the Sri Lanka Railways ply this section daily in both directions. In addition, approximately 14 to 16 trains operated by Siam City Cement pass through this section in both directions. They carry limestone from Aruwakkalu to Cement Factory in Puttalam and then return to Aruwakkalu.

f) **Puttalam to Noornagar** – This section of the Puttalam Line is single track. Length of the section is 9 kms. There are no railway stations in between Puttalam and Noornagar stations. Approximately eight (04) passenger and mixed trains operated by the Sri Lanka Railways ply this section daily in both directions. In addition, approximately 14 to 16 trains operated by Siam City Cement pass through this section in both directions. They carry limestone from Aruwakkalu to Cement Factory in Puttalam and then return to Aruwakkalu.

g) **Noornagar to Aruwakkalu** – This section is not part of Puttalam Line. This is a single rail track maintained and operated by the Cement Company and solely used for transportation of limestone. Length of the section is 22 kms. There are two (02) stations in between Noornagar and Aruwakkalu. Sri Lanka railways do not operate in this section and passenger trains do not operate in this section. Only limestone carrying trains ply this section and approximately 14 to 16 trains pass through daily in both directions.

2.1.2 Project Layout

This section provides following information.

- Layout plans of KTS, ATS and ASL sites including access roads and other components
- Reservations, buffer zone (if any) to be maintained
- Location of the final discharge point of treated leachate and the pipe line trace

(a) Kelaniya Transfer Station

Project Developer has considered several layout options to reach an optimized solution to the layout of the proposed transfer station. The proposed layout of the KTS is shown in **Figure 2.15 and Annex 2.5**. The rail alignment requirement for connectivity to the Mail Line of the SLR together with traffic management significantly governs the layout of KTS.

(b) Aruwakkalu Transfer Station

Project Developer has considered two layout options to reach an appropriate solution to the layout of the ATS. The proposed layout of the ATS is shown in **Figure 2.16** and **Annex 2.6**. In this case, the main determinant of the layout is to accommodate two trains without sacrificing the efficiency of container transfer arrangement. Since there is adequate land available, the train crossing arrangement is separated from the container transfer arrangement. There will be two transfer cranes. Transfer cranes will operate over the train and tipping trailer lane. The operation is similar to contain loading unloading facilities at ports.

(c) Aruwakkalu Sanitary Landfill

Project Developer has considered several layout options to reach an appropriate solution to the layout of the proposed sanitary landfill. The proposed layout of the ASL is shown in **Figure 2.17 and Annex 2.7**.

(d) Rail Transport Arrangement

Details of rail transport arrangement will be provided in **Section 2.1.1.4**

Figure 2.15: Layout of Kelaniya Transfer Station

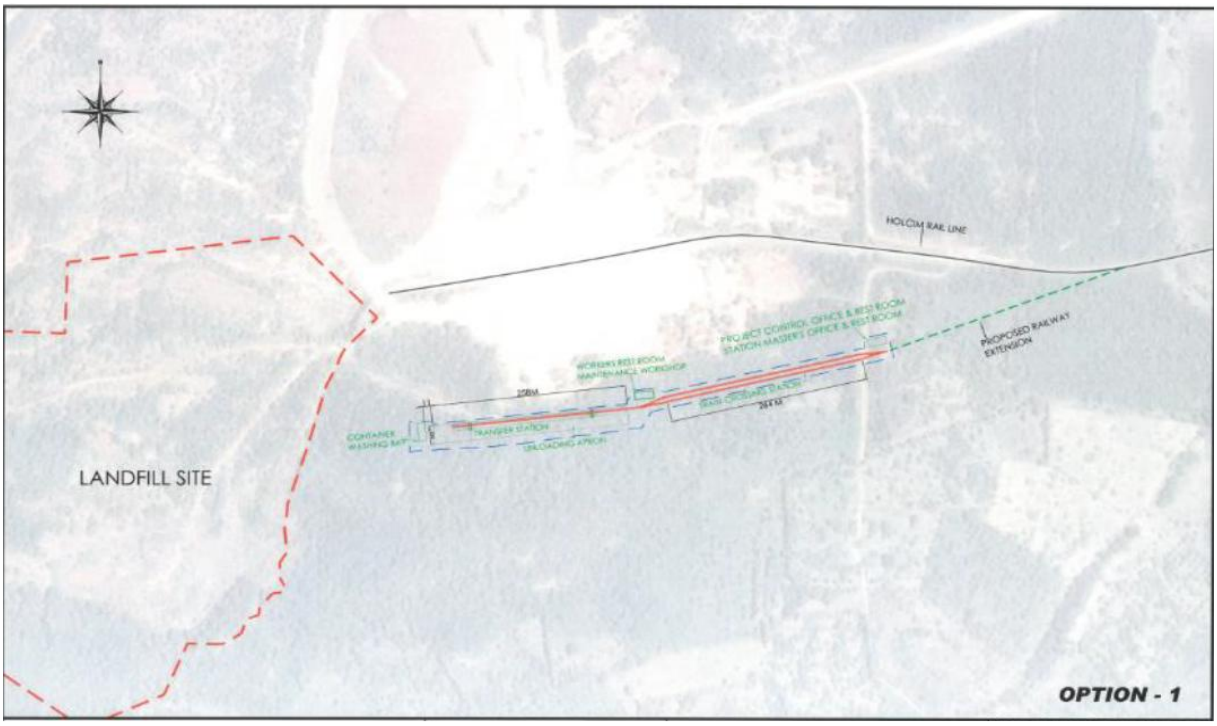


Figure 2.16: Layout of Aruwakkalu Transfer Station

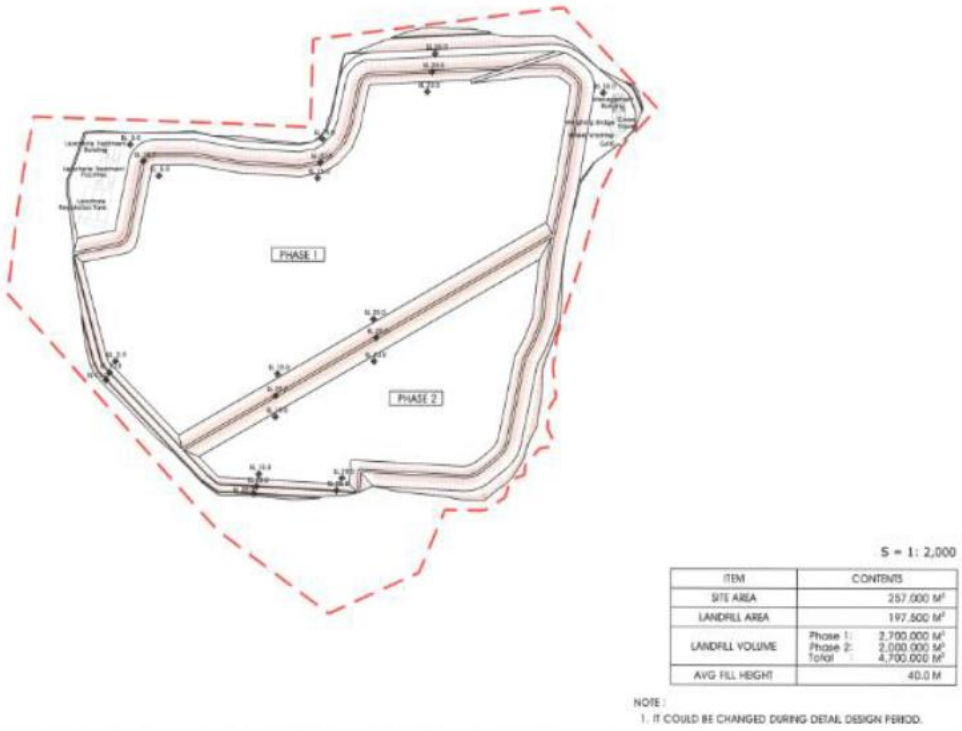


Figure 2.17: Layout of Aruwakkalu Sanitary Landfill

2.1.1.1 Reservations and Buffers

According to the technical guidelines of the CEA, it is important to provide an adequate area as a buffer zone surrounding solid waste landfills. Buffer zones are desirable to mitigate the impacts on the nearby ecosystems and such impacts as noise, odor, etc. Appropriate buffer is also an important consideration in protecting waterways against water quality deterioration, siltation, and clogging. In addition, it is required to comply with statutory reservation requirements such as buildings, road, irrigation, railway, etc.

Layout plans and designs have not specifically demarcated reservations and buffer areas. Nonetheless, both ATS and ASL are situated far from human habitats except for the office complex of the Siam Cement and few other facilities of theirs. Even those offices of Siam Cement and their other facilities are at a reasonable distance to ATS and ASL. Thus, it can be reasoned that the buffer zone is available for the Aruwakkalu facilities of the project.

KTS is situated in an urbanized area, although it is part of a marshy land. Along one edge of the KTS wide canal exists (Mudun Ela). The canal provides a kind of buffer between the transfer station and other developments, although the canal is subject to the threat of pollution due to the project. There are some unauthorized settlements next to the KTS. When those are considered, there is no buffer available at the KTS. Developer of the project however addresses the concerns of lack of buffer by good engineering as follows.

- By installing good odor control system
- By installing advance leachate treatment system
- By incorporating fire protection in the design and also having adequate fire fighting equipment at site to face any contingency
- Low noise generating machines will be procured and a good maintenance schedule for all electro mechanical equipment will be practiced
- Taking pest control measures to control rodent and vector populations

2.1.1.2 Location of the final discharge point of treated leachate and the pipe line trace

Wastewater treatment facilities will be provided at KTS and ASL sites. At KTS the combined wastewater (which include leachate, domestic wastewater and any other wastewaters such as vehicle wash water) will be treated to the levels suitable for disposal to inland waterways. The treated wastewater will be disposed to the canal system. At ASL the leachate will be treated to a level suitable for disposal to inland waterbodies. Even so, there will not be direct disposal of treated effluent to any waterway. After treatment, treated effluent will be sent to the area designed

to hold excess runoff. The water will be allowed to soak into the ground and will also be used in replantation programs. Domestic wastewater will be diverted to septic tanks.

2.1.3 Nature of the Project

The proposed project is for disposal of Municipal Solid Waste (MSW) by way of Sanitary Land Filling (SLF). Therefore, it is an environmental infrastructure development needed to address issues of urbanization. The project consists of a transfer station where the waste is collected and loaded before transportation to the landfill site. Transfer station where the waste is unloaded to be brought to the landfill site and the sanitary landfill where the waste is disposed. The proposed sanitary landfill is semi aerobic landfill. In addition, the project will include various other schemes that would be necessary to make it secure and environmentally acceptable. The additional components of importance include the following and will be installed as required.

a) Leachate plus wastewater treatment system
b) Gas collection and removal system
c) Storm water management system
d) Odor control system

2.1.1.3 Waste Transfer Stations

Transfer Stations are the places where the MSW is loaded into trains for transportation and/or unloaded from the trains. In addition to loading and unloading, other activities such as compacting, weighing. etc., are also being part of the activities of transfer stations. Two Waste Transfer Stations will be built under the project. These are KTS (at Kelaniya) and ATS (at Aruwakkalu).

A) Waste Types

The proposed project is planned to find a long-term, sustainable solution to the solid waste problem in the MCR. Four Local Authorities namely the Colombo, Dehiwala-Mt.Lavinia and Sri-Jayawardhenapura-Kotte Municipal Councils and Kolonnawa Urban Council cover this area. The waste collection program is not limited to these four LAs, but opens to other LAs in the Greater Colombo area and the LAs in Puttalam District. The major restriction is total collection and disposal is limited to 1200 tons/day. The collection is limited to MSW. Thus, it does not include hazardous waste, including health care waste. A survey done at Karadiyana by the Waste Management Authority (WMA) in 2012 demonstrations that small parts of such waste (**Table 2.1**) in MSW. MSW also do not include construction debris and spoil material, and so on In general, it is possible to assume that such wastes are not part of MSW since the entire collection of solid

waste is in the hands of the Local Authorities. However, in reality small amount of hazardous waste and construction debris can enter the MSW stream.

Table 2.1: Municipal Waste Composition at Karadiyana Dumping Site

Characteristics	Average	Characteristics	Average
Short term Biodegradable	52.20%	News Paper	4.81%
Long term Biodegradable	27.06%	Cardboards	1.28%
Cotton	1.74%	Construction Demolitions	1.03%
Nylon	0.73%	Glass	0.94%
plastic	1.60%	E Waste	0.05%
Polythene	8.15%	Others	0.11%
PVC	0.13%	Clinical Waste	0.03%
Rubber	0.14%	TOTAL	100%

As stated above, the project is planned the MCR in mind. The daily design capacity of waste load is therefore determined based on the expected waste generation in MCR over the design horizon of 20 years. The quantities of MSW generated in the MCR are reported in **Table 2.2**. The per capita generation rates of MSW for 2010 is calculated as 1.07kg in Colombo MC, 0.63kg in Kolonnawa UC, 0.64kg in Dehiwala MC and 0.82kg in Kotte MC. Using these per capita generation rates, the amount of solid waste generated in the future can be figured using the forecasted population. Since the amount of solid waste generated strongly depends on the level of consumption and lifestyle besides the population, the generation rates also require adjustments reflecting social and economic changes. Like in any other infrastructure project the design capability of the facility is fixed by the amount of MSW at the final stage of the project life. In this case, design life is 20 years. Using the current MSW generation rate and forecasted population data the MSW loads in the future for the MCR is reported in **Table 2.3**. This estimated quantity of MSW is used in the Transfer Station and Sanitary Landfill design. Considering the values reported in **Table 2.3** the daily MSW to be transferred and disposed is taken as 1,200 tons/day.

As stated above, although the design capacity is determined by the MCR waste generation, there will not be a compulsion on those LAs to supply waste only to the proposed landfill. If there is a gap between the waste load received from the MCR and the design capacity, that shortfall will be filled by other Greater Colombo LAs, after allowing for LAs in Puttalam. It should be noted that most facilities such as KTS, ATS and rail transport system will be developed 20 year design horizon, although the life of proposed landfill is only 10 years. The expectation of the developer

is that to open up another abandoned quarry site near to the proposed fill site later for another landfill with the capacity for 10 years.

Table 2.2: Quantity of MSW in MCR

MCR	1999[1)]		2005[1)]		2010[2)]		2012
	Population	MSW generation (ton/d)	Population	MSW generation (ton/d)	Population	MSW generation (ton/d)	MSW generation (ton/d)
Colombo MC	800,000	680	642,020	700	651,383[5)]	700	706[3)]
Dehiwela MC	247,000	150	209,787	150	233,290	150	150[4)*] (213)
Kolonnawa UC	65,000	3	55,785	30	55,285	35	40[4)]
Kotte MC	137,352	95	115,826	65	121,831	100	110[4)]
Total	1,249,352	928	1,023,418	945	1,061,789	985	1,006 (1,069)

Source:

1) Database of Municipal Solid Waste in Sri Lanka, Central Environmental Authority

2) The data from National Solid Waste Management Support Center

3) The data from Colombo Municipal Council

4) The data from Waste Management Authority

5) 0.29% annual growth rate from 2005 based on Population of Sri Lanka by District by Department of Census and Statistics, 2012

** 150ton/day of Dehiwala MC in 2012 is only from households (Karadiyana)*

Table 2.3: Estimated MSW Generation in the MCR

Year	2020	2025	2030	2035
Estimated population	1,126,100	1,167,600	1,210,500	1,254,900
MSW growth (ton/day)	1,032	1,064	1,097	1,130

Waste composition is very important factor that determines the leachate character and the landfill gas generation. Therefore, the knowledge of the waste composition is important for rational design of the landfill. In the MCR area and other LAs in the Greater Colombo, the waste is not sorted at present. Sorting could considerably cut down the quantity of waste that need disposal through

landfill and design of leachate treatment and gas collection/disposal systems. After the disaster at Meethotamulla the CMC has introduced measures for waste reduction and segregation at source level, but might take some years to show significant results of such actions. Therefore, this design is based on unsorted MSW.

The characteristics (composition) of MSW of the four local authorities of the MCR are similar. More than 50% of MSW content are short-term bio-degradable waste. The next in composition is polythene/plastic waste/shopping bags and then glass waste and paper. On average solid waste characteristics of MCR are 70.9% of bio-degradable waste, 9.2% of polythene/plastic waste/shopping bags, and 6.6% of paper waste. **Table 2.4** reports the MSW composition for the four Local Authorities in the MCR and the average composition of the waste. The waste from the other LAs Greater Colombo area is more or less the similar composition as the average waste character shown in **Table 2.4**. Waste load from Puttalam District will be small enough to make a significant change to the reported average waste character in **Table 2.4**. Therefore, the average composition shown in **Table 2.4** is taken as the character of waste to be disposed at the ASL.

Table 2.4: Solid Waste Composition in MCR

Characteristics	MCR				MCR Average
	Colombo MC	Dehiwela-Mt. Lavinia MC	Kolonnawa UC	Sri Jayawardenapura Kotte MC	
Bio-degradable wastes(Short term)	63.6%	67.3%	76.7%	65.8%	68.4%
Bio-degradable wastes(Long term)	6.3%	0.9%	0.0%	2.8%	2.5%
Polythene/Plastic waste/shopping bags	23.4%	6.4%	1.4%	5.4%	9.2%
Metal waste	0.4%	0.9%	0.0%	2.2%	0.9%
Wooden waste	0.0%	9.1%	0.0%	4.7%	3.5%
Glass waste	6.3%	0.9%	8.2%	1.1%	4.1%
Paper waste	0.0%	5.5%	13.7%	7.1%	6.6%
Other waste	0.0%	9.1%	0.0%	10.8%	5.0%

Density of loose MSW collected in MCR area is about 350 kgs per cubic meter. Since the haulage is substantial (170 kms) it is not economical to transport waste in loose mode. After careful study of economics of compaction, the plan is to compact the waste to a density of 750 kgs/cubic meters at the KTS. This requires special equipment and appropriate design of the facilities to carry out the compaction. Design allows for equipment for the breaking up of bulky items and the compacting of solid waste to increase density for more economical transportation.

B) Pre- processing activities and plan for disposal of refused waste

Waste to the KTS is delivered by RCVs. Tractors will not be allowed. Full quantity of waste delivered to the KTS will be compacted and transported to Aruwakkalu for disposal. Largely there will be no pre-processing activities including waste sorting and segregations at the KTS. It is not possible to inspect the RCVs one by one for undesirable waste. To assure that only acceptable waste come to the KTS, agreements will be achieved with the participating LA to ensure the waste collection and delivery are restricted to MSW without any hazardous and dangerous wastes. In addition, the RCV crew will be educated and trained through the LAs to avoid collecting hazardous and dangerous wastes during the collection rounds.

However, there will be some overseeing of delivered waste to avoid unacceptable waste being delivered. All arriving waste will be dumped on the dumping flow before being pushed into compactors. Supervisors will visually inspect the waste on the floor of the dumping pad and, if detected will remove waste types given below with the assistance of tractor shovel operators and controllers.

i. Enclosed metal containers, gas cylinders etc.,
ii. Items liable to explode
iii. Dead human bodies or parts
iv. Large solid metal pieces
v. Concrete, large stones etc.,
vi. Big timber logs

The above overseen activity is mainly to obtain a picture of the type of waste and advise the LAs to improve their collection. Other than the items about which the police to be alert and removed under the police guidance, the rest of the undesirable items will be stockpiled at the site and removed regularly through registered recyclers/agents. In case if the hazard and/or clinical waste material is detected and removed from dumping floor, such waste will be disposed through a registered hazardous waste management company of Sri Lanka. Every endeavor will be taken to

identify the sources of such material and take appropriate legal action to deter such disposal of unacceptable waste.

C) Waste storage period and Conditions of storage

During operation, there will be no accumulation of waste at the transfer site. This means continuous processing of waste covering the activities of waste unloading, compacting, and loading to rail containers. However, for the design purpose, total failure of waste transfer for one full day is considered. This means the KTS facility to provide 24 hours of storage. Waste is stored on dumping pad 1405 m^2 in size to store one-day accumulation of waste leading three meter height pile. Storage of waste, which is high in biodegradable content, will putrefy and give rise to bad smell. Odor will be controlled through ventilation and odor control system.

The waste storage building is an almost fully enclosed building with a full roof cover. The building is kept under slight negative pressure to prevent the release of odorous air, particularly adequate negative pressure is maintained at truck entry and exits, which are constantly open. Force ventilation is provided to aid adequate supply of fresh air into the building. Air sucked out of the building will be taken through an odor control unit before being released to the atmosphere. The order control unit will consist of filtration unit and/or biological reactor and an activated carbon unit. The ventilation and odor control system will be fully covered during the detailed designs.

D) Unloading and loading system, details of the rail track and the station

i. Kelaniya Transfer Station

All the buiding and other infrastructre will be built on top of concrete pile foundations. This approach is taken to prevent loss of flood retention capacity of the marsh. The waste transfer loading and unloading at KTS include following activities and functions.

(a) Receive incoming RCVs.

(b) Weigh and accept the RCVs including charging the toll, if applicable.

(c) Queuing - Queue up space for 20 to 30 RCVs inside the premises before the weighbridge.

(d) Storing - Dump Pad (Space of 1,405 ㎡to accommodate one day's MSW). Dump Pad should have 3 m high wall right round. Accordingly, the pile height of MSW on the pad is 3 m in general. Dump pad is within an enclosed building with roof cover. It is provided with ventilation and odor control arrangements.

(e) Dumping - Facility to tilt and dump 10 RCVs at a time and each shall have space of 6 m wide along the edge of the Tipping Pad.

(f) Compaction - Three "Compactor cum Loaders" shall be installed under the Dump Pad. They shall be located under the Dump Pad for easy loading of the compactors. It is necessary to compact the MSW before rail transport to minimize the transportation costs (per Ton).

(g) Loading to transfer containers - The "Compactor cum Loader" shall press the compacted MSW into transfer containers placed on tractor-trailers. The capacity of a compactor shall be 80 Tons per hour or 4 containers per hour (Container size 20 feet).

(h) (Three compactors can load twelve (12Nos) of 20 feet containers per hour. Thus approximately 2 ½ hours is required for load 26 containers required for one train.)

(i) Moving and loading of waste on the dump pad - Three tractor shovels shall operate on the Dump Pad to move and load the MSW.

(j) Towing of containers to transfer location - The loaded containers shall tow by tractors along the tractor lane to the appropriate loading point under the Transfer Crane.

(k) Loading to rail wagons - The Transfer Crane lifts the container and places it on the rail wagon.

(l) Unloading of the empty containers from the rail wagon and placing them on the tractor-trailers also done by the Transfer Crane. There will be two Transfer Cranes to ensure fast and uninterrupted transfer operation.

Altogether, 1200 tons of waste needs transferring each day. Compacted waste is of density around 750 kilograms per cubic measure. Considering handling time, ease of handling and other economic factors 20 feet container (instead of 40 feet container) is chosen as the most appropriate size to take the waste. Taking the waste density mentioned above, each 20 feet container can hold about 23 tons of waste. Thus, it needs 26 containers of 20 foot size to transfer 598 tons (say 600 tons) of waste, which means two trains with 13 wagons carrying 26 containers to transfer the daily waste load of 1200 tons. Therefore, the railway infrastructure at KTS should be adequate to accommodate two trains at any time. Each train consists of 13 wagons and carries 26 containers, two containers per each wagon.

Figure 2.18 illustrates the railway infrastructure at the KTS. The proposed layout led to the shortest possible railway extension (about 160 m). In addition, the rail approach is smooth. Two rail lines are placed inside the KTS premises. Their centers are 6,880 mm apart to facilitate a tractor lane (TL) in between. There is one rail switching point at the entrance to converge the two lines to a single outgoing line. The railway lines within the KTS premises are of sunk rail type, where only the rail top and inner flange is exposed and the rest and the area between rails covered with concrete. No sleepers or ballast will be exposed. This type of track is needed to maintain the

cleanliness. The track gauge is 1676 mm (5’ 6”) and the rails of the same standard of SLR will be used. Only new rails of good quality will be used to construct the tracks within the KTS. Two dead buffers shall be supplied at the terminal of each track so that the train can be ended at the exact position.

The rail connection from the KTS entrance to the existing Line of the SLR network needs to be newly built. A suitable controlling system with track switching facility is necessary to control the train traffic. The SLR will carry out this work. They will prepare the plans and designs for placing rail racks and signaling work as necessary for trains to enter and exit the mainline.

ii. Aruwakkalu Transfer Station

The waste transfer unloading and loading ATS include following activities and functions.

(a) Arrival of MSW train arrives at ATS

(b) Tipping Tractors line up on the transfer lane at appropriate locations, ready to receive the loaded containers.

(c) Transfer operation, which includes unlocking, lifting, traversing, lowering on the tipping trailer and locking, is then taking place.

(d) Tipping trailer takes the container to the unloading place at the Sanitary Landfill, open the doors, tipping, and unload the MSW from the rear end of the container.

(e) After unloading, the containers are taken to the washing bay and after washing, they are taken to the Transfer Station for loading the empty container to the train. The prime mover is then ready to take another loaded container.

Extension to the Siam City Railway line is provided at Aruwakkalu to establish Aruwakkalu Transfer Station. **Figure 2.19** depicts the railway track arrangement and other allied developments at ATS.

Figure 2.18 Railway Track Arrangement within KTS

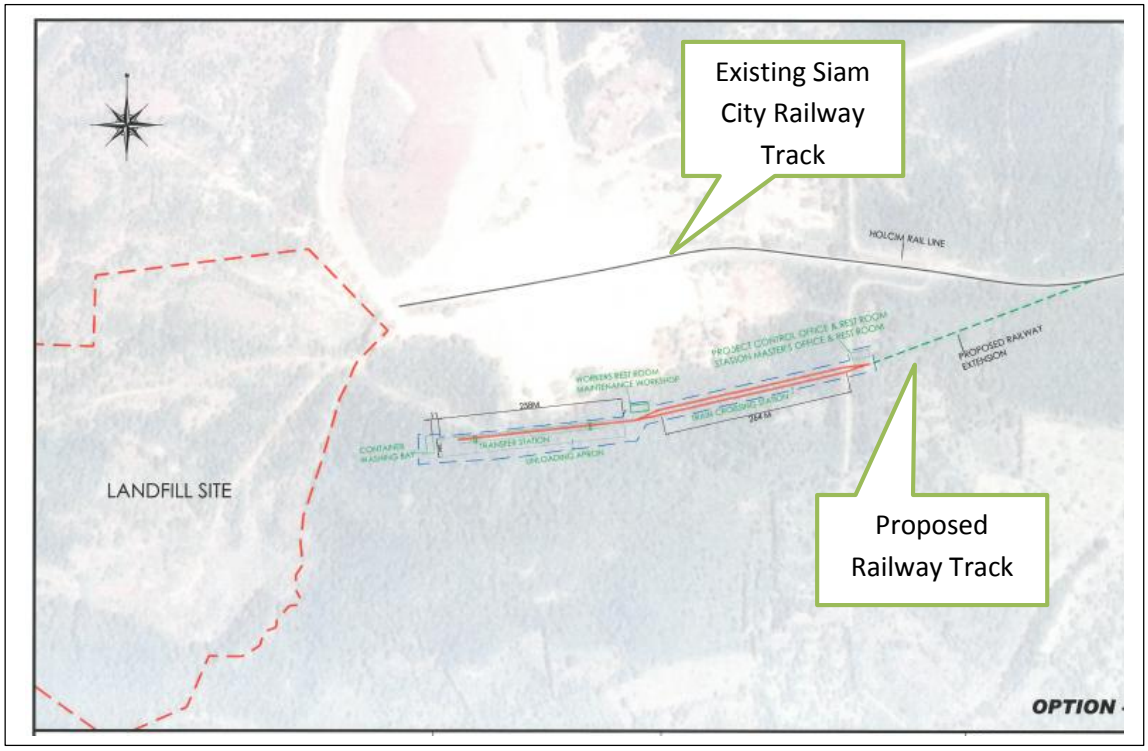


Figure 2.19 Rail Track Arrangement at ATS

E) Frequency of collection from transfer stations

Two trains will leave KTS everyday each carrying 600 tons and a total of 1200 tons of compacted waste. Waste received at the Aruwakkalu Transfer Station will be disposed at the landfill as it receives.

F) Arrangement for traffic management at the transfer station and landfill site

Road traffic management is an issue only at KTS. KTS is located in heavy traffic area near Colombo-Kandy Road. It is estimated that 300 to 400 RCVs will visit KTS to deliver the waste each day. Normally the RCVs bring the waste during morning and evening hours. Nighttime transfer is not expected. During rush hours, there is a possibility of 50 to 60 RCVs attempting to reach the KTS. This could easily contribute to heavy traffic and the developers are mindful of this situation. Considering prevailing traffic conditions, it is vital to pay close attention to minimize further buildup of traffic due to the proposed project.

As a solution to reduce traffic, it was decided to improve the traffic efficiency by not allowing tractors to the KTS. Only standardized RCVs (ex: vehicle length, turning circle) are allowed to the site (such RCV standardization may be progressively achieved). Participating LAs, will be informed of this requirement early enough so that they will have adequate time to establish a fleet of RCVs necessary for the transfer of waste to KTS.

At present, the proposed access to the KTS is through new access road to be built from the Kandy – Colombo highway parallel to the Kandy-Colombo railway line. The planned exist is Manelgama Road, which is planned to be improved as part of the project. Therefore separate in and out gates will be maintained to reduce congestion. Vehicles coming out of Manelgama Road will merge with traffic along Kandy- Colombo Road. RCVs will not be allowed to cut across the Kandy-Colombo highway at the exit of Manelgama Road. Instead, they will be required to proceed further merging with the traffic along the Kandy- Colombo Road before taking a U-turn towards Colombo.

To reduce traffic RCVs queuing along the public road in front of the KTS will be averted. For this purpose, adequate space has been offered in the KTS premises to queue up and park the incoming RCVs. The waiting time at the entrance gate will be minimized by confining the activities at the gate to a mere identification of the vehicle and the crew. One time the vehicles are registered and recorded in the database, it is possible to grant entrance to the KTS without any manual verification. The gate will be an electrically operated barrier type with fast operation. A normal flap type steel gate also will be provided to use during the shutdowns.

Detailed traffic management plan will be developed based on the above-explained outlines with the assistance of the relevant road authorities (RDA, PRDA) during the detailed design phase.

Developer agrees to provide adequate funds to carry out the implementation of the traffic management plan.

Traffic at Aruwakkalu Transfer Station and Landfill

ATS and ASL are located in remote part of Puttalam district away from pubic roads. Traffic is not a critical or significant issue at those two sites. However, developer will discuss with the Cement Company during the detailed designs so that the road network between the ATS and ASL will not in conflict with the road transport arrangement of limestone between quarry sites to loading point.

G) Types of machinery and vehicles

The machinery deployed at KTS and ATS are provided in **Table 2.5** and **Table 2.6** respectively.

Table 2.5: Key Machinery and Equipment at KTS

Items	Capacity	Number
Transfer Crane	30 Tons	2
Trailers	20 feet, 30 Tons	8
Tractors (Prime Movers)	30 Tons	8
Compactors	Density 750kg/m^3 80 tons/hour	3
Weigh Bridges	20 tons	2
Tractor Shovels	One ton	3

Table 2.6 Key Machinery and Equipment at ATS

Items	Capacity	Number
Transfer Crane	30 Tons	2
Trailers	20 feet, 30 Tons	8
Tractors (Prime Movers)	30 Tons	8
Tractor Shovels	One ton	3

H) Leachate generation points, quantity and quality

Not only the leachate there are three other sources of wastewaters at KTS. These are:

1. Waste compaction leachate
2. Tyre washing wastewater (contained oil)
3. Tipping Pad wash water
4. Sewage

The main and most concentrated wastewater is the leachate coming out of compaction of solid waste. The estimated quantity of wastewater is 120 m^3/day. The combined influent quality based on the wastewater characteristics experienced at similar sites is provided in **Table 2.7.**

Table 2.7: Characteristics of Combined Wastewater

Items	COD_{Cr} (mg/ℓ)	BOD_5 (mg/ℓ)	TSS (mg/ℓ)	NH_4^+-N (mg/ℓ)	T-P (mg/ℓ)	Remarks
Influent	5,000	3,000	500	400	10	Combined wastewater

I) Leachate collection, treatment and disposal methods

Wastewater from all the sources will be collected in a collection tank for equalization. Collection will use catch pits, pipe network and where necessary the pumping. Sewage will be directed to the collection tank without any pretreatment. Tyre wash water will be subjected to pretreatment to remove grit/sand and oil. At KTS pre-compaction will be used to compact the waste. The pre-compactor not only brings down the volume of MSW for transportation, but also cuts the weight by pressing out the water from the waste. The squeezed water and leachate will be drained through a permanent piping system from the compactor chambers. Tipping pad wash water will also be picked up through drains via catch pits and directed to the collection tank. Full arrangement of the wastewater collection network will be developed at the detailed design stage. At the equalization tank the wastewater will be neutralized and treated at the KTS. Biological treatment process is proposed as depicted in **Figure 2.20**. Wastewater will be treated to meet the Treated Effluent Disposal Standards stipulated under the National Environmental Act (Gazette Extra Ordinary 1534/18 dated 1st February 2008) for Inland Waters (**Table 2.8).** The Design Build Contractor to the project will design the treatment system to meet this requirement.

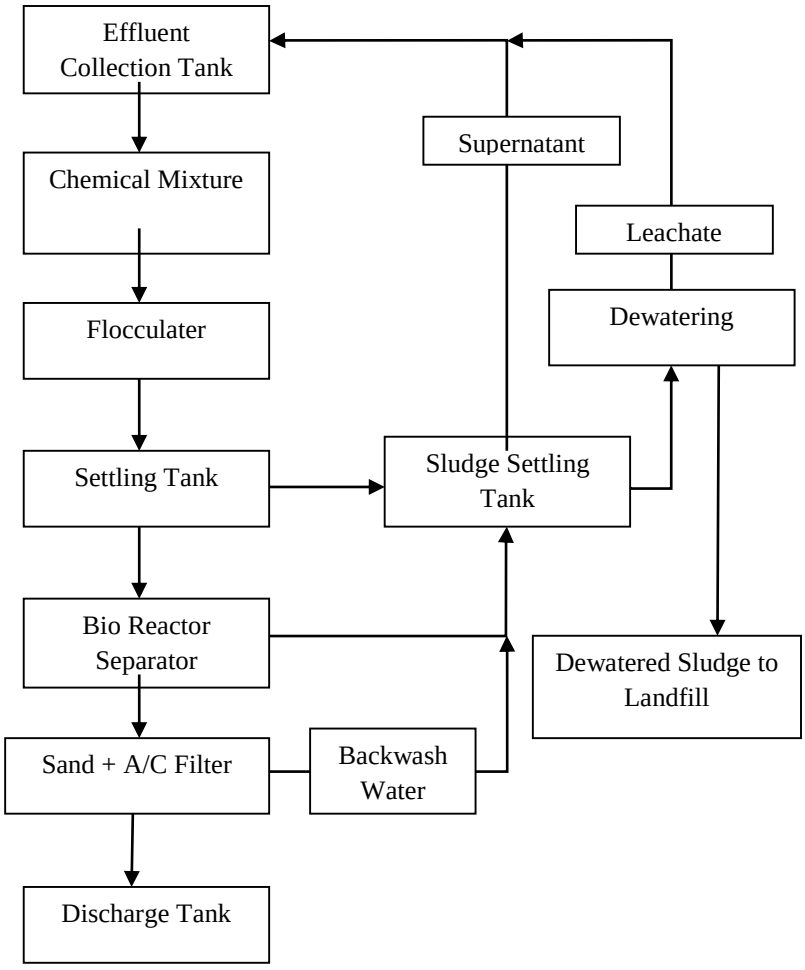


Figure 2.20: Proposed Wastewater Treatment Process for KTS

Table 2.8: Treated Effluent Quality Standard for Inland Waters

Item	TSS (mg/ℓ)	pH -	BOD (mg/ℓ)	COD (mg/ℓ)	P (mg/ℓ)	TKN (mg/ℓ)	NH^{+4} (mg/ℓ)	CN (mg/ℓ)	Pb (mg/ℓ)	Hg (mg/ℓ)
Value	50	6~8.5	30	250	5	150	50	0.2	0.1	0.0005

J) Quality of treated effluent /possibility of reuse and recycle

Quality of treated effluent will meet the treated effluent disposal standard to inland waters. Thus the treated effluent could be used in dumping floor and tyre washing, etc. To minimize release of

treated effluent to the natural environment treated effluent will be reused for the above functions. The treated effluent collection tank and recirculation pipe network will be constructed for this purpose. Part of treated effluent in excess of recirculation requirement will be bleed off from the treated effluent collection tank to the nearby canal system.

K) Control of odor

Odor is expected to be brought forth at the waste input, store, and compaction point of transfer station due to the emission of odorous gases. Odor control system will be installed in order to control and remove the odor generated within the transfer station to improve the working environment and preventing public complaint in adjacent area. The odor control plan has been made mainly focusing on odor-concentrated points such as dumping pad/building. The details of the odor control system will be prepared at the detailed design stage.

2.1.1.4 Waste transportation to Puttalam

L) Distance to be transported

Distance from KTS to Aruwakkalu is 170 kms.

M) Details of railway tracks and stations, nature and extent of upgrading required

At the present only principal agreement has been reached to use railway as the mode of transport of waste. To support the waste transfer from KTS to Aruwakkalu considerable improvements and modifications to the railway infrastructure will be required together with enhancement in railway operations. The project developers have covered significant distance in carrying out studies and planning work to make the proposed railway transport arrangement feasible. The possibility of extending the rail tracks to KTS from the Main Line was studied with due consideration of the standards adopted by the SLR. Consequently, taking trains in and out from/to the Main Line at KTS was found to be viable and suitable alignment and orientation of the rail track in compliance with SLR standards was made. Based on the studies number of wagons in the train, maximum load, locomotive power requirement, etc., were tentatively determined. Likewise, the railway infrastructure requirements at ATS also determined to facilitate easy and efficient operation. However, the involvement of SLR in the design and planning work carried out so far is not extensive. It will be the SLR, which will specify the precise nature of improvement and modifications to railway infrastructure. They are also the only party authorized to implement the modifications. Thus, very soon the developer will elevate the ongoing work related to railway infrastructure improvement as a coordinated effort with the SLR.

N) Railway Extension at Kelaniya Transfer Station

To facilitate the MSW transportation by rail, a connectivity rail line shall be made between the KTS and the Main Line of the SLR. To decide on the best design for this connectivity, various options were considered. The railway connectivity plan was prepared considering standards and technical requirements of the SLR, which are outlined below.

1. Curvatures should not be sharper than 100 m radius.
2. Gradients should not be steeper than 1 in 200.
3. Connection should be tangential to the existing line
4. Soil condition should be improved or other methods such as piling are required to carry trains of 18 tons axle load

In addition, following project specific requirements were considered in the planning and design of the railway connection.

5. The line inside the KTS shall be a straight line of 208 m long and the incoming line should be tangential to this straight portion.
6. The line inside the KTS shall be perfectly level.

Further to the above, the design of the connecting rail alignment and orientation considered the following social and environmental concerns.

7. Minimum damage to the private property
8. Reduce delays in Main Line trains due to construction of connectivity line
9. Existing water passages or canals should not be blocked

The exact alignment of the railway connecting to the mainline and track inside the KTS will be determined at the detailed design stage by the SLR. The design will comply with the above guidelines and engineering designs will be prepared after the detailed topographical surveys and geotechnical investigations as requested by the SLR. According to the already prepared layout plan by the project developer a smooth merging of the connecting line with the Main Line is possible within a very short distance of 160 meters.

O) Improvement of the Existing Railway Operation

Altogether, there are 40 railway stations on Puttalam line beyond Ragama upto Aruwakkalu. As per the details offered in Section 2.1.1.6 nearly 20 up and 20 down passenger and mixed trains, operate on Puttalam Line daily. Most of the passenger and mixed train operation is between 04:00 - 21:00 hours. Around 95% of the passenger and mixed trains by the SLR operate during daytime i.e. 4.00am to 19.00pm. To minimize and adverse interference with functioning of normal train traffic, the project design calls for nighttime operation of waste carrying trains.

Where the only single track is present, to minimize delays it will be necessary to increase the number of stations with transfer loops. Loop lines are available at 15 stations as shown in **Table 2.9**. In order to accommodate waste transfer train that consists of container wagons approximately 231.6m (760ft) length is required. Accordingly, loop lines at eight of the railway station can accommodate waste transfer trains without any trouble. As the waste trains are scheduled during the off peak and nighttime, delays may not happen in the near future as per the present schedule of SLR passenger and mixed train operation. However, this aspect should be examined by the SLR and make a determination regarding increasing the stations with longer loops to accommodate the passing of waste carrying trains. The addition of more stations with extended loops shall base on avoiding delays to both passenger and waste transport trains as the latter also work based on a tight schedule. The project will invest in the rail infrastructure improvement through the SLR to meet the requirements.

Nevertheless, a new extended loop is required at Noornagar. The Cement Company explained that they operate 7-8 trains daily and their operation is affected by the lack of a long enough loop at Noornagar. They stated that the lack of long enough loop will certainly affect the waste transfer operation and will become an added constraint on their operations. The project will pay for addition of a loop at Noornagar by the SLR.

Table 2.9: Loop Line Details

No	Station		Existing Loop Length (m)	Crossing possible without any improvement
1	JLA	Ja- Ela	195.1(640'-0"ft)	No
2	SED	Seeduwa	285.3(936'-0"ft)	Yes
3	KTK	Katunayake	243.2(798'-0"ft)	Yes
4	NGB	Negombo	197.2(647'-0"ft)	No

5	KCH	Kochchikade	197.2(647'-0"ft)	No
6	BLT	Bolawatta	197.2(647'-0"ft)	No
7	LWL	Luniwila	191.4(628'-0"ft)	No
8	NAT	Nattandiya	314.6(1032'-0"ft)	Yes
9	KWW	Kudawewa	216.7(711'-0"ft)	No
10	MDP	Madampe	260.6(855'-6"ft)	Yes
11	CHL	Chilaw	290.8(954'-0"ft)	Yes
12	BGY	Bangadeniya	379.5(1245'-0"ft)	Yes
13	MNL	Mundel	370.3(1215'-0"ft)	Yes
14	PVI	Palavi	198.1(650'-0"ft)	No
15	PTM	Puttalam	251.5(825'-0"ft)	Yes
16	NOO	Noornagar	-	No

P) Safety and Controlling System

The train movements will be handled by the CTC (Central Traffic Controller) of SLR up to Noornagar. Uniformity of configurations of signals between the new line from KTS and the existing main lines will be maintained. This is to avoid confusion in understanding meanings of signals by train drivers. For train movements inside the KTS, the concurrence of the Controller of the KTS is required. No train will be allowed in to the KTS entry line when two trains are inside the KTS. To ensure full compatibility of railway operation within KTS and outside the signaling, occupation sensors and route setting mechanisms will be incorporated in the final design in full consultation with the SLR. These include detailed planning and will be carried out during the design-build phase. To doubly sure of avoiding confusion of railway signaling by the drivers only those railway drivers having experience with SLR will be recruited by the project for its operation.

The Cement Company presently manages the operation between Noornagar and Aruwakkalu. In the future railway operation between the Cement Company and the ASL Operation Company needs to be established. An appropriate operational plan will be established in consultation with the Cement Company. Due consideration will be given for establishing a unified operating system which could be handled by Cement Company since they operate bulk of the trains (16 up and down trips) compared to four (04) up and down trains operated by the waste management operation. If necessary improvements/additions to loop arrangement will be made at Karadipuwal and

Periyangavillu stations situated between Noornagar and Aruwakkalu. The Cement Company maintains the line between Noornagar and Aruwakkalu at present, although the SLR owns the line. At the detailed design stage the operation and maintenance of the rail section between Noornagar and Aruwakkalu will be discussed with the Cement Company together with the SLR. An appropriate mechanism will be set up to cover both O&M of this rail section thereby.

Q) Types of waste transporting containers / carriages and locomotives

Key machinery and equipment deployed for railway transportation are provided in **Table 2.10**.

Table 2.10: Key Machinery and Equipment for Railway Transportation

Items	Capacity	Number
Locomotives	SLR S12 Class or similar	5
Wagons	40 feet	28
Containers	20 Feet	54

Q.1 Container Carrying Rail Wagons

Waste transfer operation needs 26 containers carrying wagons for the two trains. Two extra wagons will be purchased as standby. The containers carrying wagons will be similar to the existing BCF (Bogie Container Flats) of SLR (**Figure 2.21**), with the following exceptions.

a. They should be fitted with the air brakes in accordance with the accepted standard of SLR, instead of vacuum brakes.

b. They should wire with the control cable required for the dual head operation.

c. They should be equipped with automatic couplers according to the accepted standard of SLR, instead of screw couplings.

d. The length of the frame shall be limited to the length required for loading two 20-feet containers.

The wagons will be equipped with standard container locks for two 20 feet containers. Further, they are fitted with a brake regulating system to avoid wheel slips during empty running. There should be a voice communication system between the front and rear engines. Similar to locomotives the specifications of the wagons will match the SLR's requirements and SLR will be consulted to find detailed specifications for wagons.

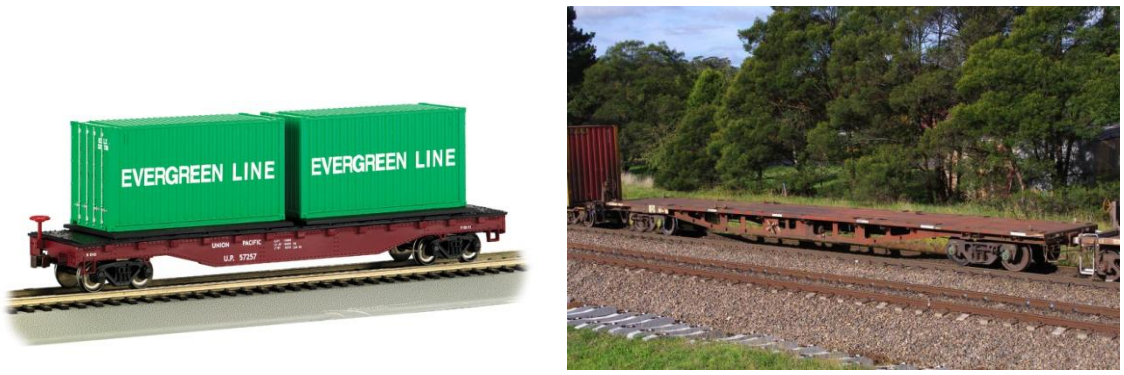


Figure 2.21: Boogie Container Flats

Q.2 Locomotives

The two train sets are required for operation. Since double-headed train sets are selected to avoid the need of long track and turning tables, four are required for the two trains. In order to increase the capacity of the train to carry 13 wagons and to minimize the train length, it has been decided to eliminate the conventional Guard Vans and provide with locomotives with built in Guard Compartment, similar to the S12 Class of SLR (**Figure 2.22**). Otherwise the specifications of the locomotives shall match the SLR's requirements. The locomotives will be purchased in consultation with the SLR and in accordance with the specifications provided by the SLR. One spare locomotive will be obtained as standby to ensure uninterrupted operation on a daily basis.

Figure 2.22:S12 Class Locomotive of SLR

R) No. of train journeys per day and the quantity per journey

Two train journeys are planned each day. Each train has 13 wagons loaded with 26 Nos of 20 feet containers. Each train will carry 600 tons of waste. Thus, total waste load that can be delivered in a day is 1200 tons.

2.1.1.5 Sanitary landfill site

S) Pre- processing activities if any at the landfill site

Pre-processing activities are not planned at the landfill site.

T) Details of composting plant (if any)

There will be no composting arrangement (plant) at Aruwakkalu Landfill Site.

U) Type of waste to be disposed

Waste that will be disposed at the site is Municipal Solid Waste. The composition of the waste is described in **Section 2.1.3.1 - (a).**

V) Capacity and life span

Sanitary Landfill at Aruwakkalu is designed to dispose 1200 tons of waste per day. It has a life span of 10 years considering the space available and waste filling at the said rate. The sanitary landfill planning details are given below.

- Open year: 2019 year
- Sanitary Landfill lifespan: 10 years (1,200 ton/day)
- Landfilling capacity: About 4,653,750 m^3
- Lifespan of landfill Phase 1: 5.9 years
- Lifespan landfill Phase II: 5.2 years
- Density of MSW: 0.75 ton/m3 Note: density is expected to increase with time to 0.80 tons/ m3
- Settlement : 25% of Landfilled Waste
- Soil Covering : 10%

W) Conceptual Design of the landfill facility

W.1 Sanitary Landfilling Method

The semi-aerobic landfill method is selected after a comparative analysis of advantages/disadvantages of different other landfilling methods. **Figure 2.23** depicts the landfilling arrangement. The method does not require force aeration (less in energy cost), delivers better quality leachate, and allows for LFG collection after its closure. It is also comparatively low in construction and operational costs (compared to aerobic landfill method) while providing an environmentally acceptable solution to MSW disposal.

W.2 Sanitary Landfill Layout Plan

ASL will be developed two phases as Phase I and Phase II. Landfill layout including the areas to be developed under Phase I and Phase II are shown in **Figure 2.24**. Each phase will be able handle little over 5 years of waste. Several layout options were considered before the suggested layout design was selected. Layout plan selection was based on such criteria as capital cost, simplicity of operation and management; waste transport arrangement, etc. In the eastern side of the project site, the management office, weighbridge and security office will be located. The Leachate treatment facility will be built in the west of the site. The layout is so planned to allow maximum height of waste column to be 40 meters. This height is reached in eight (08) stages of five (05) meters high stacks of waste. Total fill volume is 4,700,000 m^3.

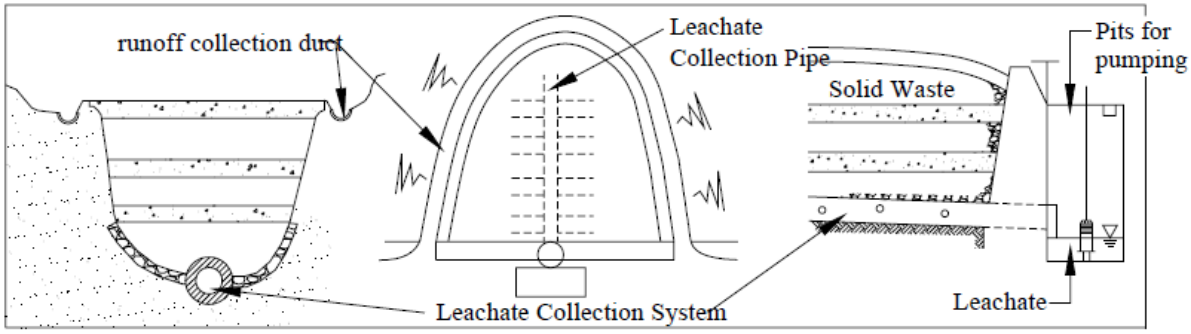


Figure 2.23: Illustration of Semi Aerobic Landfilling Method (*Source: JICA, 2004)*

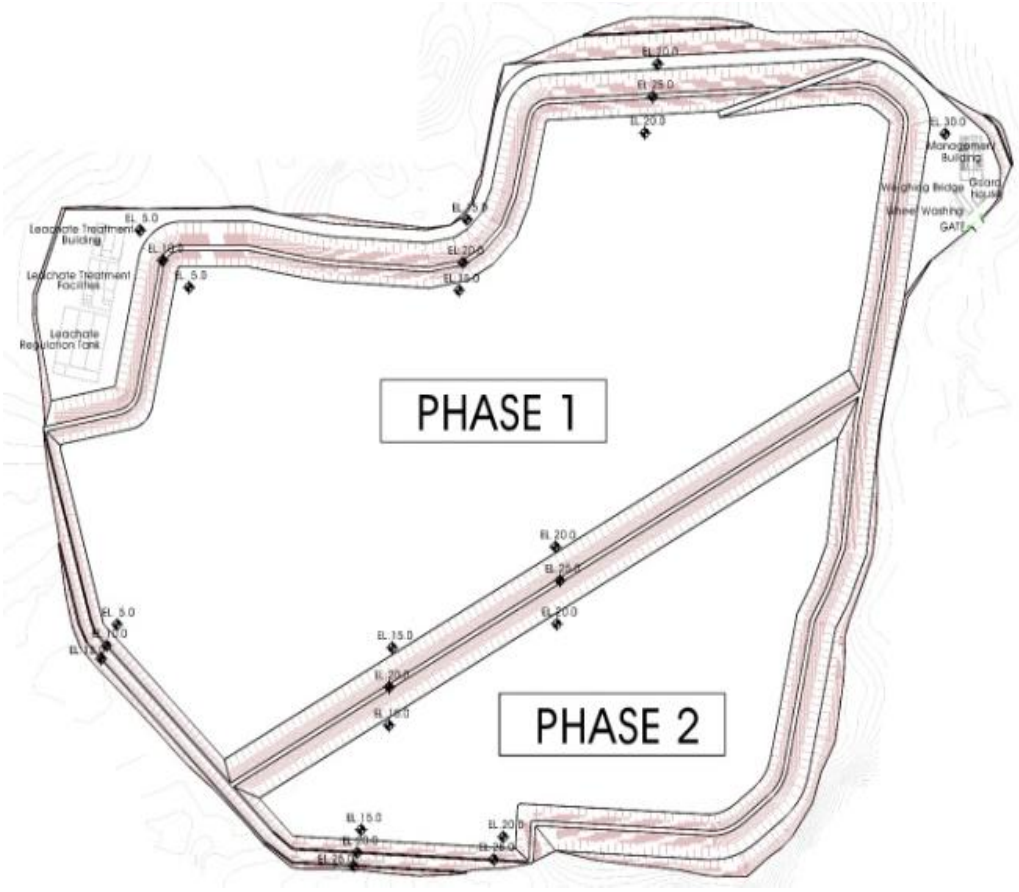


Figure 2.24: Landfill Layout Plan

W.3 Phased Sanitary Landfill Development Plan of the Entire Project Site

The landfill development plan is divided into two (02) phases. The first phase covers about 19 ha. In the second phase about 7 ha will be developed. As per the plans the Phase 2 development will commence prior to the completion of Phase 1. **Figure 2.24** depicted the areas covered by the two phases. **Table 2.11** provided the details of the landfill development for Phase I and II.

Table 2.11: Phased Sanitary Landfill Plan

Items		Phase 1	Phase 2	Total
Area (m²)	Landfill	141,500	56,000	197,500
	Infrastructure	9,400	-	9,400
	Road	6,900	-	6,900
	Others	27,200	16.000	43,200
	Total	185,000	72,000	257,000

Items	Phase 1	Phase 2	Total
Landfill Capacity(m^3)	2,700,000	2,000,000	4,700,000
Landfill Height	40m (stage 8)	40m (stage 8)	40m (stage 8)
Landfill lifespan (year)	5.9	5.2	10.1
Subsidiary facilities	• Building : • Management building • Guard building etc. • Leachate treatment plant : 1 • Weighing bridge: 1, • Groundwater inspection well : 3 • Road : 8.0m width • Tyre wash Bay • CCTV • Oil Storage facility	• Groundwater inspection well : 2 •Road : 8.0m width	• Building : • Management building • Guard building etc. • Leachate treatment plant : 1 • Weighing bridge: 1, • Groundwater inspection well : 5 • Road : 8.0m width • Tyre wash Bay • CCTV Oil Storage facility
Construction phase	First	Second	

In both phases, the Sanitary Landfill will be operated as cells. Detailed design will establish the cell size. The operational objective presently is to maintain the cell size as small as the economically possible as small cell size facilitates reduced leachate generation, minimizes the area of exposed solid waste, assist the control of windblown litter. For each cell the estimated void space volume, the active life, and development sequence will be developed during the detailed design stage. The total volume of the fill will reach up to 4,700,000m^3 at the end.

The site development work for the second phase landfill is able to commence in the area south of the first phase project. By doing so, it is possible to share the same facilities (weighbridge, wheel cleaning, leachate treatment facility etc.) between the two phases. This will reduce the construction and operation & maintenance cost.

Filled waste will be provided with soil cover. The net earth volume generated from earthwork at site is shown in **Table 2.12**. The soil generated during Phase 1 will be stored in the Phase II area. This soil will be utilized as cover material for the Phase I. As per the volume calculations, the stored soil from Phase I together with the soil generated through Phase II would not be adequate to meet the soil requirement to provide the cover. This deficit needs to be filled from outside. Therefore, it is necessary obtain earth form outside the site area.

Table 2.12: Earth Work Balance

Item	Phase 1	Phase 2	Borrow Pits (Adjacent Quarries)		Total
			Phase 1	Phase 2	
Cutting	520,000㎥	220,000㎥	130,000㎥	160,000㎥	740,000㎥
Filling	330,000㎥	140,000㎥	-	-	470,000㎥
Disposal	190,000㎥	80,000㎥	-	-	270,000㎥
Covering soil	320,000㎥	240,000㎥	-	-	560,000㎥
Balances	-130,000㎥	-160,000㎥	130,000㎥	160,000㎥	-

W.4 Sanitary Landfill Bottom Elevation and Bottom and Side Liners

As per the guidelines released by the CEA regarding establishment of Sanitary Landfills the landfill bottom should be not less than 3 meters above the groundwater level. The proposed project site is located in a hilly area (**Figure 2.25**). According to the boring tests, the groundwater level fluctuates between –0.05 and - 6.85 meters. Thus, the bottom foundation level of the Sanitary Landfill is higher than that of the groundwater. Therefore, the influence of the groundwater to uplift the landfill liner will not be present during the dry period. Nevertheless, during the rainy season, the groundwater level could rise rises up. To prevent ground water pressure build up during such conditions a bottom liner will be installed to drain the groundwater. **Figure 2.26** depicts the complete bottom liner arrangement including the groundwater drainage layer. Total thickness of the drainage layer is 300 mm. Total thickness of the liner and drainage layer together is one meter. **Figure 2.27** depicts the sidewall/slope liner arrangement.

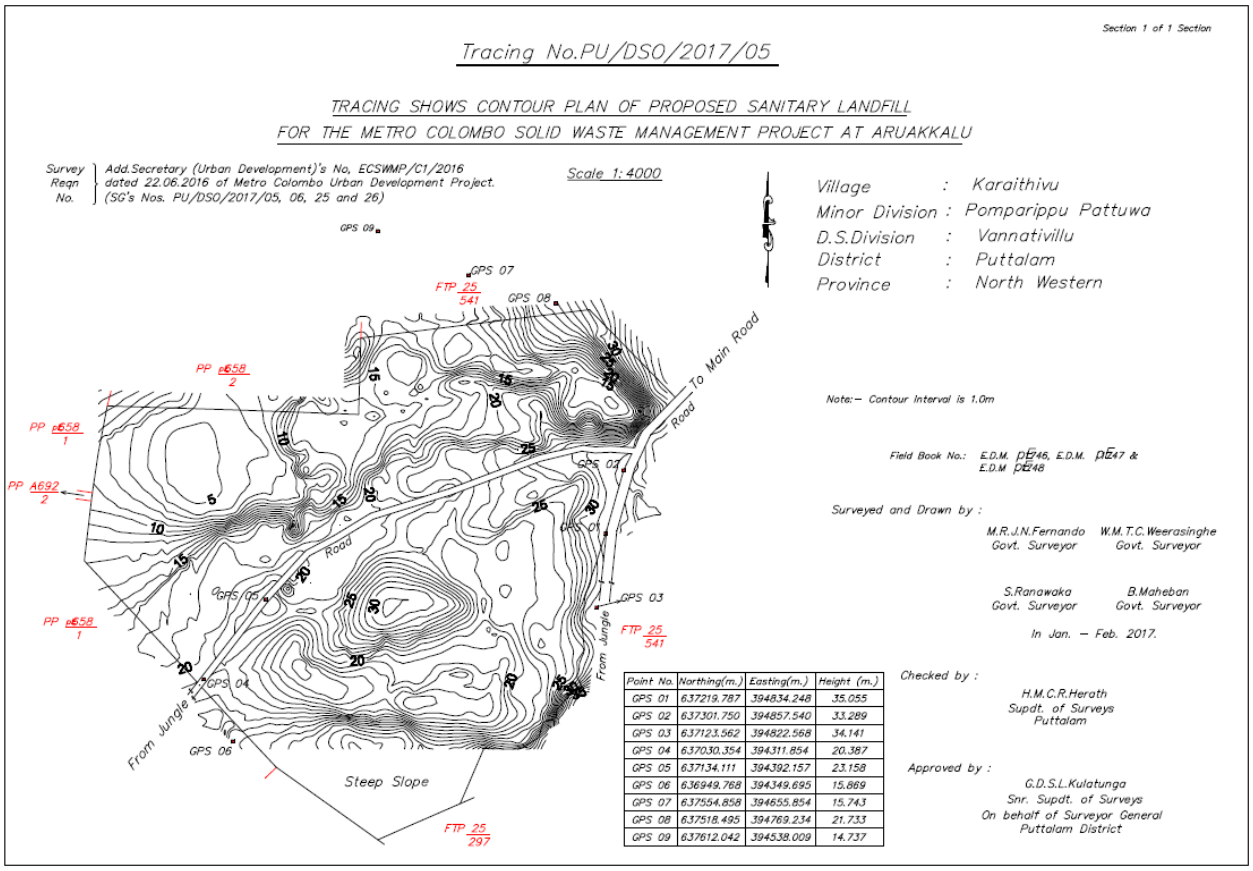


Figure 2.25: Contour Map of the Project Site

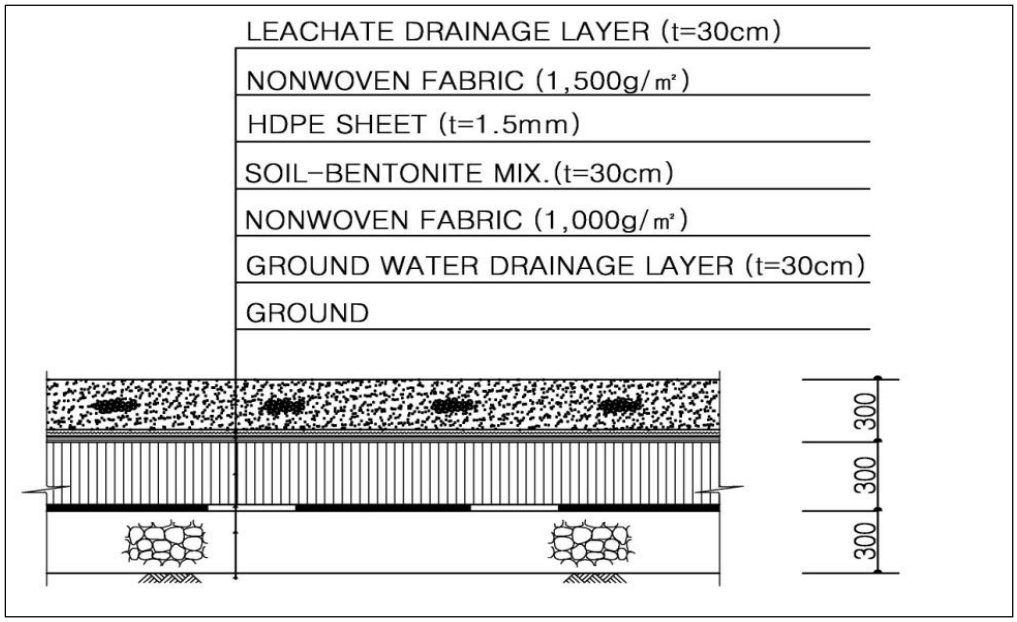


Figure 2.26: Bottom Liners and Drainage Layer Profile

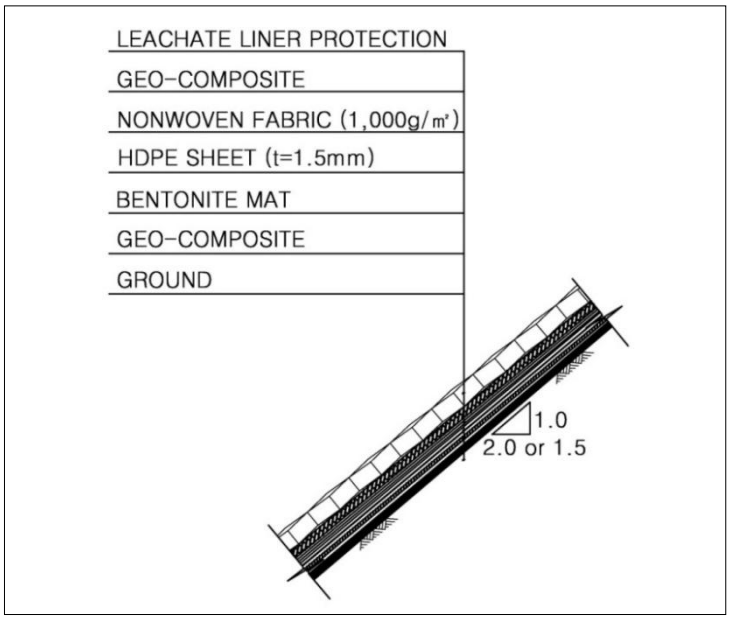


Figure 2.27: Side Slope Liner and Drainage Layer Profile

W.5 Landfilling Plan

Downward landfill method is adopted for the 1st platform (**Figure 2.28**). Upward landfill method will be adopted for other platforms (**Figure 2.28**). Downward landfill method is applied for the 1st platform for the purpose of protection of drainage layer and leachate pipeline facility. Upward landfill method is applied for the rest of the platforms because of ease of achieving planned landfill height. As stated before landfill will be raised to a height of 40 meters in five meter steps. **Figure 2.29 (A), 2.29(B) and 2.29 (C)** illustrate the profile of the landfill.

Downward Method

Upward Method

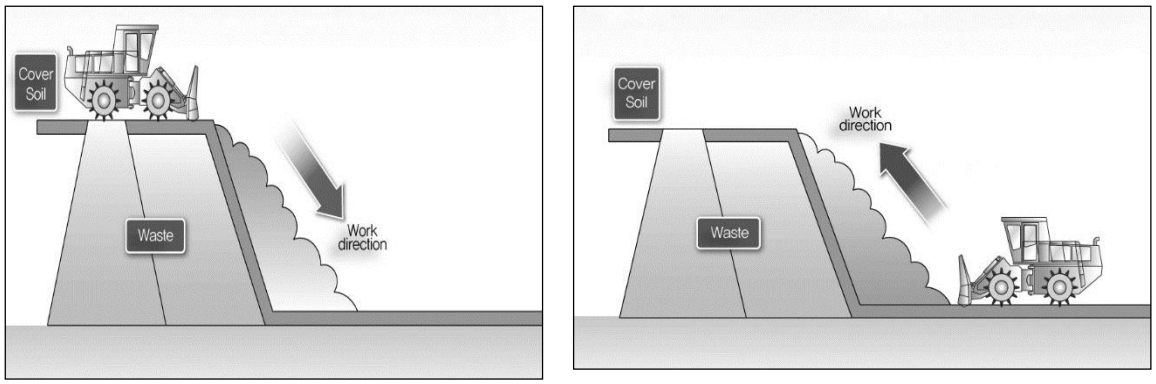


Figure 2.28: Illustration of Downward and Upward Landfill Methods

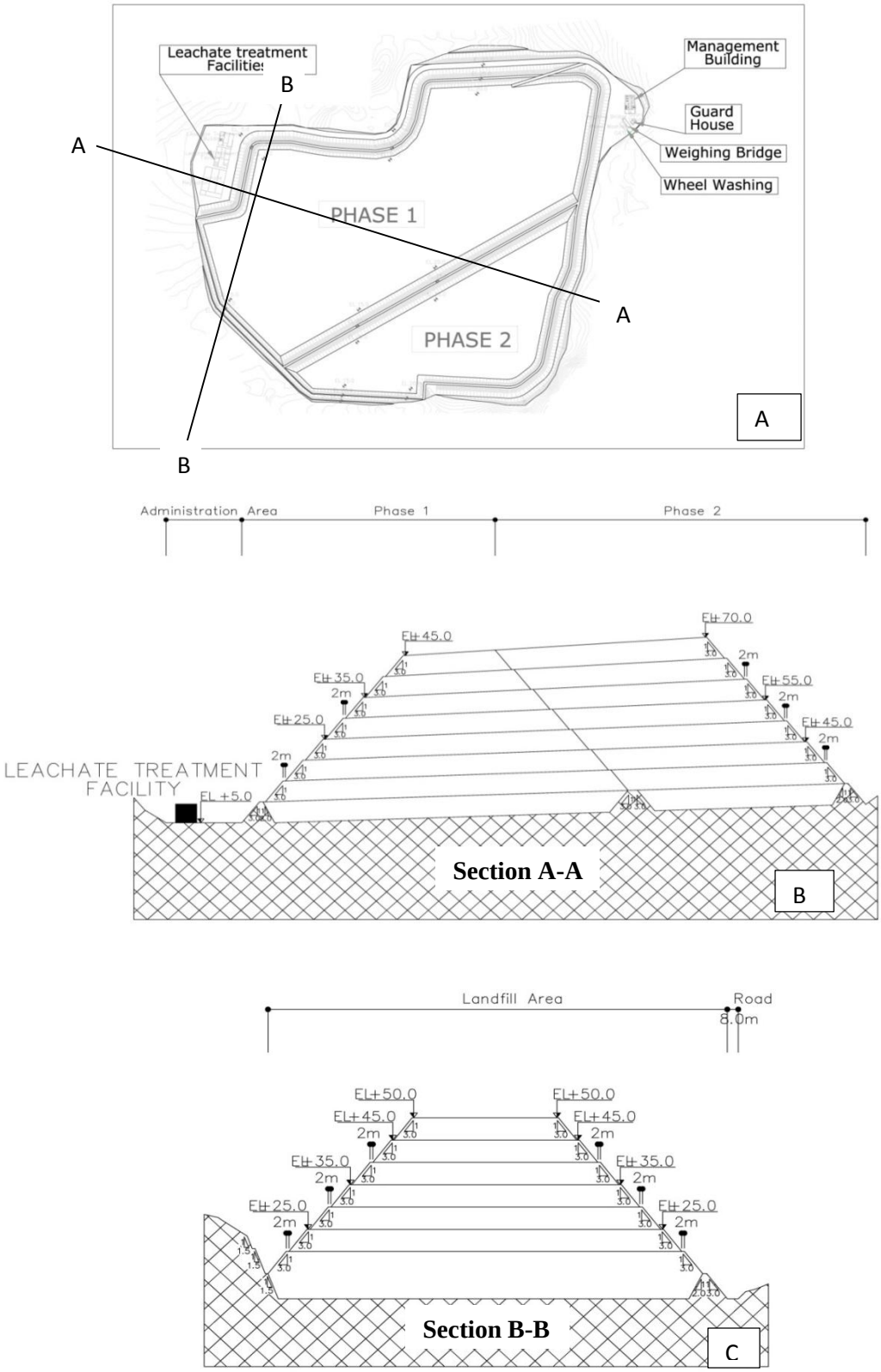


Figure 2.29: Landfilling Profile

X) Construction Details

Land clearing is needed to facilitate the landfill construction. Earthen embankment will be built to support the storage of waste as shown in **Figure 2.30**. This embankment will provide the support for the first five-meter layer of waste. Material for the embankment is available in the site area.

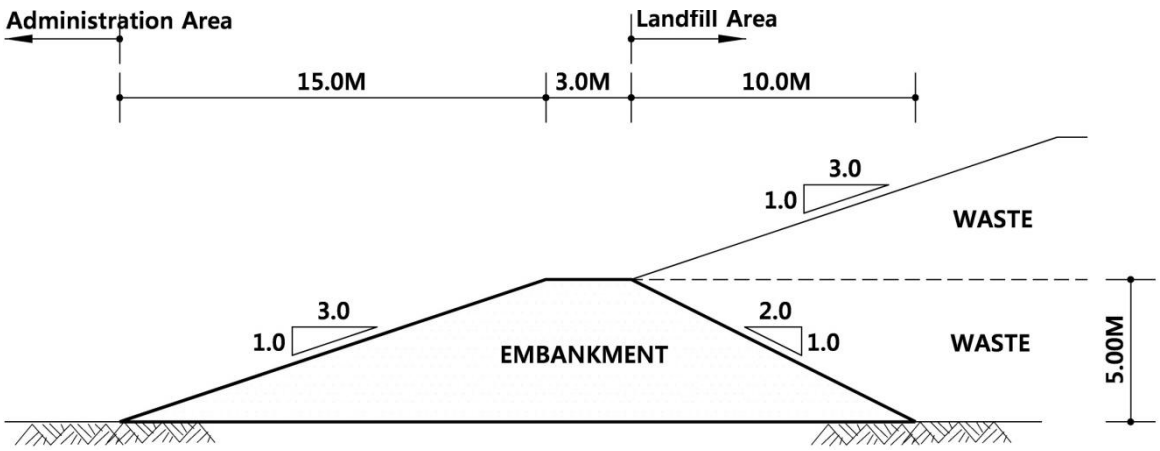


Figure 2.30 : Earthen Embankment (Solid Waste Storage Structure)

Although the groundwater table is below the landfill bottom during the dry period, there is a possibility of lifting of the groundwater table during the heavy rainfall period. To enable rainwater drainage during such periods a drainage layer is installed at the bottom of the landfill. To facilitate speedy drainage of inflows landfill bottom is maintained at 2% slope or more. The laying of liners on bottom and at the sides follows. **Figure 2.26** and **Figure 2.27** show the bottom and side liners.

Prior to the laying of drainage layer and the liners, it is necessary to get the landfill bottom nearly impermeable. According to the result of boring tests, the in-situ soil has a permeability coefficient of $k=2.68X10^{-3}$~$1.08X10^{-4}$cm/s. This permeability level is somewhat high. Therefore, it is difficult to achieve permeability coefficient less than $k=5\times10^{-10}$cm/s by compacting the in-situ soil while mixing it with bentonite along. Therefore a composite liner system is designed to bring down the permeability coefficient lower than $k=1\times10^{-7}$cm/s (as for clay) by mixing in-situ soil with bentonite and then reinforce with an additional HDPE sheet. This is a well proven approach adopted in similar situations. Lining materials used for the drainage layer is gravel and crushed stone.

After the preparation of the grade, the drainage layer will be laid (**Figure 2.26**). On top a non-woven fabric will be laid to prevent material loss from the soil-bentonite mix on the top. The HDPE sheet and mixed clay-mineral method is employed as the bottom liner as a composite liner system. The Bentonite mixed soil method is applied to secure permeability of 1×10-7㎝/Sec. In this case bentonite powder is mixed with in-situ soil and thereafter compacting. The complete bottom liner plan includes a drainage layer of gravel or crushed stone (D 25~40 mm, t = 30 cm) + 1,000 g/㎡ non-woven fabric on top of the ground. The bentonite – soil mixture (t = 30 cm) + HDPE sheet (t = 1.5 mm) will cover the top of the non-woven fabric and the top of the HDPE sheet will be covered with 1,500 g/㎡ non-woven fabric. Slope result in a situation where construction of leachate elimination layer or clay isolation layer difficult. In such situation solution to liner plan is based on syntactic material. Geotech style (1,000 g/㎡ non-woven fabric) and Geosynthetic Clay Liner (Bentonite matting of t = 1.5 mm) is used. Non-woven fabric (1,000 g/㎡) shall be laid on top of the HDPE sheet for its protection and Geo-net, that is Geo-composite replaced instead of waste tire, will be filled with gravel to act as the leachate removal and protection layer at the slope. Leachate collection pipe networks will be laid on the top of the liner layer inside the leachate collection gravel pack. The landfill development also includes the construction of the road network for the tipping trucks to access the site and the stromwater drainage arrangement. During landfilling, heavy equipment could cause damage to slope liners. Therefore, protection shall be installed on the slope liners. One approach is the use of waste tires filled with concrete/aggregate. There are other methods as well. It is expected for the design build contractor to select an appropriate method for the protection of slope liners based on economics and Environmental acceptability.

There are some activities of construction, which will continue with the operation i.e. with the land filling. These include extension of gas extraction piping arrangement, drainage and leachate collection arrangement, cell construction, and modification/extensions to the internal roads.

Y) Construction of other structures attached to the landfill facility

In addition to landfill, the ASL facility will include several other buildings and infrastructure. These include the following.

1. Leachate treatment building and facility
2. Leachate regulation tank
3. Treated effluent disposal system
4. Management building
5. Weighing bridge

6. Vehicle washing facility
7. Guardhouse and entrance
8. Vehicle parking area
9. Fencing
10. Eclectic fence to protect the site from wild elephants
11. Yard lighting
12. Internal road network
13. Power supply system including CEB transformer and switch gear
14. Water supply system
15. Tire Wash Bay
16. Strom Water Drainage
17. Artificial Wet Land
18. Oil Storage
19. Auxiliary facilities at the Sanitary Landfill are designed to support efficient operation and management of the Sanitary Landfill. These include stores, maintenance workshop, etc.

All the building and other civil structures are made as reinforced concrete structure on footing foundations. Infilling between column and beam framework will be by brick masonry or block masonry work. The roads used by the Cement Company to transport limestone are gravel roads. In this case the road pavement will be determined at the detailed design stage considering the need to maintain the 365 days operability perhaps with the exception of very intense rainy condition. Road drainage will be developed together with roads.

Z) Any other support facilities proposed

For other support facilities such as security system, vehicle-parking facility, site offices, storehouses, truck wash bay, maintenance shops, and fire protection facilities, see the details given in **Sections W.7**.

AA) Operational procedures for unloading and handling of waste, cell operation

Tipping trailers pick up the waste filled containers from trains at ATS and take the containers to the unloading location at the Sanitary Landfill. At the tipping location the container doors will be opened and unload the MSW from the rear end of the container. After unloading, the containers

are taken to the washing bay and after washing, they are taken back to the Transfer Station for loading to the train. The prime mover is then ready to take another loaded container.

In both phases, the Sanitary Landfill will be operated as landfilling cells (sub-divisions). Cells within a phase are separated by inter-cell bunds. Maximum cell height is 40 meters. Cells are filled with waste up to that height that height in eight steps of a 5 meter rise. Waste unloaded at each cell will be provided a cover of 150mm soil on a daily basis with compaction. The cover will be provided at the end of each working day. This will prevent fly and rodent attraction, blowing of papers, production of odors, fire hazards, etc.

BB) Availability of Cover Material

One advantage of the siting of the landfill at Aruwakkalu is that the material suitable for soil cover is easily found in the area. Quantities of soil required are estimated at 130,000 m^3 and 160,000 m^3 for the Phase I and Phase II respectively. The limestone mining work result is large quantities of excess soil due to removal of top soil to reach the limestone deposits. These materials are at present stockpiled around the mining site and in the nearby areas to the site. Portion of this soil is used in mine site restoration. However, still significant quantities are left unused. Investigation to use such excess soil will be carried out and the Cement Company is consulted in this regard.

If there will be a further deficit in the soil requirement suitable locations for earth quarries will be identified within the project area. Such quarries will be developed with the approval and subjected to the conditions laid down by the GSMB.

CC) Equipment and Machines

The equipment and machinery employed at the landfill includes.

- Construction equipment such as motor graders, bulldozers, excavators, tipper trucks, etc. will be used during construction for excavations work and operation of quarries, transport of earth, road construction, maintenance, and earth quarries. In addition light construction equipment such as compactors, small excavators, concrete mixers, etc., used in construction of buildings and other structures
- The machineries employed for waste transfer from ATS to ASL are identified under the Section describing the ATS. In addition, at the ASL site compactors and bulldozers will be used to spread and compact the waste. Motor-graders will be utilized for road work and the excavators and tipper trucks will be used for excavation of cover material and transport.

DD) LANDFILL GAS EXTRACTION SYSTEM

Mathematical model using the concept of first order reaction rate is used to estimate the landfill gas generation. In this case, EPA Landfill Gas Emission Model (ver. 3.02) was applied to estimate landfill gas emission. Major factors of EPA Landfill Gas Emission Model are Methane Generation Rate (k) and Potential methane generation capacity (Lo), and amount of landfill gas is calculated cumulatively at 0.1-year intervals using the following equation.

$$Q_{CH_4} = \sum_{i=1i}^{n} \sum_{=0.1}^{1} kL_o \left(\frac{M_i}{10}\right) e^{-kt_{ij}}$$

Where, n : year of the calculation-initial year of solid waste acceptance

j : 0.1 year time increment

i : 1 year time increment

k : methane generation rate(year^{-1})

L_o : potential methane generation capacity(㎥/Mg)

M_i : mass of solid waste accepted in the i^{th} year (Mg)

t_{ij} : age of the i^{th} section of solid waste mass M_i accepted in the i^{th} year

Methane generation rate constant (k) and potential methane generation capacity (Lo) are affected by composition of solid waste. In addition, landfill period and change of leachate amount also influence those parameters. Considering variability of waste composition and associated uncertainties. Thus it is difficult to accurately estimate these coefficients. However standards procedures are available for their estimation and widely used in estimation of these coefficient to predict the LFG production. In this case, the Project Development Consultants have used Lo [60 (㎥/Mg)] and k [0.18 (year-1)] which were used in Philippines to estimate the LFG generation. This coefficient will provide a lower Methane generation potential and faster generation rates. However, the EIA consultants recommend to use Lo [93 (㎥/Mg)] and k [0.04 (year-1)] values developed by Rajarathne W M and Kumara O M P A (2014) specifically considering the MSW generated in Colombo City. The two coefficients obviously register higher quantity of methane production and over a longer period. Concentration of methane gas in landfill gas is assumed to 50%, capture rate is assumed as 75%. **Table 2.13** presents the estimated gas generation and collection on annual basis. The same is illustrated in **Figure 2.31**.

Project development consultants have not included energy recovery presently. In this case, simple incineration is proposed for disposing the landfill gas. However, the project development consultants stated that energy recovery to be considered in the future after analyzing the landfill gas character and collection efficiency. They have also stated that if the energy recovery is viable

then switching to energy recovery instead of simple incineration. It seems that lack of inclination towards energy recovery is mainly due to lower potential and shorter period of methane generation predicted by the model application by the Project Development Consultant. On the other hand the use of Lo [93 (m³/Mg)] and k [0.04 (year-1)] values recommended by the EIA consultants indicates more viable picture for the energy recovery. For example as per **Table 2.13** the LFG production reach the peak in 2030 (44 x10^6 m^3/year) and the LFG production is substantially reduced by 2035 (18 x10^6 m^3/year). On the other hand the application of the Lo [93 (m³/Mg)] and k [0.04 (year-1)] values provide peak LFG production of 29 x10^6 m^3/year in 2030 and could provide LFG volume of 18 x10^6 m^3/year in year as late as 2043. The LFG generation rate for 2050 reported in **Table 2.13** will extend to 2110. The use of k value is linked to the moisture content in the waste and if necessary, the treated leachate could be used to improve the moisture content in the waste. However, the EIA consultants do not have any objection to the Project Development Consultants recommendations to go into energy recovery after studying the LFG character and recovery efficiency.

A simple incinerator is proposed on the surface to incinerate the collected landfill gas. Landfill gas is mixed with air and other supplementary fuels for incineration.

Table 2.13: Estimation of landfill gas generation

Year	MSW (ton/yr)	LFG generation		Collection Efficiency (%)	LFG Recovery (m^3/min)	Methane Recovery (m^3/min)	Landfill years
		(m^3/yr)	(m^3/min)				
2020	438,000	-	-	-	-	-	1
2021	438,000	8,736,355	16.62	75%	12.47	6.23	2
2022	438,000	16,033,573	30.51	75%	22.88	11.44	3
2023	438,000	22,128,721	42.10	75%	31.58	15.79	4
2024	438,000	27,219,816	51.79	75%	38.84	19.42	5
2025	438,000	31,472,257	59.88	75%	44.91	22.45	6
2026	438,000	35,024,194	66.64	75%	49.98	24.99	7
2027	438,000	37,991,021	72.28	75%	54.21	27.11	8
2028	438,000	40,469,124	77.00	75%	57.75	28.87	9
2029	438,000	42,539,009	80.93	75%	60.70	30.35	10
2030		44,267,922	84.22	75%	63.17	31.58	
2035		17,997,994	34.24	75%	25.68	12.84	
2040		7,317,438	13.92	75%	10.44	5.22	
2045		2,975,048	5.66	75%	4.25	2.12	
2050		1,209,564	2.30	75%	1.73	0.86	

Year	MSW (ton/yr)	LFG generation		Collection Efficiency (%)	LFG Recovery (m^3/min)	Methane Recovery (m^3/min)	Landfill years
		(m^3/yr)	(m^3/min)				
2055		491,772	0.94	75%	0.70	0.35	
2060		199,940	0.38	75%	0.29	0.14	

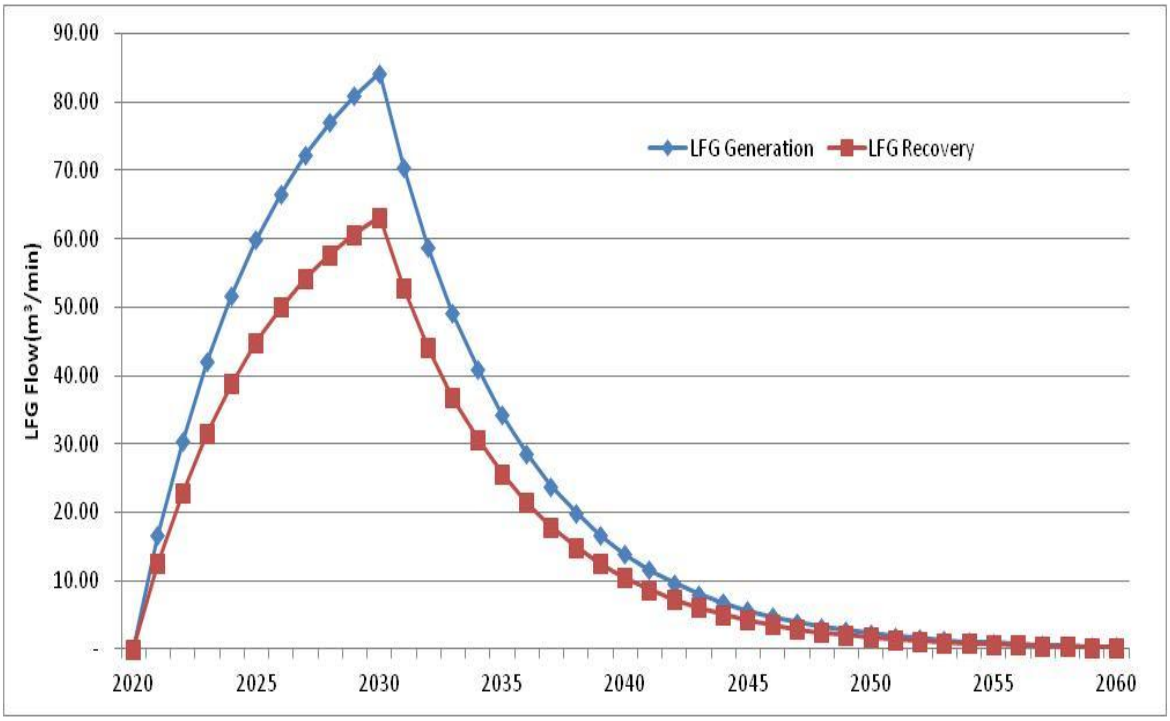


Figure 2.31: Estimated Gas Generation and Generation Pattern

EE) Leachate collection, treatment and disposal methods, quality of treated effluent / possibility of reuse and recycle

Leachate is drainage from solid waste. The purpose of leachate drainage system is to prevent the leachate, from accumulation above the lining system. The leachate collection system installed at the landfill will comply with the installation standards of leachate collection system as applicable to Sri Lanka and Internationally. The key standards followed in the installation are given below.

- Leachate collection/drainage layer

  ① Thickness: 30cm minimum

② Permeability coefficient: 10^{-3}cm/sec or more

③ Particle sizes of collection/drainage layer: 10/13mm, 16/32mm: in recent years more or less 50mm are in use

④ Bottom ground floor slope: 2 ~ 4%

- Leachate collection/drainage pipes

① Minimum diameter of collection/drainage pipes

- 15cm or more per U. S. EPA
- 20 and 30 cm pipe diameters are provided for lateral and main pipes to facilitate air flow to maintain semi aerobic condition in the landfill

② Pipe hole diameter of collection/drainage pipes: 1 cm or larger and smaller than the minimum diameter of collection/drainage pipes

③ Distance between holes: Collection pipe diameter; 1:1 ~ 1.5:1

④ Spacing distance between collection/drainage pipes: 15 ~ 40m (50m maximum)

The design capacity of solid waste for this project is 1200 ton/day. Therefore it is classified as Class D landfill as per the CEA Guidelines. In order to ensure a speedy leachate discharge, the requirement specified for Class D landfills is followed. **Table 2.14** provides details of leachate collection and drainage layer for the proposed landfill together with Sri Lanka and International standards. **Figure 2.32** depicts the leachate collection and drainage installation plan.

Table 2.14: Standards on the leachate collection & drainage layer

Items	General	Sri Lanka (Class D)	Aruwakkalu Landfill	Remarks
Thickness	30~50cm	30cm	30cm	-
Permeability coefficient	-	> 10^{-3}cm/sec	> 10^{-3}cm/sec	Drainage of leachate
Slope	> 2%	none	> 2%	Make full use of natural ground

Items	General	Sri Lanka (Class D)	Aruwakkalu Landfill	Remarks
Materials	Gravel, rubber, etc.	Gravel, rubber, etc..	Gravel or crushed stone (D25~40mm)	-
Spacing distance between collection/drainage pipes	20~50m	none	Inside and outside 30m	Minimize the cumulative effects of leachate
Collection and drainage materials	PVC or HDPE pipe	PVC or HDPE pipe (D100)	Perforated PE	main D300, branch D200

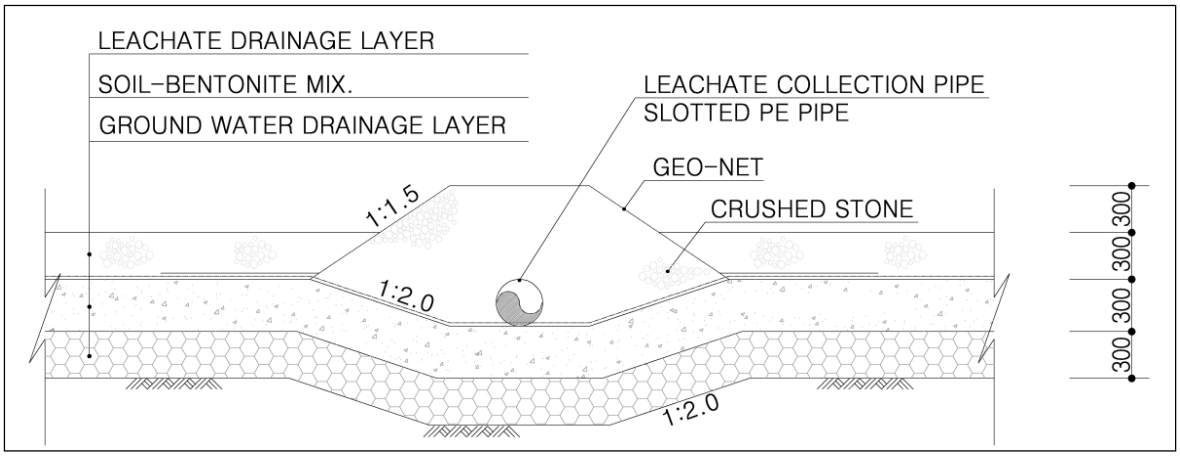


Figure 2.32: Leachate collection & drainage installation plan

The proposed project will implement all measures necessary to cut off the stormwater flowing into the landfill using measures such as perimeter embankments and cut off drains, diversion of stormwater flow, etc. Therefore, leachate will mostly from the moisture content of the waste and direct precipitation. Since direct precipitation, significantly dominates the leachate quantity, only the precipitation driven leachate volume is considered in the design leachate volume estimation.

Leachate volume from landfills will the leachate volume is calculated by using following equation.

$$Q = \frac{1}{1,000} (C_1 \cdot A_1 + C_2 \cdot A_2) \cdot I$$

Where, Q : leachate amount (㎥/d)

I : rainfall intensity (mm/d)

C : Leaching factor

A : landfill area (㎡)

Leaching factor is coefficient to show the ratio of leachate in relation to total precipitation (rainfall) on the Sanitary Landfill. Leaching factor varies widely ranging from 0.2 to 1.0 depending on the climatic condition, type of solid waste and the terrain and geological conditions of Sanitary Landfill. Generally leaching factor used in the Sanitary Landfill design varies as follows.

- For landfilling area 0.4~0.7 taken as 0.5 for the design
- For landfill completed areas 0.2~0.4 taken as 0.3 for the design

For ASL the C value is taken as 0.5 for the landfilling section and 0.3 for the completed area. For the application of the above equation, the daily average rainfall was calculated using the height monthly average rainfall data reported by the Department of Meteorology for 30-year period from 1960 to 1990. Accordingly 250.3 mm rainfall is taken as the maximum average rainfall, which occurs in the month of November. Accordingly, the daily precipitation of leachate generation rate calculation is taken as 8.3 mm/day. Accordingly, the daily average production of leachate is calculated and presented in **Table 2.15**.

Table 2.15: Standards on the leachate collection & drainage layer

Item	Area (A, ㎡) Landfilling	Leaching Factor(C) Landfilling	Daily precipitation (mm)	Leachate generation (㎥/day)	Leachate treatment facility capacity (㎥/day)
Phase 1 Landfill In operation	141,500	0.5	8.3	587.0	600.0
Phase 1 Landfill Completed	141,500	0.3	8.3	352.0	
Phase II Landfill In operation	56,000	0.5	8.3	232.0	600.0 [352+232=584]

In general, the leachate regulation pond is placed provided as 10 times more than the design the leachate volume. Based on this result, the capacity of leachate regulation pond/tank is calculated as 6000 m^3. The maximum one in ten-year rainfall of 24-hour duration is 30mm. The volume of leachate generated by the said rainfall event is 5500 m^3. Therefore, it is within the leachate retention pond capacity.

Like for any other sanitary landfill while the leachate volume varies with time the characteristics of leachate also varies with time for the ASL. The factors that influence the leachate character include: waste characteristics, age of the waste in the landfill, degree of stabilization of solid waste, storm water penetration volume, compressive strength, solid waste moisture contents, and size of the landfill area. Thus, it is hard to predict the leachate characteristics accurately by mathematical or analytical way. As a result leachate characteristics at similar other landfills is the best way to establish the expected leachate character. In this case, leachate characters at two landfills were used to postulate the leachate characters of ASL. These are Dompe landfill in Sri Lanka and K Landfill in Korea. Leachate character of those two landfills and the leachate character for ASL considered in the designs are reported in **Table 2.16**.

Table 2.16: Leachate Characters of Two Existing Landfills and Design Leachate Character for Aruwakkalu Landfill

Items		COD (mg/ℓ)	BOD (mg/ℓ)	SS (mg/ℓ)	NH^{+4} (mg/ℓ)	T-P (mg/ℓ)
Sri Lanka	Range	135~10,680	15~2,000	440~2,940	12~1,625	1.9~8.1
K landfill in Korea		6,000	4,000	440	1,500(TN)	12
ASL - Design		4,000	2,000	500	1,200	8

The BOD, COD and nitrogen are the major design factors in selecting the leachate treatment process. BOD and COD levels will be extremely high at the early stages of the fill whereas the nitrogen level is low. This situation changes with time where COD and BOD decreases while the nitrogen content increases. Therefore, the plant will be designed to respond to such variation in leachate quality. Furthermore, leachate may contain heavy metals, which could be toxic. Due to environmental reasons it was decided not to release treated effluent to any waterway that would carry the treated effluent to the lagoon. Therefore, the treatment standard was set at the treated effluent discharge standards for disposal of treated effluent to inland water. Few important parameters of the said standards are reported in **Table 2.17**. Accordingly, Table **2.18** presents the influent and effluent quality of the leachate treatment plant.

Table 2.17: Tolerance Limits for the Discharge of Waste in to Inland Surface Waters

Items	TSS (mg/ℓ)	pH -	BOD (mg/ℓ)	COD (mg/ℓ)	P (mg/ℓ)	TKN (mg/ℓ)	NH^{+4} (mg/ℓ)	CN (mg/ℓ)	Pb (mg/ℓ)	Hg (mg/ℓ)
1	50	6~8.5	30	250	-	-	50	0.2	.1	.0005

Table 2.18 Expected Influent and Effluent Quality to the Treatment Plant

Items	Q (m^3/d)	COD_{Cr} (mg/ℓ)	BOD_5 (mg/ℓ)	TSS (mg/ℓ)	NH_4^+-N (mg/ℓ)	T-P (mg/ℓ)	Remarks
Influent	600	4,000	2,000	500	1,200	6	
Effluent	600	<250	<30	<50	<50	-	Guideline in Sri Lanka

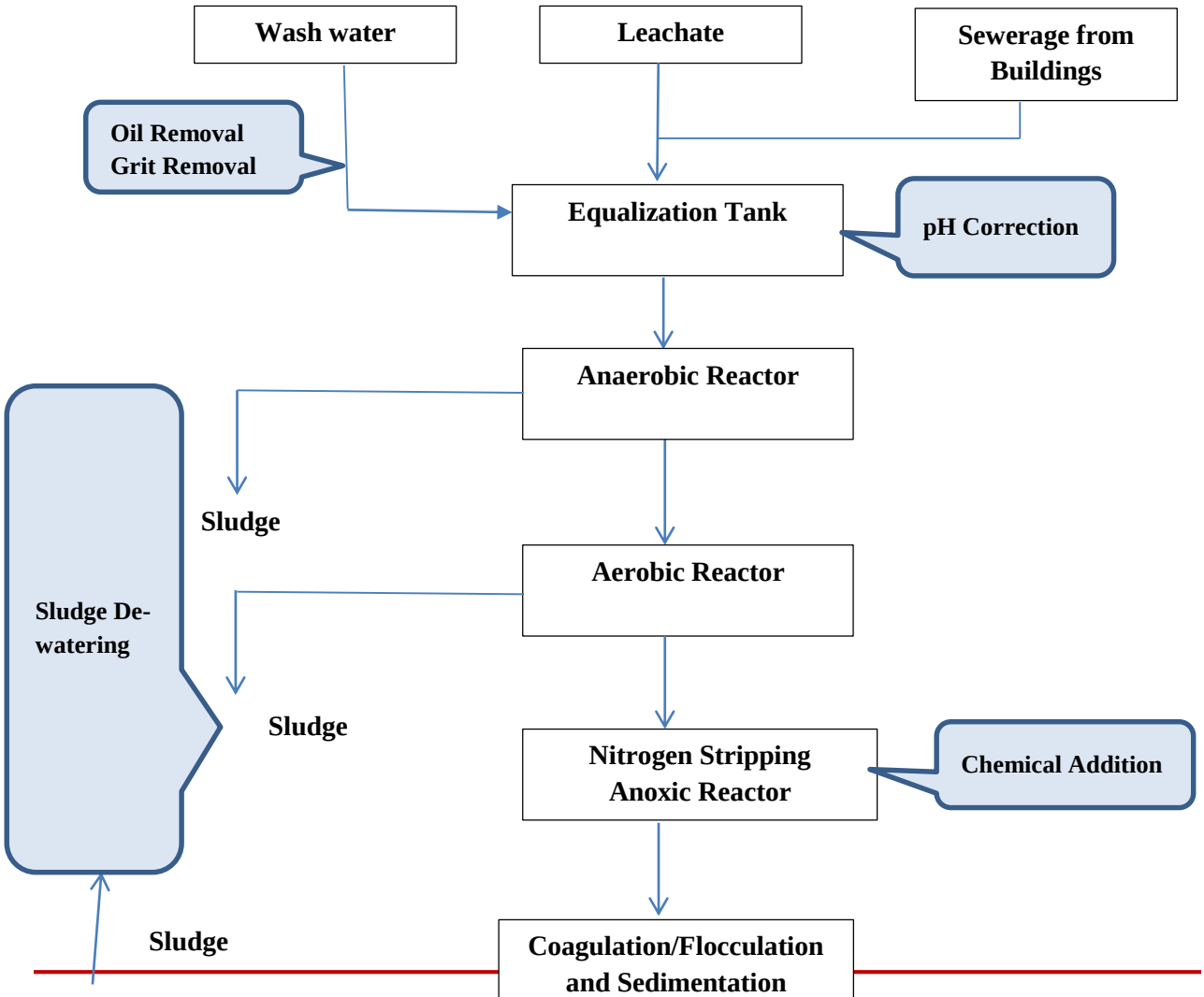
Initially, all key wastewater streams generated at the site will be sent to the equalization tank. These include:

- Leachate generated in the landfill
- Oil and grit containing washing bay wastewater, through an grit separator and oil inceptors to separate grit and oil
- Sewage generated from the management building etc.

The conceptual wastewater treatment flow chart is shown in **Figure 2.33.** The sludge collected from treatment process will be dewatered and dried in drying beds. Dried sludge will be disposed in the landfill site. The wastewater from the drying beds will be redirected to the equitation tank.

Leachate is having very high COD and BOD levels thus well suited to anaerobic biological treatment. During anaerobic treatment biological matter is reduced to methane and carbon dioxide and removed reducing the COD and BOD with very little cell production. The effluent from anaerobic treatment is then subjected to aerobic treatment for further reduction of COD and BOD. This process will convert ammonia nitrogen to nitrate. Thereafter wastewater is subjected anoxic biological condition to allow nitrogen striping. After nitrogen stripping the effluent will be subjected to floaculation and coagulation process using alum and flocculation aids. Treated effluent is send to a retention pond.

There will be significant change of quality and quantity of leachate with the age of the fill. Accordingly the treatment system will be built to function in in a wide range of wastewater strength and flow.



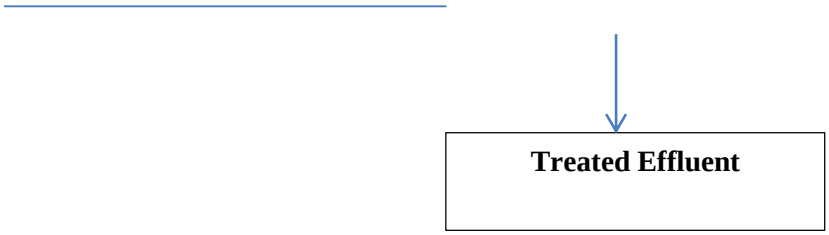


Figure 2.33: Conceptual Wastewater Treatment Flow Chat

FF) Details of buffer zone to be maintained around the landfill site

There will be no buffer zone around ATS and ASL sites planned presently. Nevertheless, two layers of fencing will protect both sites as follows.

- The boundary of the site, including the Transfer Station, Rail Crossing Station, and the Sanitary Landfill shall be fenced with 4m high chain link fence to prevent wild animals.
- Additional electric shock fence will be provided to protect the site from wild elephants.

GG) Control strategies for noise, vibration and dust

Excessive noise and disturbances that may be caused by dusts or vibrations emitting from the landfills are a nuisance and causes discomfort to the neighborhood. These nuisances are usually caused by the waste transport activities/vehicles and machinery used at the site. For the landfills located near populated areas, it may be necessary to improve on the way the site is operated by reviewing the waste transportation system, and the selection and use of machinery and equipment to limit the effects of noise, vibration and pollution. The ASL site is located far from human habitat as well as any declared wildlife habitat. Thus, it is not a sensitive site in terms of noise, vibration, and dust. In addition, the area is continuously being used for limestone quarrying. The machineries used in the construction and during operation are similar to those used at the existing quarry site. Thus, specific measures to suppress noise and vibration are not considered.

Nevertheless, use of soil as cover material, soil transport and stockpiling of soil could lead to windblown dust problem. Therefore, as dust suppression measures spraying of treated effluent will be carried out on soil stockpiles, during application of soil as a cover and prior to transport of soil in tippers.

HH) Ground water monitoring plans

Purposes of groundwater monitoring around the Sanitary Landfill are:

a) To monitor weather the landfill isolation (by leachate collection system) is effective;

b) To monitor the extent of spread of leaked pollutants to groundwater, if the leachate isolation system is breached

For collection of samples for monitoring groundwater, wells will be set up. The two wells will be installed downstream of the fill site. Locations of the two wells will be determined later with the assistance of the ground well contractor. **Figure 2.34** illustrates a typical groundwater well to be installed at the site. Two monitoring wells are planned considering the configuration of ASL, topography, and groundwater flow direction. Both wells will be located downstream of the site in the general direction of groundwater flow. Monitoring will use water quality data obtained prior to landfill operation as baseline data for comparison.

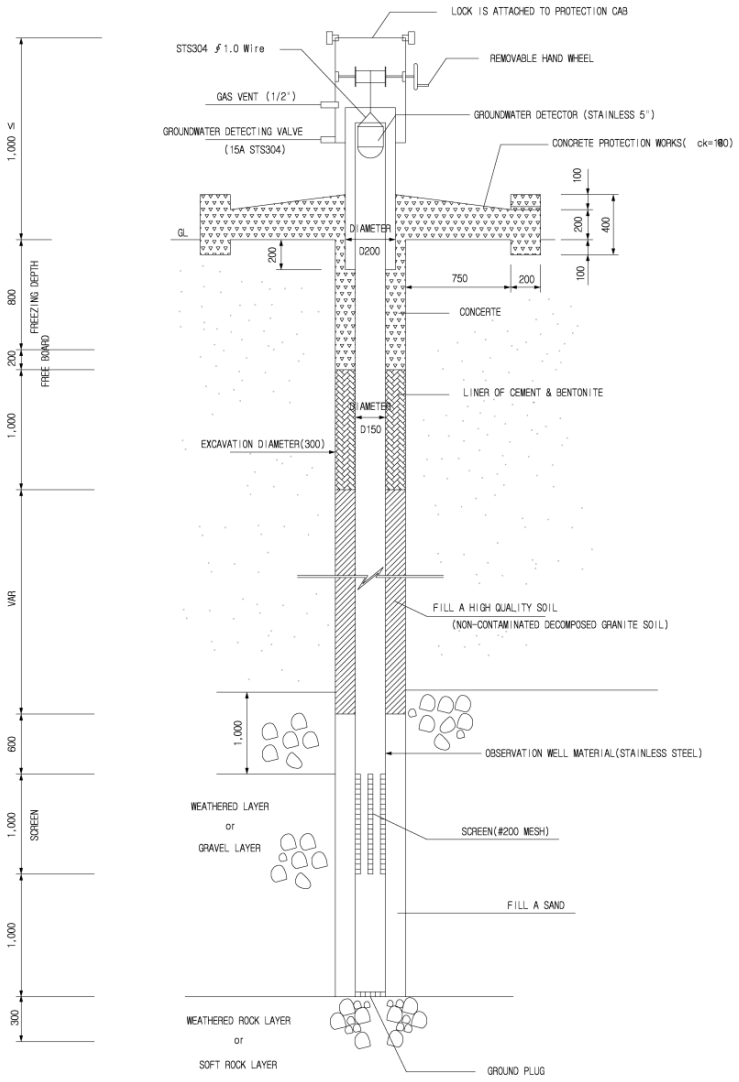


Figure 2.34: Groundwater inspection well detail

II) Final closure procedure

The proposed landfill will be operated for 10 years and then maintained for another 10-15 years until the gas generation will be significantly reduced and leachate become less and less harmful. However, in the opinion of the EIA consultants there is a possibility of significant gas generation for a long period. Since this is a long time, the planning requirement at that time could be vastly different to the present planning considerations. In addition, the energy recover may be incorporated in the future as part of the landfill operation. Therefore the final closure plan was

proposed to be developed towards the end of the operation period considering the requirements at that time including the land-use.

JJ) Development and restoration

This will be considered at the time closure procedure will be prepared.

2.1.4 Construction and operation procedure

2.1.4.1 Construction and Implementation with time frame

This Project will be implemented through a Design & Build Contractor. Detailed Design including field surveys and investigation work are expected to take four months from the award of the Contract. Construction work will commence only after the designs were completed and accepted by the developer. However, it is possible that some initial works such as temporary site office and land preparation to be carried out in parallel with the detail designs. Construction including improvements to existing infrastructure will take 1.5 to 2 years. This includes time for performance testing and the period of Test Operation.

The construction of the Kelaniya Transfer Station will last 18 months, including 12 months of equipment procurement. The building of railway infrastructure improvements of the Kelaniya approach railway and the Aruwakkalu approach railway will take 7 months and 6 months respectively.

Construction of Sanitary Landfill, will take 2 years, taking into account the rainy season. Electronic fence will be installed first to protect construction sites as well as labor facilities from aggressive elephants.

The complete project schedule is provided in **Figure 2.35**

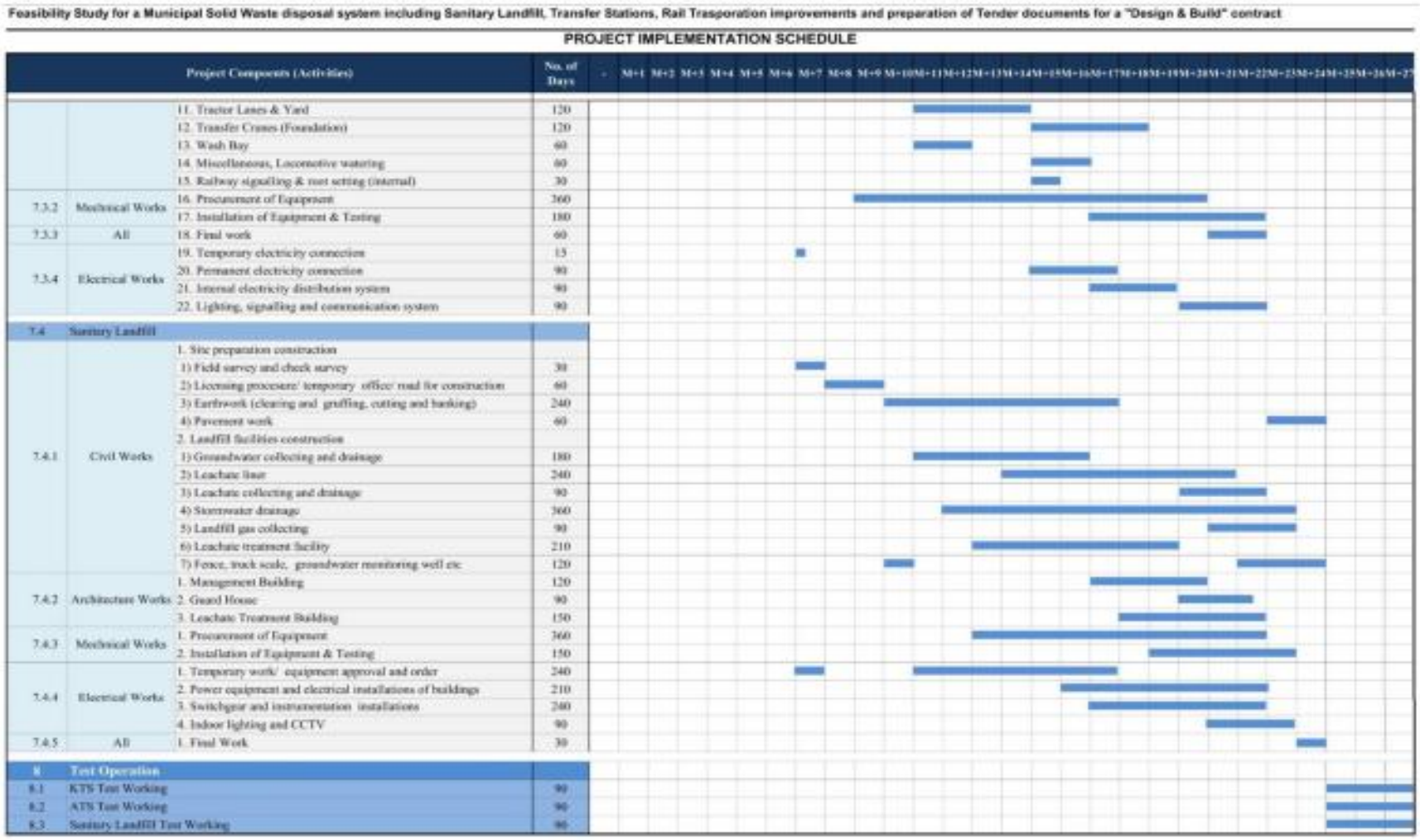
2.1.4.2 Operation Arrangement

Developer plans to establish a fully state owned company to handle the operation. This company will be responsible for the operation of all the facilities built under this project and their maintenance. While the landfilling will be over by 2030, the LFG and leachate generation will continue for a considerable period further. Therefore the O&M Company will remain functional for considerable period after the end of landfilling. As such they will also handle the landfill closure. This will include landscaping of the filled site as well as reforestation. Since it is expected that more landfills in the area to be opened after 2030 the future such projects are expected to be initialed and implemented by this Company.

Feasibility Study for a Municipal Solid Waste disposal system including Sanitary Landfill, Transfer Stations, Rail Trasporation improvements and preparation of Tender documents for a "Design & Build" contract

PROJECT IMPLEMENTATION SCHEDULE

	Project Components (Activities)		No. of Days
1	Approval of Feasibility Study and IEE		30
2	International Competitive Bid (ICB) for Design & Build Contract		30
3	Evaluation of Design & Build Bidding		15
4	Design & Build Contractor Negociation and Award		15
5	Detailed Design (Field Survey, Check Survey, Detailed Design Approval)		120
6	Construction Supervision		630
7	Construction Activity		
7.1	Kelaniya Transfer Station (KTS)		
7.1.1	Civil Works	1. Temporary site office and stores	30
		2. Land preparation and levelling	60
		3. Preliminary setting out	15
		4. Piling work & load testing (internal)	120
		5. Fencing	60
		6. Front Wall , Gates & Barriers	60
		7. Front Office	90
		8. Workshop & Workers Rest	120
		9. Main Structure	210
		10. Up Ramp & Down Ramp	120
		11. Effluent Treatment Building	120
		12. Weigh Bridges (2 Nos)	30
		13. Control Tower	120
		14. Rail Tracks (Internal)	120
		15. Tractor Lanes & Yard	120
		16. Transfer Cranes (Foundation)	120
		17. Miscellaneous, Locomotive fueling & watering	90
7.1.2	Mechnical Works	18. Procurement of Equipment	360
		19. Installation of Equipment & Testing	180
7.1.3	All	20. Final work	90
7.1.4	Electrical Works	21. Temporary electricity connection	10
		22. Permanent electricity connection	120
		23. Internal electricity distribution system	120
		24. Lighting, signalling and communication system	120
7.2	Railway Infrastructure Improvement		
7.2.1	Kelaniya Approach Railway		210
7.2.2	Aruwakalu Approach Railway		180
7.3	Aruwakkalu Transfer Station(ATS)		
7.3.1	Civil Works	1. Temporary site office and stores	15
		2. Land preparation and levelling	60
		3. Preliminary setting out	15
		4. Fencing	30
		5. Gates & Barriers	30
		6. Approach & Internal Roads	60
		7. Public Roads	120
		8. Project & Railway Office	120
		9. Workshop & Workers Rest	120
		10. Rail Tracks (Internal)	90



Feasibility Study for a Municipal Solid Waste disposal system including Sanitary Landfill, Transfer Stations, Rail Trasporation improvements and preparation of Tender documents for a "Design & Build" contract

PROJECT IMPLEMENTATION SCHEDULE

		Project Components (Activities)	No. of Days
		11. Tractor Lanes & Yard	120
		12. Transfer Cranes (Foundation)	120
		13. Wash Bay	60
		14. Miscellaneous, Locomotive watering	60
		15. Railway signalling & root setting (internal)	30
7.3.2	Mechincal Works	16. Procurement of Equipment	360
		17. Installation of Equipment & Testing	180
7.3.3	All	18. Final work	60
7.3.4	Electrical Works	19. Temporary electricity connection	15
		20. Permanent electricity connection	90
		21. Internal electricity distribution system	90
		22. Lighting, signalling and communication system	90
7.4	Sanitary Landfill		
7.4.1	Civil Works	1. Site preparation construction	
		1) Field survey and check survey	30
		2) Licensing processes/ temporary office/ road for construction	60
		3) Earthwork (clearing and grubbing, cutting and banking)	240
		4) Pavement work	60
		2. Landfill facilities construction	
		1) Groundwater collecting and drainage	180
		2) Leachate liner	240
		3) Leachate collecting and drainage	90
		4) Stormwater drainage	360
		5) Landfill gas collecting	90
		6) Leachate treatment facility	210
		7) Fence, truck scale, groundwater monitoring well etc	120
7.4.2	Architecture Works	1. Management Building	120
		2. Guard House	90
		3. Leachate Treatment Building	150
7.4.3	Mechincal Works	1. Procurement of Equipment	360
		2. Installation of Equipment & Testing	150
7.4.4	Electrical Works	1. Temporary work/ equipment approval and order	240
		2. Power equipment and electrical installations of buildings	210
		3. Switchgear and instrumentation installations	240
		4. Indoor lighting and CCTV	90
7.4.5	All	1. Final Work	30
8	Test Operation		
8.1	KTS Test Working		90
8.2	ATS Test Working		90
8.3	Sanitary Landfill Test Working		90

Figure 2.35: Project Implementation Schedule

2.1.4.3 Site preparation activities at the transfer station and landfill site

Site preparation activities are part of construction work and covered in itemized manner in **Section 2.1.4.3**.

2.1.4.4 Construction and operational activities at transfer station and landfill

A Kelaniya Transfer Station

Construction Activities at KTS	**OperationalActivities at KTS**
• Temporary site office and stores • Land preparation and leveling • Preliminary setting out • Piling work & load testing (internal) • Fencing, Paving, Water supply • Front wall, Gate & Barriers, Internal roads • Workshop & Workers rest • Main Structure, Earthwork, Stormwater drainage • Up Ramp & Down Ramp • Effluent Treatment Building • Weigh Bridges (2 Nos) • Control Tower • Rail Tracks (Internal) • Tractor Lanes & Yard • Transfer Cranes (Foundation) • Miscellaneous, Locomotive fuelling & watering • Procurement of equipment (Tractors, Trailers, Shovels, Transfer Cranes, Compactors,) • Temporary electricity connection • Permanent electricity connection • Internal electricity distribution system • Lighting, signaling and communication system, CCTV • Test working	• Receiving, weighing, toll charging and record keeping of incoming RCVs • Movement control of RCVs • Controlling of Shovels and compactors • Controlling of the movements of the tractors and transfer crane • Controlling of Train Movements • Security and Lighting Control • General Administration

B Aruwakkalu Transfer Station

Construction Activities at ATS	Operational Activities at ATS
• Temporary site office and stores • Land preparation and leveling • Preliminary setting out • Fencing • Gate & Barriers • Approach & Internal Roads • Public Roads • Project & Railway Office • Rail Tracks (Internal) • Tractor Lanes & Yard • Transfer Cranes (Foundation) • Wash Bay • Miscellaneous, Locomotive watering • Railway signaling & root stetting (internal) • Procurement of equipment (Tractors, Trailers, Transfer Cranes, etc.) • Temporary work/ equipment approval and order • Power equipment and electrical installations of buildings • Switchgear and instrumentation installations • Indoor lighting and CCTV	• Controlling of the movements of the tractors and transfer crane • Controlling of Train Movements • Security and Lighting Control • General Administration • Dispatch waste to Sanitary Landfill.

C Aruwakkalu Sanitary Landfill

Construction Activities at ASL	Operational Activities at ASL
• Field surveys and investigations • Licensing procedure/ temporary office and access road for construction • Earthwork (clearing, cutting and banking) • Pavement work • Groundwater collecting and drainage work • Leachate interception construction work • Leachate collecting and drainage work • Rainwater drainage work	<u>Landfilling</u> • Obtaining cover soil (try to use soils gotten from construction of the landfill) • Landfilling and covering • Stormwater drainage • Leachate drainage • Real-time landfill operation and management system <u>Management of facilities</u>

Construction Activities at ASL	Operational Activities at ASL
• Landfill gas collecting work • Leachate treatment facility • Other facility construction works: Fence, weighing bridge, groundwater inspection well, workshop, etc. • Administration office, security office, leachate treatment Building • Mechanical field : Equipment order/ equipment installation • Electric field : Temporary work/ equipment approval and order/ power equipment and electrical installations of buildings/ switchgear and instrumentation installations/ indoor lighting and CCTV • Test working : Receiving the Transmitted Electricity, A Single Trial Run, Multiple Trial Runs • Install Real-time Landfill Operation & Management System	• Road • Storm water drainage facilities • Leachate treatment facilities • Gas collectors • Landscaping facilities • Auxiliary facilities <u>Equipment and Machinery</u> • Landfilling and covering equipment • Mechanical, electrical, and surveying equipment <u>Environmental and Saferty Management</u> • Scattering of waste, diffusion of malodor, pollution of groundwater, noise • Fire prevention, firefighting equipment, ground sinking, vehicle safety <u>Other Areas of Management</u> • Storm water drainage methods • Leachate treatments methods • Groundwater quality study methods • Gas management/treatment methods • Maintaining stability of structures and the foundation • Methods for studying Environmental pollution in surrounding areas

D Railway Infrastructure Improvement

Construction Activities	**Operational Activities**
• Kelaniya approach railway • Aruwakkalu approach railway (Incl. Transfer Station railway) • Signaling System	• Railway track maintenance • Railway wagon and locomotive repair and maintenance • Railway signaling system operation and maintenance (area managed by the development) • Coordination with SLR

2.1.5 RELOCATION OF SETTLERS

There is no involuntary relocation of people involved in the project.

2.1.6 Financial cost for the project

Estimated capital and operational costs are provided in **Table 2.19** and **Table 2.20** respectively.

Table 2.19: Construction Cost

Item		Qty.	Price (USD)	Remarks
1	Transfer Station (KTS & ATS)	1	26,300,000	
2	Aruwakkalu Sanitary Landfill	1	35,740,000	Phase 1
3	Railway Connectivity Line	1	7,620,000	
4	Equipment	1	14,610,000	Locomotives & Wagons
5	Sub-Total		84,270,000	Including Engineering fee
6	Construction Supervision fee	1	6,740,000	8% of 5
7	Contingencies	1	8,420,000	10% of 5
Total			**99,430,000**	5+6+7

Table 2.20: Operation and Maintenance Cost

Facility	Unit	Operation & Maintenance Cost
KelaniyaTransfer Station	USD/year	1,329,828
Railway Transportation Cost		1,325,424
Aruwakkalu Transfer Station		575,688
Aruwakkalu Sanitary Landfill		1,301,343
Total		4,532,283
Design Capacity of the facility	Tons/day	1,200
Annual Capacity	Tons/year	438,000

Operation & Maintenance cost per Ton of MSW	**USD**	**10.35**

2.2 Analysis of alternatives

2.2.1 No action alternative:

"No action alternative" would mean the proposed activity (that is the overall project) would not take place, and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward. The "no-action" alternative is developed for two reasons. It is almost always a viable choice in the range of reasonable alternatives, and it sets a baseline of existing impact continued into the future against which to compare impacts of action alternatives. This is important context information in determining the relative magnitude and intensity of impacts. No action alternative will pave way for completely avoiding harmful socio economic and environmental impacts. Avoiding harmful socio economic and environmental impacts will be similar to having a situation where there will be no stress to existing natural habitats, floral and faunal assemblages. In absolute terms, it will also create no implications to the society in the short term. However, when compared to short terms gains as against the long term incremental socio economic benefits the proposed project amply justify that no action alternative will be of very little relevance.

2.1.2 Technological Options for the proposed project:

The proposed project seeks to collect and transfer the wastes from the Colombo metropolitan area to the landfill in Puttalam by rail using a loading transfer station at Kelaniya and unloading transfer station at Aruwakkalu from which the wastes will be transferred to the landfill. Another component added to the project in the feasibility study is to ensure that measures to be taken to minimize waste generation, improve segregation and composting capacities by the respective local authorities.

The option of transferring waste to the landfill by train has been evaluated against other options such as options to have a landfill close to the Colombo, which will not be involved a long distance transfer of wastes by train.

Other technological options available are the options such as using the waste for productive purposes other than using the same for a landfill.

The first options was not found viable, being the first option confronted with difficulty in finding land for sanitary landfilling in any of the closets areas in Colombo and its suburbs. The previous efforts made in this regard at, Meethotamulla, Blohemendal, Karadiyana, and Dompe had been found with strongest resistance from the public.

The second option has been evaluated quite positively and plans are under consideration to use the wastes for producing energy. Already the Ministry has given green light for two private investors to construct waste to energy projects using the wastes in Colombo Metropolitan area and Gampaha District. There is potential that the two projects will use most of the wastes generated in these areas by 2020, when the

projects are ready for commissioning. Still the landfill in Aruwakkalu will be required as a disposal area for the bottom ash which is generated from the two power plants.

Further, ashes and the inert materials could be transported by the normal containers by existing roads. In the meantime, the life time of the landfill is also limited and could be used only up to 10 years.

However, the project considered the landfill is the more suitable immediate option for the existing solid waste problem in the Metro Colombo Area until long term solutions are identified

2.1.3 Alternative site for transfer station

The following sites have been considered for the Transfer Station by the project.

1. Kelaniya Transfer Site

The previously demarcated sites were found unsuitable (Bloemendhal and Meethotamulla sites). No other suitable site which will have proximity to metropolitan Colombo area could be found for a transfer station mainly due to inaccessibility to the railway station, environmental and geo political issues. Although the land demarcated is on the marshy area which is considered a flood water retention area, the designs indicate that the marsh will not be reclaimed. Since there is already an open waste dump located in the area, there are pressing social issues mounting against using the existing land for an open dump area. The proposed transfer station is considered by the community as an option to get rid of the open dump site.

3 Alternative sites for the sanitary landfill

The quarry site (already mined and left for reinstatement) close to the mining areas used by Siam City Cement (formerly Holcim) was considered as an alternative option to the previously earmarked site for the landfill which was close to Gangewadiya. As this site was located in the buffer zone of the Wilpatu National Park and it has not been approved by the CEA. The mined areas identified now to be prepared to suit the requirements of a sanitary landfill are far away from the previously demarcated site with less ecological impacts. Therefore, this option will be considered for the present proposed landfill activities.

Different layouts options have been provided in the feasibility report. The summary of the alternatives considered in the feasibility report are given in the following **Table 2.12**.

Table 2.21: Summary of the technological options considered in the design

S.No	Activity	Options considered	Selected option
1	Design option for the Transfer Station	Three options were considered as follows	Option (3)
		Option 1	Place the transfer station in almost parallel with the existing railway that is vertical layout All RCVs are from Manelgama Road that is connected from Colombo-Kandy Highway.

S.No	Activity	Options considered	Selected option
			Site land utilization is economical as two large plots of lands are kept vacant for other development projects.
		Option 2	Place the transfer station to the east edge of the site that is horizontal layout. All RCVs are from Manelgama Road that is connected from Colombo-Kandy Highway. Site land utilization is economical as two large plots of lands are kept vacant for other development projects
		Option 2	Place the transfer station to avoid a replacement of the houses and to divert of the existing water canals. All RCVs are from Manelgama Road that is connected from Colombo-Kandy Highway but the Manelgama Road shall be improved in order RCVs to use this road for the entrance. Special concerns in this option are to minimize impact to the existing dwelling area with sufficient gaps and that a part of one water canal needs a diversion instead of filling of the canal with soils. The gantry operators and the train crew can have a better environment disjointed from the garbage area.
2.	Analysis of Rail type	Uses of Conventional trains - Longer rail yard with 3 rail tracks are required. Engine turn table required for conventional trains. Use of double headed trains- Shorter train yard with 2 rail tracks is sufficient. Engine turn table not required.	Due to the limited space availability, the use of double headed trains has been selected.
6	Two options of sanitary landfill designs were considered	Options are provided as follows.	Option 2 was considered to be the most suitable one.
		Option 1. This is to place the (unloading) Transfer Station at the unoccupied site where is the southern part of	

S.No	Activity	Options considered	Selected option
		the Holcim's railhead facility. It needs new railway extension to ATS but it will not cause interruption to Holcim's operation.	
		Option 2 This is to place the (unloading) Transfer Station on the Holcim's railhead facility It uses the existing rail line but it causes much interruption to Holcim's operation.	
7	Solid Waste Storage Structures Plan	Earthen embankments, Gravity concrete embankments, Reinforced concrete retaining walls	The earthen embankment is selected in this plan after considering various local conditions and economics factors
8.	Storm water drainage system	The internal drainage system and the external drainage system were considered.	External drainage system has been selected
9	Selection of Sanitary landfill operational Method	Semi aerobic, Aerobic Improved anaerobic	Semi aerobic landfill method has been selected.
10	Landfill gas treatment methods.	Natural Attenuation Simple Incineration Recycling	Simple Incineration technique using flaring has been decided after collection the gas.
11.	Leachate Lining System Evaluation. Four options have been considered	Clay Bentonite + soil mixture Clay+ HDPE sheets Bentinite + soil + HDPE sheet	Considering the in-situ soil permeability coefficients option 4 has been selected.

Source: Adopted from Feasibility Study, August 2014

Note: Due to lengthy analysis, only the summary of the alternatives considered are given in the above table.

Alternative mode of transport of waste using different sizes of containers:

The consultants had evaluated the possibility of transferring the waste in 40 footer containers or 20 footer containers considering various parameters such as the time, cost and efficiency. It had been observed that, there are many advantages of using 20 foot containers in the place of 40 foot Containers. Most important is the safety of the operations. The capital cost saving is Rs. 219 MN. The only disadvantage is that the 20 footers need more time for the transfer operations. However with 20 footers, the required transfer time is within the acceptable limit i.e. the possible station time of the train. Therefore this disadvantage does not affect the final performance. Therefore, the use of 20 foot containers in the place of 40 foot containers had been recommended.

CHAPTER III

3 DESCRIPTION OF THE EXISTING ENVIRONMENT

3.1 Physical Environment

3.1.1 Transfer Station- Kelaniya (KTS)

The Proposed Transfer Station at Kelaniya will be located approximately 7 km east of Colombo along the Colombo – Kandy Highway in Wanawasala DN Division of Kelaniya Divisional Secretariat area in Gampaha District. The area belongs to Western lowland wet zone of Sri Lanka. The proposed project area is an inland wetland ecosystem with a marshland falls within the administrative purview of Sri Lanka Land Reclamation and Development Corporation (SLLRDC).

3.1.1.1 Topography

The proposed project site is located in Colombo district, Western province. The terrain of the Study area is almost flat but with gentle undulating topographic features due to associated marshes associated with the floodplain and inter-connected canal layout. Elevation is very low (3.0 ~ 4.0 4m from MSL) and the stream flow rate is also low due to flat terrain and downstream control at the outlet (water is almost stagnated in the rivers/streams/canals).

The southern and eastern sides of the project area are surrounded by small hills (isolated lateritic hills) and originally the proposed Transfer Station area (project area or study area) which was a marshy low land helped to detain the quick runoff from the hilly catchment. Now part of the low land is reclaimed for other development activities and a part is fully covered with solid waste and relatively high in elevation.

The elevation is 2.5 m (8 ft.) above the sea level and annual rainfall is about 2600mm. The mean temperature around 27.6 0C and average humidity is about 78%, and interconnected water canal system. The water in these canals is polluted and provides an ideal habitat for the many aquatic plant species including few alien invasive species. Heavy urbanization occurring around the proposed project area and few human settlements and a solid waste dumping site in the surrounded 100 m area has been observed.

3.1.1.2 Geology and soil

Ground stratification, types and permeability of soil Proposed transfer site in Kelaniya (**Figure 3.1**) is located in a marshy area submerged in water and covered with marshy plants. These marshes could have been originated due to increase in sea level during Holocene climate optimum inundating coastal areas of Kelaniya River.

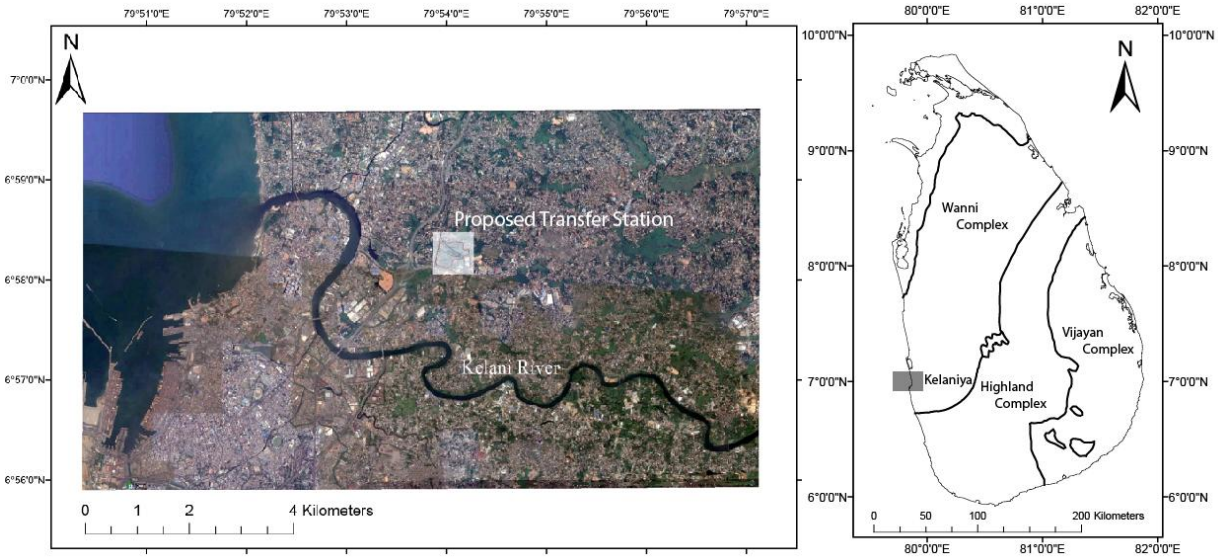


Figure 3.1: Location map of the transfer site at Kelaniya.

Basement rocks in Kelaniya area belongs to the Wanni complex rocks.

Holocene Climate Optimum was a warm period during roughly the interval 9,000 to 5,000 years BP. Marshes are associated with peat deposits. Peat forms when plant material does not fully decay in acidic and anaerobic conditions. The area might have been accumulating peat at least for last 5000 years and the depositional environment is more or less similar to the Muthurajawela marsh which has 2-5m of thick peat and organic matter rich sedimentary layers.

Therefore, the present site may also have at least 2-3 m of peat considering its smaller distribution. Usually, peat soil has high compressibility and consolidation settlement; low pH, bulk density and bearing capacity. The peat deposit may underlain by basement metamorphic rock with a gradually transitional overburden. Nine tenths of Sri Lanka consists of high grade metamorphic basement rocks. They are originated during Precambrian age, lithologically, sub divided into Highland Complex, Wanni Complex and Vijayan Complex rocks. Kelaniya is located inside Wanni complex and these rocks are usually consisting of Biotite Hornblende Gneiss, Pink Granitic Gneiss, Charnockitic Gneiss, Calc Gneiss and Quartzite.

These rocks are hard and usually have a higher bearing capacity and very low compressibility. However, depending on the rock types and there structure hydraulic conductivity may vary. For example, quartzite with its characteristic fractures has very high hydraulic conductivity whereas granitic gneiss which is usually characterized with less joints and fractures may be a poor hydraulic conductor. Geological profile in the selected location at Kelaniya may have more or less similar profile to that of Meethotamulla.

3.1.1.3 Meteorology

The climate of the area which lies in Low Country Wet Zone is influenced predominantly by the South West Monsoon. It lies in a part of the Wet Zone which receives 2000 – 2500 mm of rainfall per year. There are two periods of heavy inter-monsoonal rainfall immediately preceding and following the monsoon period lasting from mid-May to September.

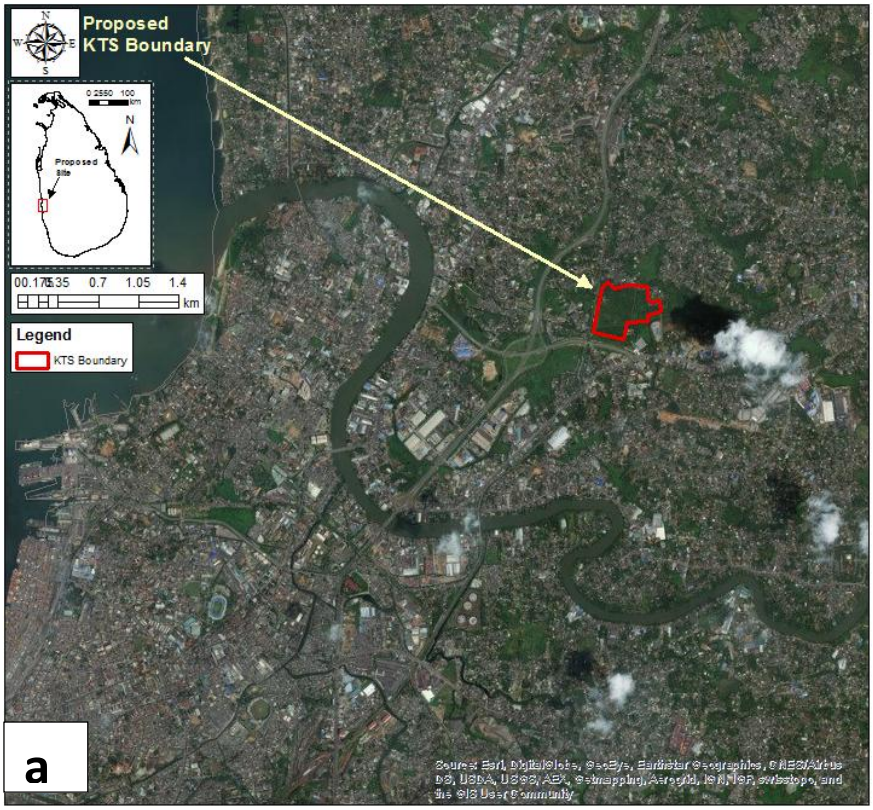
Evaporation exceeds rainfall in January, February and March. In all other months, there is an excess of rainfall. The highest mean daily maximum temperature of 31.5 °C occurs in April and the lowest mean daily minimum of 22.3 °C in January.

The main wind directions as recorded by the Meteorological Department at Katunayake at 8.30 hours are North to North West from November through February and mainly South West during the rest of the year. At 17.30 hours the winds are North East from November through February, East in April. Average

3.1.1.4 Hydrology

Surface water drainage pattern and Occurrence of flooding

The Study area falls on to the Kelani river basin (flood plain of Kelani river), located in the Wet Zone of Sri Lanka where the average annual rainfall is around 2,388.4 mm (Source: Department of Meteorology, Sri Lanka (**Figure 3.2 a & b**).



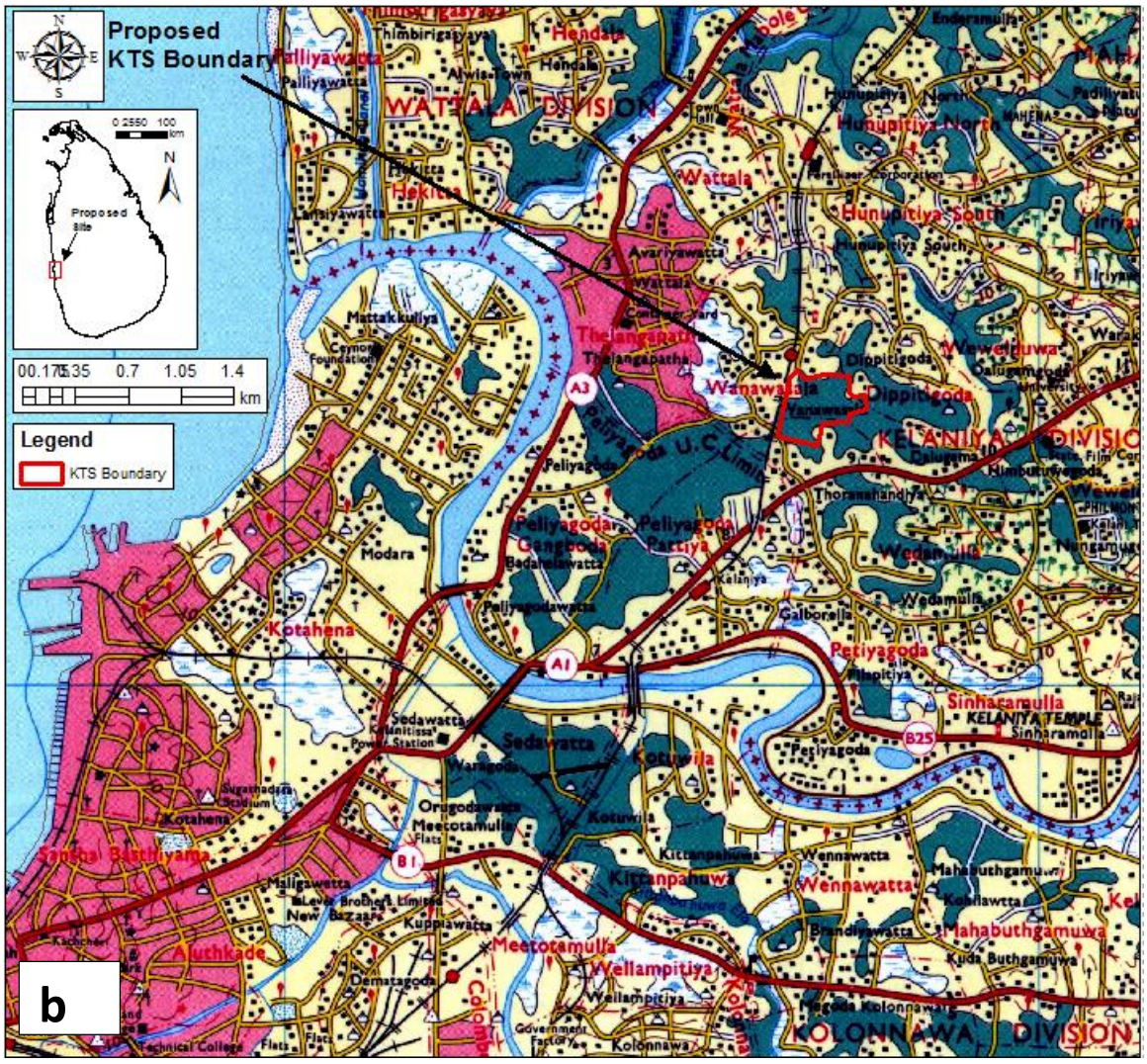


Figure 3.2: Location Map of Proposed Kelaniya Transfer Site with Water Bodies

***Note** : Base Map: 1:50,000 Topographic Map of the Survey Department, Sri Lanka*

According to the regional geological characteristics of the Study site area, it is located on a sheared zone. Clayey zones have been identified above the basement rock, due to complete weathering of the gneissic rocks probably as a result shearing.

The regional and local flow paths and flow directions in the vicinity of and within the Proposed KTS area is depicted in **Figure 3.4**.

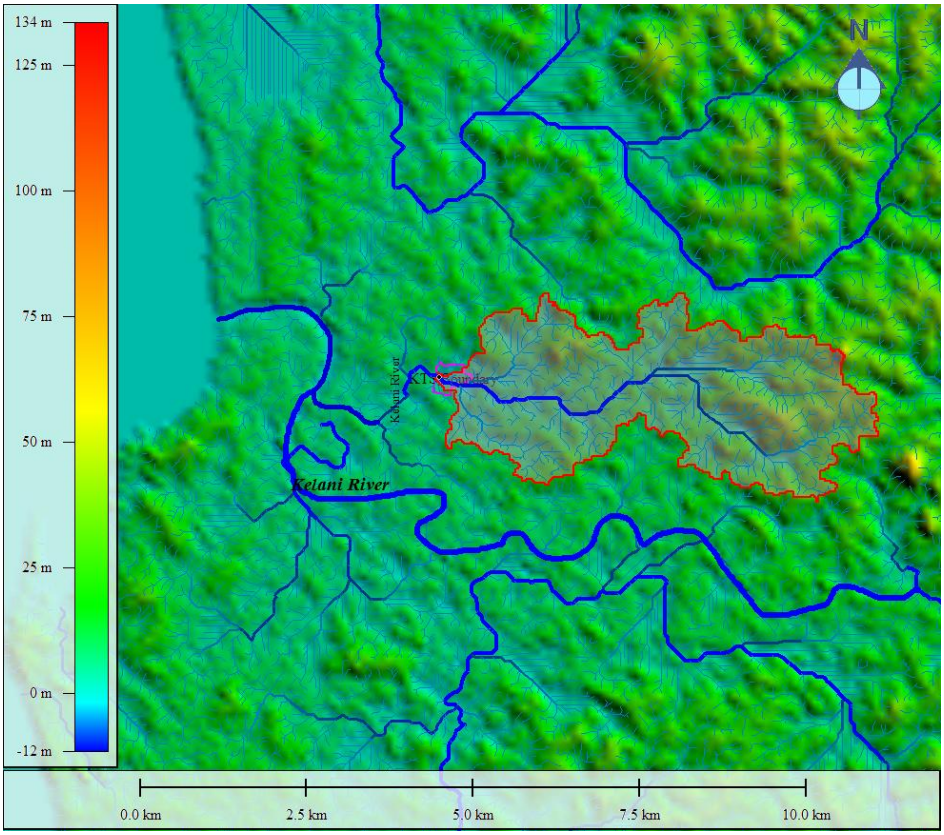


Figure 3.3: Regional Drainage Pattern in the Vicinity of KTS (Base Map: SRTM DEM)

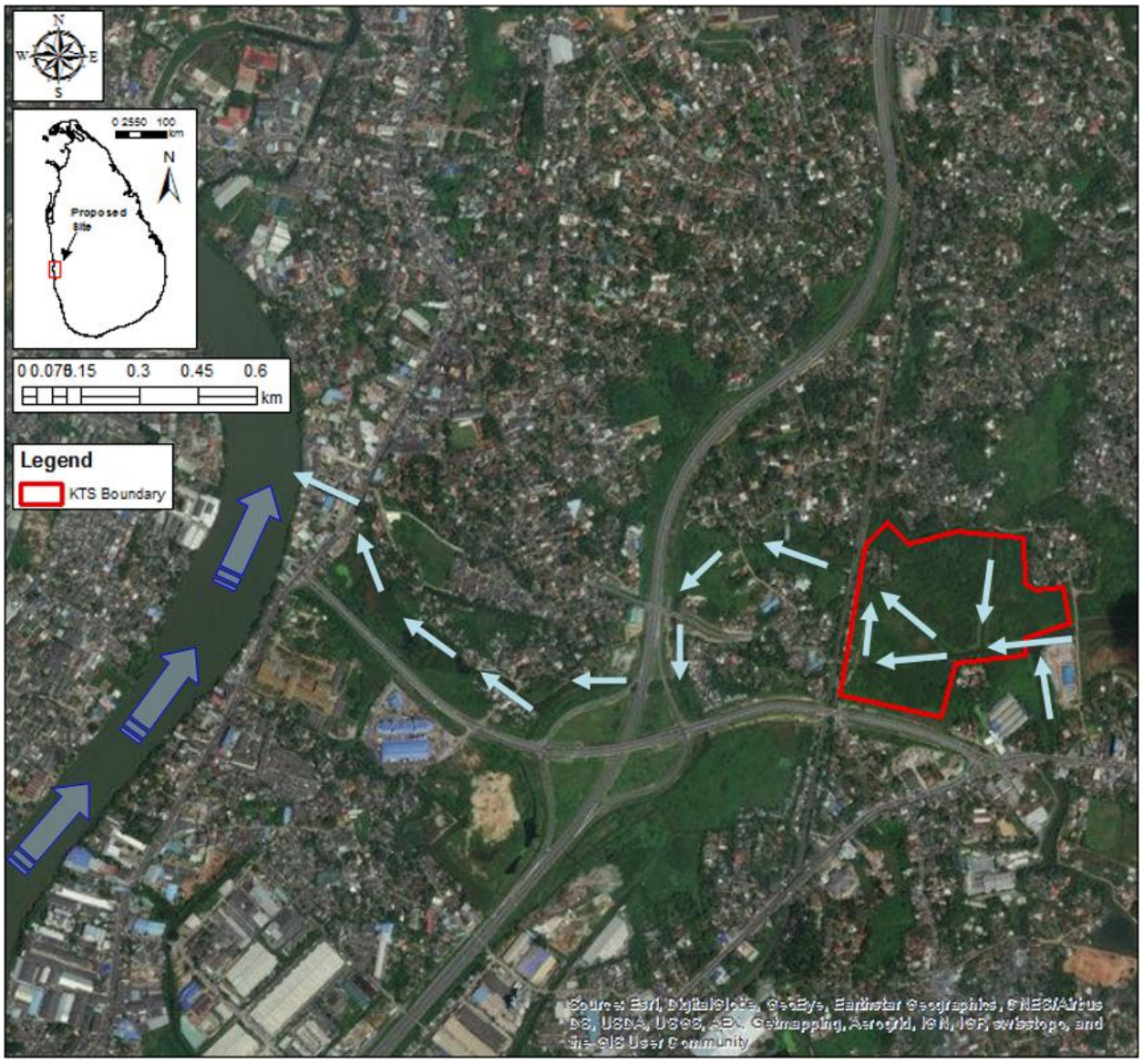


Figure 3.4: Local Drainage Pattern in the Vicinity of KTS

Note: *Base Map: Google Maps Inc.*

Stream Flow Records (of Kalani River)

As shown **Fig. 3.2** the project area is located within the immediate floodplain of the Kelani River and hence the low elevated areas are subjected to frequent inundation when the Kelani River spills over, especially during monsoonal/inter-monsoonal periods.

Classification of Floods

As shown in **Table 3-1**, floods of the Kalani River can be classified (Source - EIA Waste to Energy Project– Draft final Report) according to its magnitude

Table 3.1: Flood of the Kalani River

Classification	Reading – Nagalagam Street Stream Gauge (Stage in ft.)	Stage in MSL (m)
Minor Flood	5 feet and above and below 7 feet	1.52< X <2.13
Major Flood	7 feet and above	2.13< X <2.74
Dangerous Flood	9 feet and above	2.74< X <3.66
Critical Flood	12 feet and above	3.66< X

Flood Occurrences:

According to the records of the Department of Irrigation, Minor floods above 2 m (from MSL) have occurred 7 times since 1837 (Source - EIA Waste to Energy Project– Draft final Report; Fig. 3-6). Minor floods of the Kelani river (above 1.5 m & below 1.83 m) occur more frequently once a year or once in two year and subside within two or three days. Following table shows the annual maximum water levels of Kelani River (at Nagalagam street gauge) during last two decades.

The recent flood in May 2016 in Kelani Basin was recorded as 2.33 m (after 1971). Since year 1837, only 3 critical flood events have occurred as shown **Table 3.2** and Kalani river flood level has reached 'Dangerous Flood' level on 17 occasions since 1837 while it has reached 'Major Flood' level 5 times in the past, as per the historical records as shown in the figures given in **Table 3.3**. The occurrence of major floods has been witnessed 5 times as given **Table 3.4**.

Table 3.2: Critical flood events

Year	Water Level m (at Nagalagam Street Stream Gauge) (from MSL)
1837	4.12
1922	3.84
1947	3.92

Source: *Adoption from Department of Irrigation (1993)*

Table 3.3: Dangerous Flood level of Kelani River

Year	Water Level at Nagalagam Street Stream Gauge (from MSL)	Year	Water Level at Nagalagam Street Stream Gauge (from MSL)
1872	3.63	1933	3.03
1891	2.99	1936	2.87
1904	3.02	1937	3.15
1906	3.29	1939	2.85
1913	3.35	1040	3.35
1925	3.51	1966	2.74
1928	2.77	1967	2.79
1930	3.33	1989	2.80
1930	3.00		

Source: Adoption from Department of Irrigation (1993)

Table 3.4: Major Flood levels of Kelani River

Year	Water Level at Nagalagam Street Stream Gauge (in m MSL)
1942	2.49
1952	2.51
1955	2.44
1966	2.64
2016	2.33
1971	2.23

The Kelani river flood level has not reached the major or dangerous flood levels since June 1989 and this may be related to the sand mining activities in the upstream of the river. The map indicating flood inundation extents due to extreme event in 2016 May shows that the flood level increased to 2.33 m in Nagalagam Street Gauge after 1971 (2.23 m) and the project proposed site area was flooded (**Figures. 3.5 & 3.6**).

Table 3.5: Maximum Water Levels of Kelani River from 1990 to May 2011

Year	Water Level m (at Nagalagam Street Stream Gauge) (from MSL)	Year	Water Level m (at Nagalagam Street Stream Gauge) (from MSL)
1990	1.19	2001	1.19
1991	1.49	2002	1.25
1992	1.55	2003	1.20
1993	1.52	2004	1.42
1994	1.40	2005	1.72
1995	1.28	2006	1.51
1996	1.52	2007	1.49
1997	1.68	2008	1.80
1998	1.49	2009	1.28
1999	2.01	2010	1.58
2000	1.52	2011 May	1.65

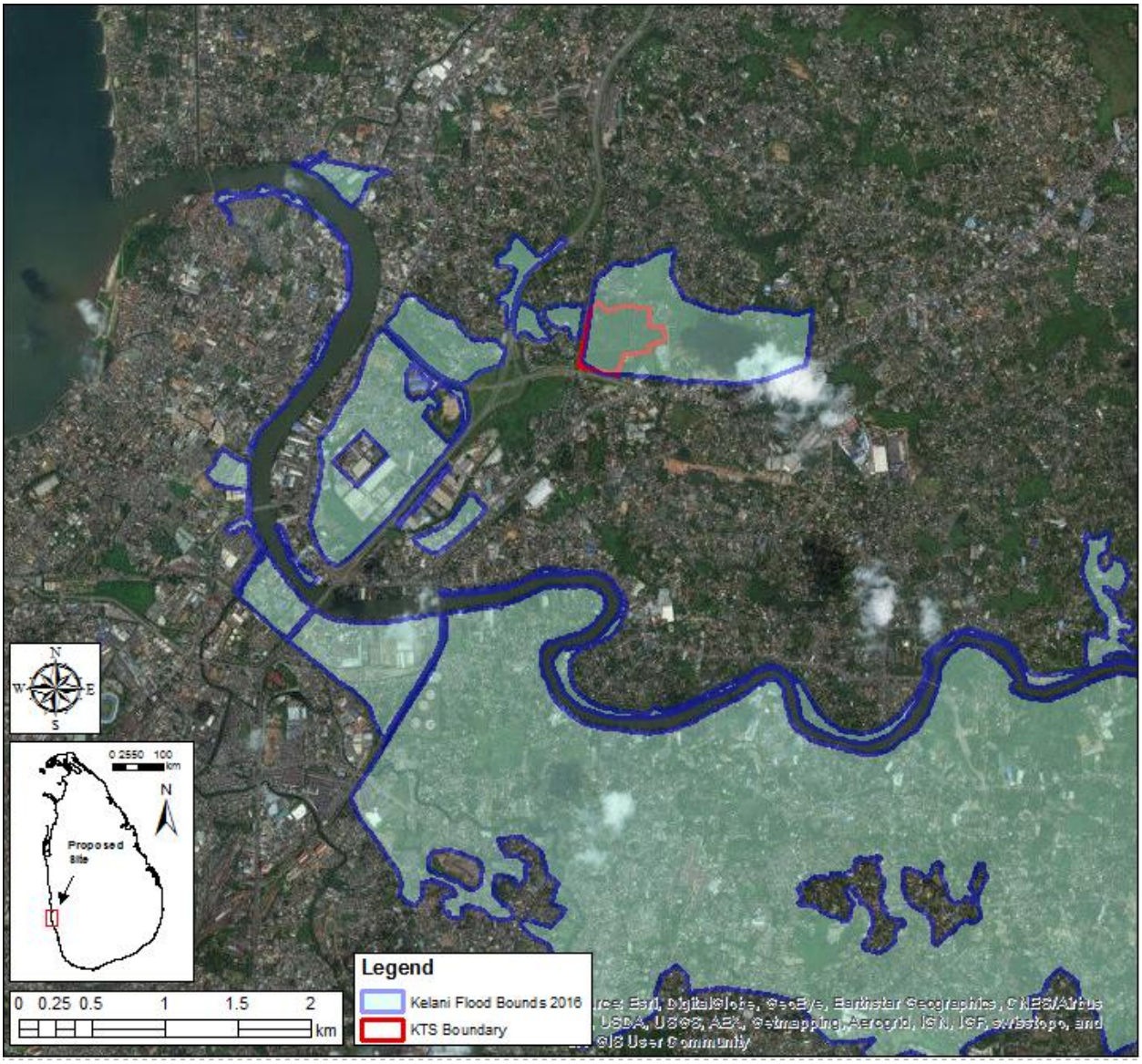


Figure 3.5: Flood Inundation Extents in 2016 May in the Vicinity of KTS (Base Map: Google Maps Inc.)

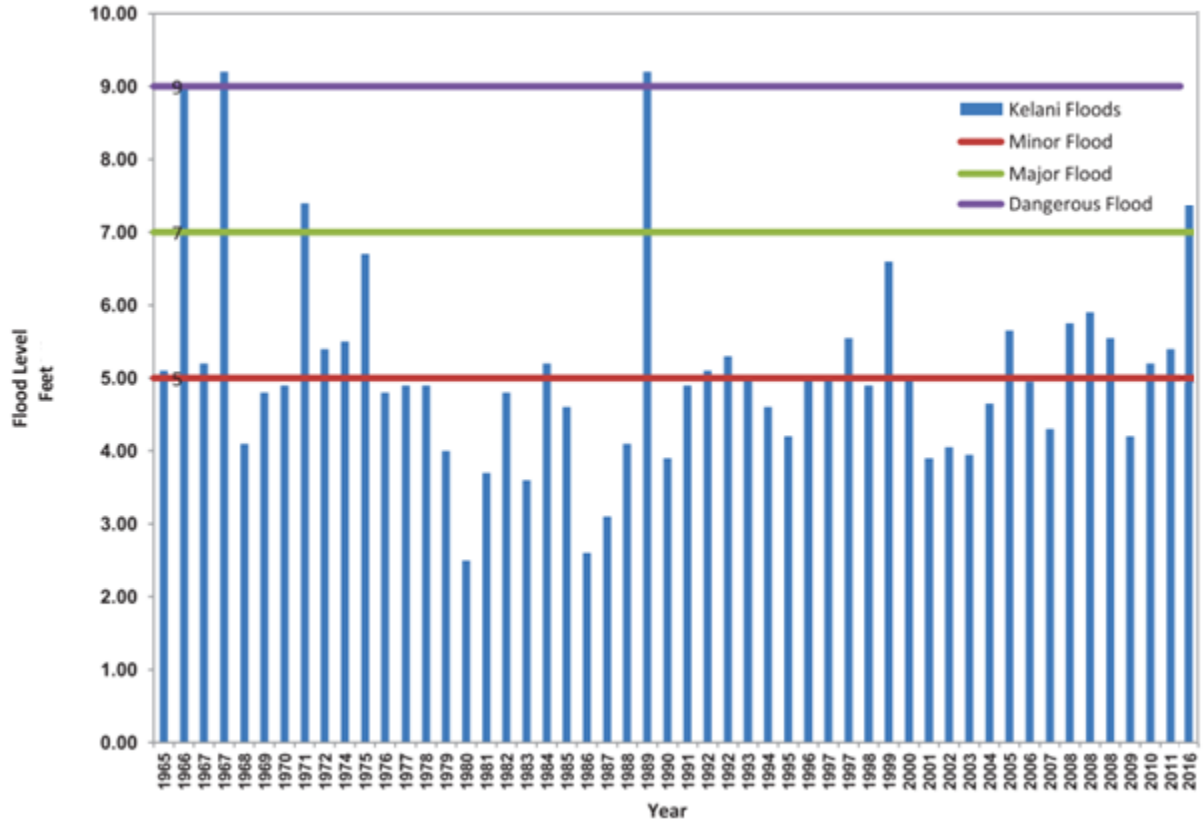


Figure 3.6: Kelani River Flood Levels at Nagalagam Street from 1965 to 1911

Figure 3.7: Layout Plan of the Kelaniya Transfer Site

The project layout map (**Figure. 3.7**) indicates that all local floodways are clearly demarcated. Further it should be ensured that the necessary flood conveyance capacities are maintained unaffected. It is strongly recommended to demarcate the required canal and stream reservations as per the stipulated guidelines and there should strictly be no permanent construction within these reservations.

The flood maps and water stage data shows that the area is affected by floods when the Nagalagam Street Gauge reading exceeds ~2.0 m. Therefore, if the operational grounds are to be maintained above this level, there will be no flood risk due to the spilling of the Kelani River. But surrounding low elevated areas are subjected to inundation because of floods or storm water as results of heavy rains in the area (Almost no flow in the surrounding canal due to blockages and very low gradient).

It is highly recommended that all operational areas within the proposed KTS Site be raised above the identified 50- or 100-year Average Recurrence Interval (ARI) return period peak flood levels as identified based on above historical flood records and all construction works are recommended to be carried out on pile props or elevated platforms, instead of reclaiming land to avoid loss of scantly available retention/detention and flood storage capacity in the lower part of the catchment.

Height of ground water table and hydraulic characteristic of ground water

Since the area lies within the immediate floodplain of Kelani River, the groundwater levels were observed to be very shallow/high even during dry periods (GL -0.3 m ~ -0.5 m). Near surface groundwater levels are expected on frequent basis, and flooding occurs especially during monsoon/inter-monsoon seasons.

No definite information on groundwater flow movement or groundwater hydraulics is available. However, it is presumed that the groundwater flows are either almost stagnant due to downstream control condition of the mean sea water level or moving very slowly towards the ocean.

Existing and planned uses of surface and ground water

There is no major water usage of the project area in the form of either groundwater or surface water because of water quality issues.

For the project site, the daily water consumption is only 3.7 m^3/s

Surface /Ground water quality (BOD, COD, pH, conductivity, heavy metals)

There is a canal bordering the proposed land. The canal water is almost stagnant and certain area is filled with water hyacinth. The water in the canal is highly polluted due to the leachate from the adjacent municipal solid waste dump site managed by the Kelaniya PS. The water quality test conducted indicates that the Dissolved oxygen, Biological Oxygen Demand, Chemical Oxygen Demand, Dissolved Phosphates, Cadmium, Lead, Fecal Coliform and Total coliforms do not confirm to the Proposed Ambient Water Quality Standards proposed by the CEA. This clearly indicates that the Mudun Ela is highly polluted by the leachate from the nearby solid waste dump. The water quality report with the comparison of the water quality standards is given in **Annex 3.1**

3.1.1.5 Land use

Land use of the area falls within the KTS is increasingly influenced by the growing population, industrial expansions and the development of infrastructures such as highways. The below data shows that much of the land use in Kelaniya DS Division is under home gardens whereas, marshes and water bodes occupy nearly 300 ha. This marsh is important as a flood retention area in view of the low lying nature of the Division

Table 3.6: Land Use pattern of the Area

Type of land use	Extent (ha)	%
Build-Up area	60	7.2
Home-gardens	1400	63.1
Agricultural	10	0.5
Paddy lands	320	14.4
Annual crops	10	0.5
Grasslands	20	0.9
Marshes	240	10.6
Water bodies	60	2.7

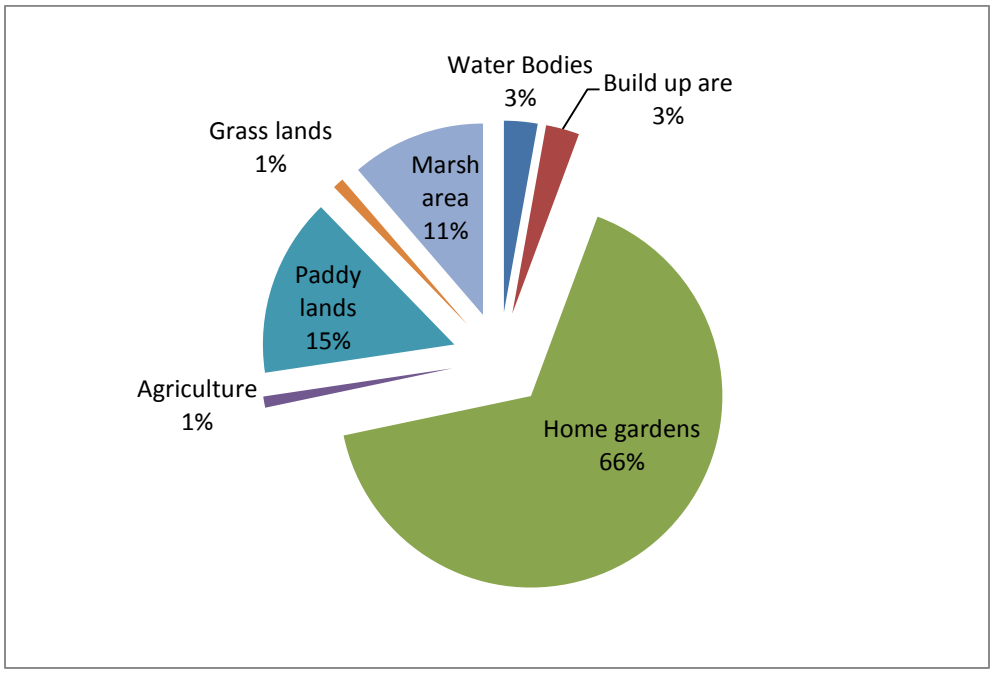


Figure 3.8: land Use pattern of the Kelaniya DSD

3.1.1.6 Air Quality

Existing Air Quality

The existing air quality at the selected site of the transfer station is mainly dominate by on-road vehicular emissions closer to the site, thermal power plant emissions located about 3 km south-

western side of the site and commercial and residential sources closer to the site. Also, gaseous emissions such as CH_4, VOC and H_2S etc. generated by the existing dumping site would also contribute.

Since there are no air quality database for the area, ambient air quality levels available at NBRO at residential area close to the site were considered as the baseline air quality of the area. According to the air quality results given in **Table 3.7**, the baseline air pollutant levels were well below the Sri Lanka National Standard for Ambient Air Quality in the area. The Ambient Air Quality Report is attached (**Annex 3.2**)

Table 3.7: Existing Ambient Air Quality Levels around the proposed Transfer Station site

Location	Measuring Date	Parameter	24 hour average pollutant concentration (mg/m3)	24 hour National Ambient air quality Standard Level
Sri Bodhirukkarama Viharaya, Waragoda, Kelaniya	16-17/03/2017	SO_2	0.024	0.080
		NO_2	0.052	0.100
		PM10	0.048	0.100
		PM2.5	0.026	0.050

Please ref. Figure 3.9 for location

Noise

Noise generated due to the vehicular movements on nearby roads to the site and activities of the existing waste dumping site dominates the existing noise levels at the site. In addition, insects noise at the marshy land is also contribute during nighttime. The measured residual noise level by NBRO are summarized in **Table 3.8**, around the site indicates that the Existing Noise Level, (L Aeq, T) at the site area were marginally exceeded during day and night time to the maximum permissible noise level (55 dB (A) Leq for day time and 45dB (A) Leq for night time) stipulated in the schedule I of the NEA of the National Environmental (Noise Control) Regulations No.1 of 1996. This is mainly due to the heavy vehicle movement in the roads. The Noise Level Report is attached (**Annex 3.3)**.

Table 3.8: Existing Noise Levels around the proposed Transfer Station site

Location	Measuring Date	Time	1 hr Residual Noise Level Leq(A) / dB	Background Noise Level L_{90}(A) / dB
At the Northern boundary of the site	31.05.2017	Day	57	52
		Night	50	47
At the Eastern Boundary of the site		Day	59	55
		Night	51	48
At the Sothern Boundary of the site		Day	60	56
		Night	54	50
At the Western Boundary of the site		Day	59	55
		Night	55	50

Please ref. Figure 3.9 for location

Figure 3.9: Air quality and Noise measuring locations

Vibration

Since there are no sources of vibration within the study area, the existing vibration levels were not measured and will be well below the proposed interim vibrational standard levels for the operation of machinery and vehicle movements etc.

3.1.2 Physical Environment Landfill site in Aruwakkalu (ATS)

3.1.2.1 Topography

The proposed Sanitary Landfill area is located almost 41 km north of the Puttalam City. Proposed landfill is located at Aruwakkalu adjacent to the limestone mining site of the Siam City Cement (Lanka) Limited which was previously owned by Holcim Pvt. Ltd. The proposed Sanitary Landfill area is abandoned limestone quarry located almost 30 km North of the Puttalam City. The site lays the west of Holcim quarry loading ramp and east of the Dutch Bay. The Project site forms roughly a rectangular/elliptical area, approximately 700m (East to West) by 670m (North to South). This abandoned and half filled quarry site is mainly a concave and undulate feature of about maximum of 30m depth.

- Area of excavated – 670m North-South

  700m East-West
- Maximum Height – 35m (from MSL)
- Minimum Height – 5m (from MSL)

As per above data, the onsite ground elevations vary from 5.0 m ~ 35.0 m MSL according to the land contour survey map attached in Fig. 3-11. The west and north-east end boundaries are low lying (5.0 m ~ 15.0 m MSL25.0 ~ 35.0 m MSL) while eastern and southern parts are characterized by isolated ridges/hilltops ranging up to 25.0 m ~ 35.0 m MSL. The site lays the west of quarry loading ramp and east of the Dutch Bay. The Project site forms roughly a rectangular/elliptical area, approximately 700m (East to West) by 670m (North to South).

In general the topography is a concave undulating landform with relatively steeper slopes at the northern and southern/south-eastern boundaries. Those steeper slopes could be the slopes of the abandoned limestone mine that operated on site 20 years ago. Approximately, 20% of the area lies below 10 m from MSL where possibly the major extraction of limestone had taken place.

The unloading of waste will be at a site within the railhead facility of the Siam Cement Quarry site. The quarry loading station is operated by Siam City Cement along with rail lines for the transporting of excavated quarry.

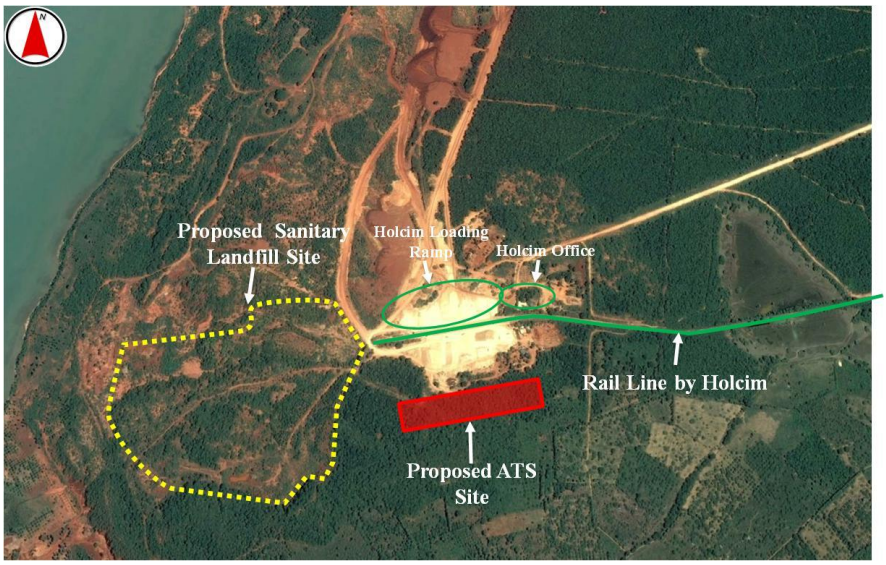


Figure 3.10: ATS Transfer Station Site at Aruwakkalu

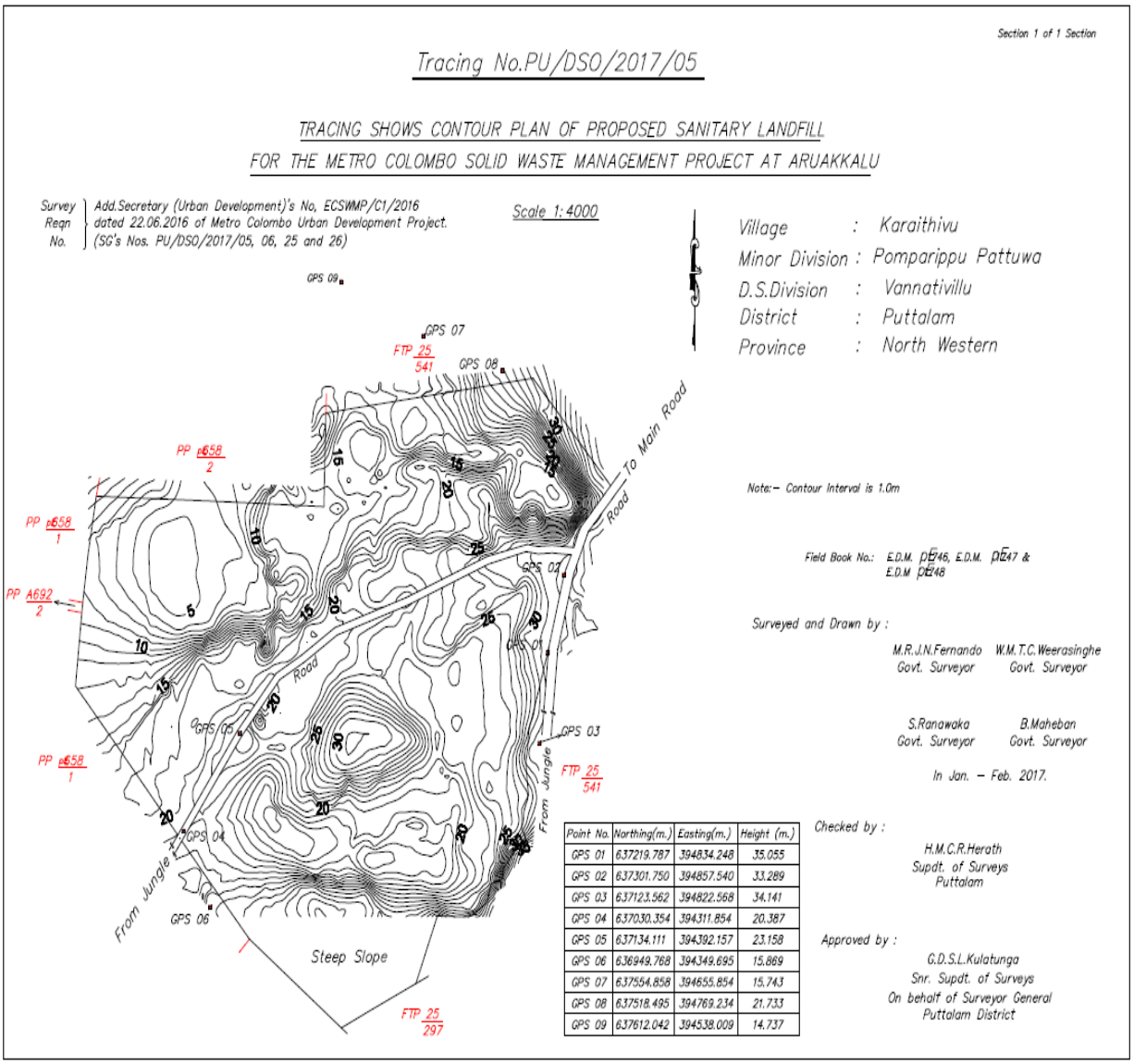


Figure 3.11: Contour map of the ATS

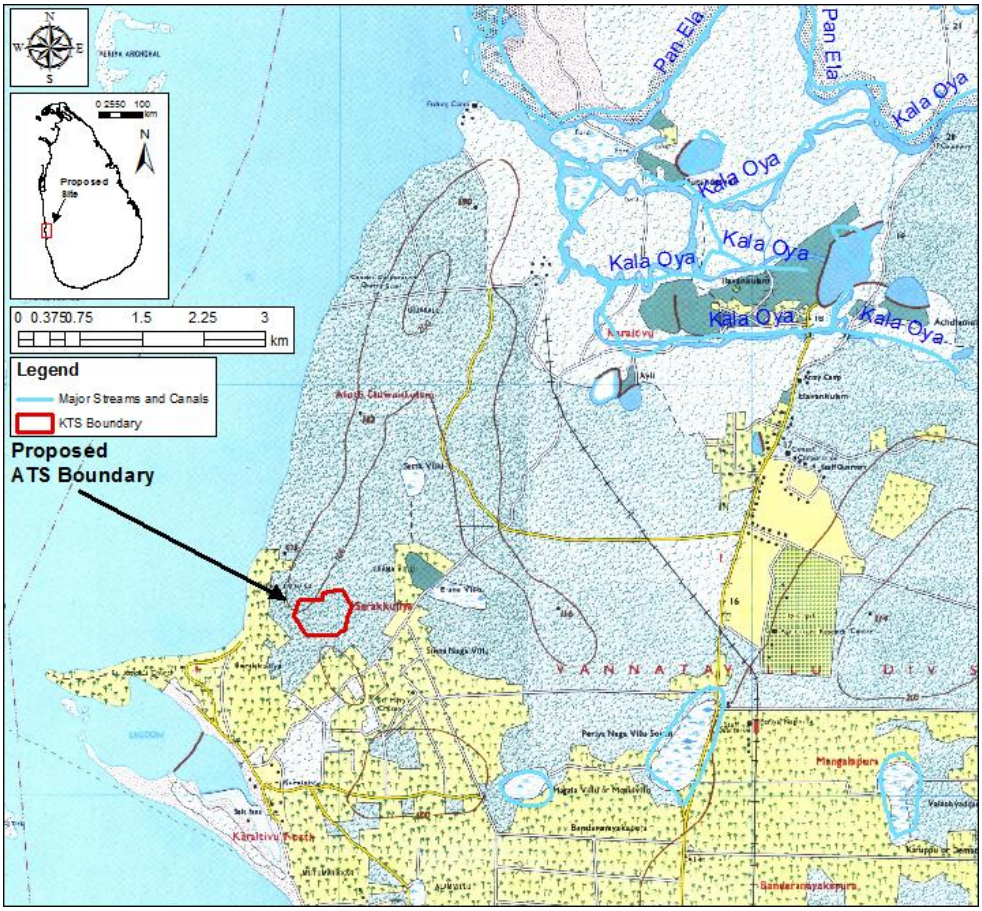


Figure 3.12: Location Map of Proposed Aruwakkalu Transfer Site with Water Bodies

(Base Map: 1:50,000 Topographic Map of the Survey Department, Sri Lanka)

3.1.2.2 Geology and soil

Regional Geology

Nine tenths of Sri Lanka consists of high grade metamorphic rocks of Precambrian age, lithologically, sub divided into Highland Complex, Wanni Complex and Vijayan Complex rocks. The remainder consists of Quaternary deposits, along with Miocene Limestone mainly in the North Western coastal belt from Puttalam to Jaffna. These sediments/sedimentary rocks were deposited on the Precambrian basement rock and found very close to the surface about 4-5m depth in the Jaffna area whereas Limestone is found in somewhat deep levels in the southern part of the Miocene Belt. For example, in Aruwakkalu area the economically viable limestone deposit is found at a depth of 40 m. Limestone is a sedimentary rock, made up of skeletal fragments of marine organisms such as coral, forams and molluscs or formed partially or completely by the chemical precipitation. Its major materials minerals are calcite and aragonite, which are different crystal forms of calcium carbonate ($CaCO_3$). Calcite can be dissolved or precipitated by groundwater, depending on several factors, including the water temperature, pH and dissolved ion concentrations. The solubility of limestone in water with a weak acidity leads to karst landscapes, in which water erodes the limestone over many years. These Krast

erosional landforms include pot holes, caves and gorges. Regions overlying limestone bedrock tend to have fewer above-ground water sources (ponds and streams), as surface water easily drains downward through joints in the limestone. Limestone is less resistant than most metamorphic and igneous rocks, but more resistant than most other sedimentary rocks.

In general at Aruwakkalu, fresh limestone rocks are found comparatively in deeper levels about 40 m or more in the South – Western strip closer to the Puttalam area of the Miocene belt. But, the weathered limestone is found comparatively at shallow depths about 10 m at the Aruwakkalu site. In Aruwakkalu area limestone rocks are interlayered with sandy clay and sandy silt or clayey sand layers. Those layers are also calcareous in nature with mostly low permeability.

Top soil of the area is the red earth formation (Quaternary deposits) consisting of brick red to orange red clayey sand and sandy clay and forms mainly narrow elongated ridges or domes. These ridges are consistently aligned in a north south direction. The thickness of the red earth Formation varies from place to place, but is usually around 10-20 m. The red earth deposit is made up mainly of small rounded quartz with considerable amount of heavy minerals.

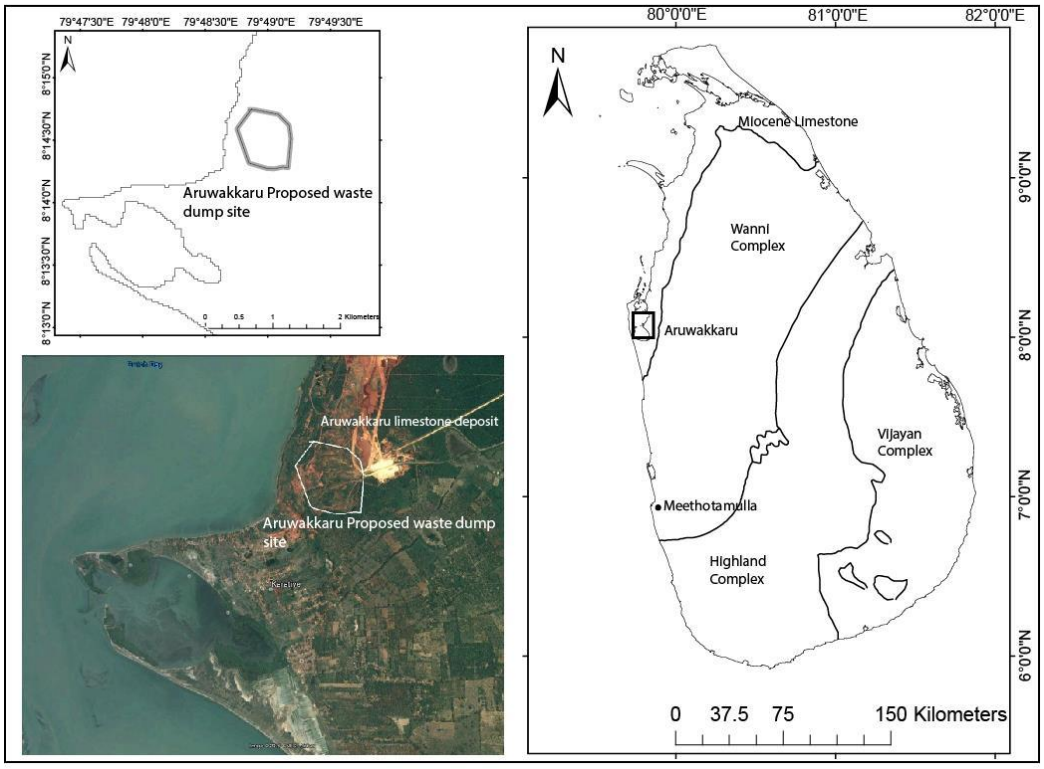


Figure 3.13: Geology at the proposed dump site

During the feasibility stage, 2 numbers of borehole and 16 numbers of test pits were made to identify geological, geotechnical and hydrogeological properties of the underlain lithological units. Based on the subsurface soil conditions of each borehole location, it can be generalized that the subsurface condition at the proposed site area are as below.

I. Top most layer consist of filled material of heterogeneous composition; Reddish brown sand, metamorphic rock boulders, concrete fragments, limestone boulders, hard yellowish brown sandy clay and yellowish brown clay

II. Underneath the filled material, a completely decomposed, impure limestone rock layer disintegrated into very dense, silty/clayey sand is found.

Filled material was 24 m thick at BH-03 and 42 m thick at BH-04. Figure 1-3 shows the cross section of the dumpsite running across BH-03 and BH-04. The Boreholes were not drilled until the basement metamorphic rocks and groundwater was not encountered in drilled depths of both BH03 (33.45 m) and BH04 (58 m) cores. Standard penetration test results shows >50 N values and most showed hammer bounce indicating occurrence of harder material rather than lose soil.

All the 16 pits were shallow (2 m) and consist of entirely fill material indicating mine restoration activity by filing mine spoils and overburden material. None of these shallow pits encountered groundwater. **Figure: 3.14** shows the locations of the boreholes and the test pits. The Bore hole logs are given in **Annex 3.4.**

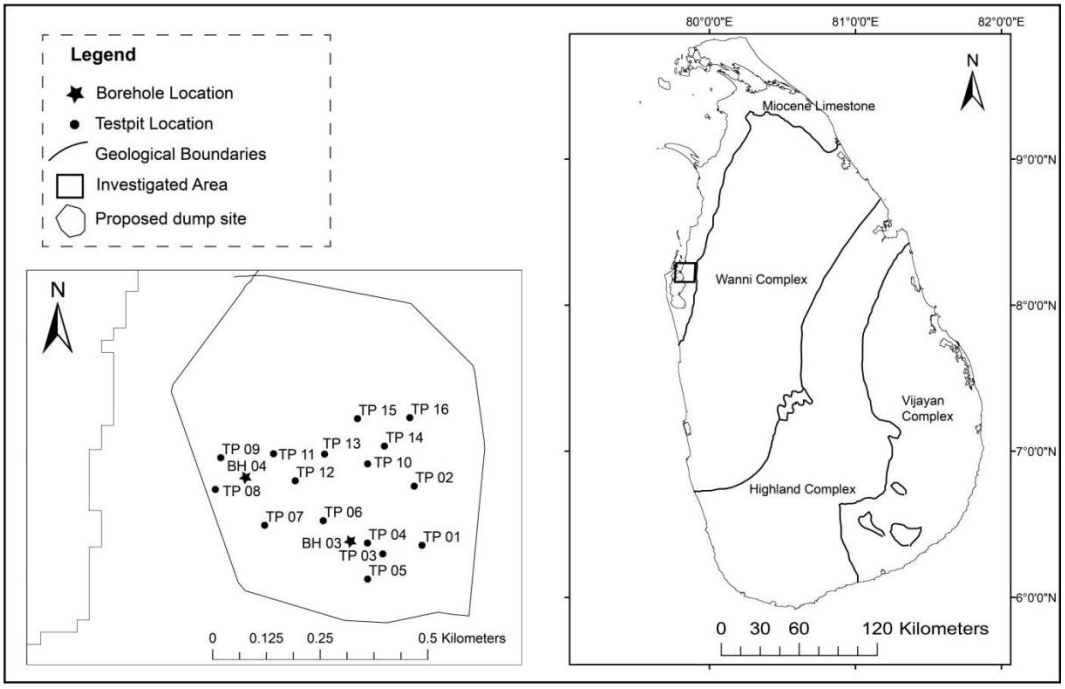


Figure 3.14: The locations of the boreholes and the test pits

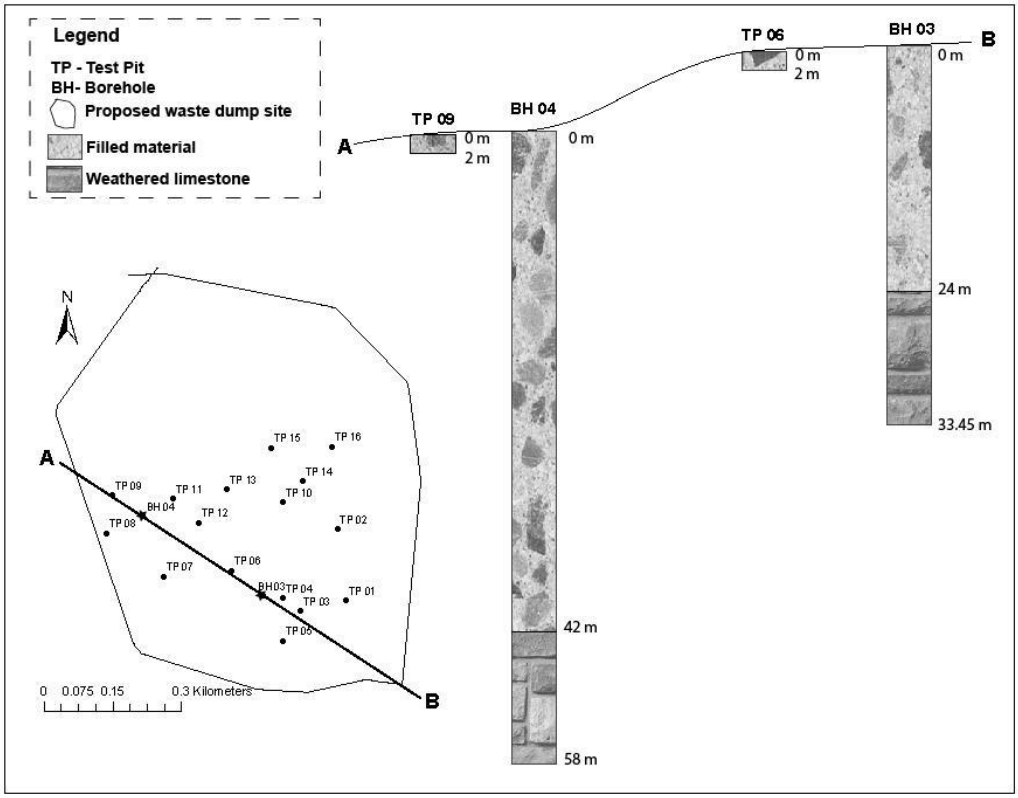


Figure 3.15: The cross section of the dumpsite running across BH-03 and BH-04

3.1.2.3 Meteorology

In general, Aruwakkalu area has a semiarid climate with an annual average rainfall of 875mm, and annual mean temperature of 27.9 ^{o}C. This site has been identified as an area within the high wind zone. The average annual wind speed is about 9 km/hr and 2.5m/sec**. (Table 3.9).** At this speed, generally more than **5** µ size particles could move from the site and could be deposited in the surrounding area. The month of June and July get high wind speeds of 3.29 and 3.35m/sec respectively, which could easily take away large objects like paper, shopping bags, leaves etc.,

Table 3.9: Wind patterns in the landfill site area

	2006	2007	2008	2009	2010	Average km/hr	m/s
Jan	6.2	7.3	5.8	6.3	6.3	6.4	1.77
	NE	NE	NE	NE	NE		
Feb	7.0	6.7	6.3	6.0	6.9	6.6	1.83
	NE	NE	NE	NE	NE		
Mar	4.7	5.8	5.2	3.9	5.9	5.1	1.42
	VRB	VRB	VRB	VRB	NE		
Apr	6.5	4.9	5.8	6.0	5.3	5.7	1.58
	SW	VRB	VRB	SW	VRB		
May	10.6	10.9	11.2	11.4	9.2	10.7	2.96
	SW	SW	SW	SW	SSW		

	2006	2007	2008	2009	2010	Average km/hr	m/s
Jun	11.2	11.0	11.5	13.3	12.2	11.8	3.29
	SW	SW	SW	SW	SW		
Jul	12.6	12.2	11.8	12.9	10.8	12.1	3.35
	SW	SW	SW	SW	SW		
Aug	12.3	11.8	9.7	11.3	10.9	11.2	3.11
	SW	SW	SW	SW	SW		
Sep	10.4	11.6	10.0	12.6	9.2	10.8	2.99
	SW	SW	SW	SW	SW		
Oct	6.6	7.5	5.2	7.5	9.4	7.2	2.01
	VRB	SW	SW	SW	SW		
Nov	4.8	5.3	5.7	4.6	4.6	5.0	1.39
	NE	VRB	VRB	NA	VRB		
Dec	4.6	6.0	6.0	5.9	5.6	5.6	1.56
	NE	NE	NE	NE	NE		

Note: In each month, the upper raw represents the wind speed km/hr and the down raw represents the wind direction
Source: Metrological Department

The annual wind direction is from south-west and partly from the north-east particularly during the North East monsoon period.

Figure 3.16: Average annual wind pattern of the area

3.1.2.4 Rainfall

Monthly rainfall records from 1994 to 2010 shows that the average annual rainfall in Puttalam area is about 875 mm. However annual rainfall patterns show increasing tendency of 800 mm to 1350 mm from 1994 to 2011. Further, the monthly rainfall patterns show two distinct highs in Oct. to Dec. and March to April and the most significant rainfall occurs during Oct. to Nov. period which are the inter-monsoonal months.

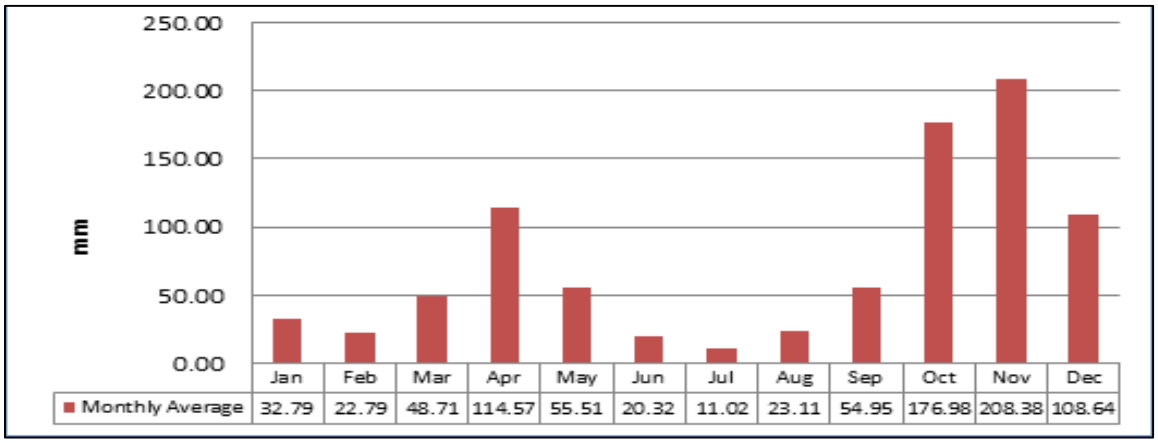


Figure 3.17: Monthly average rainfall records from 1994 to 2010 from Puttalam (Palavi meteorological station)

3.1.2.4.1 Temperature

Mean annual temperature in the area is 27.9 ^{0}C while the highest recorded temperature is during May-June period causing more evaporation during this period.

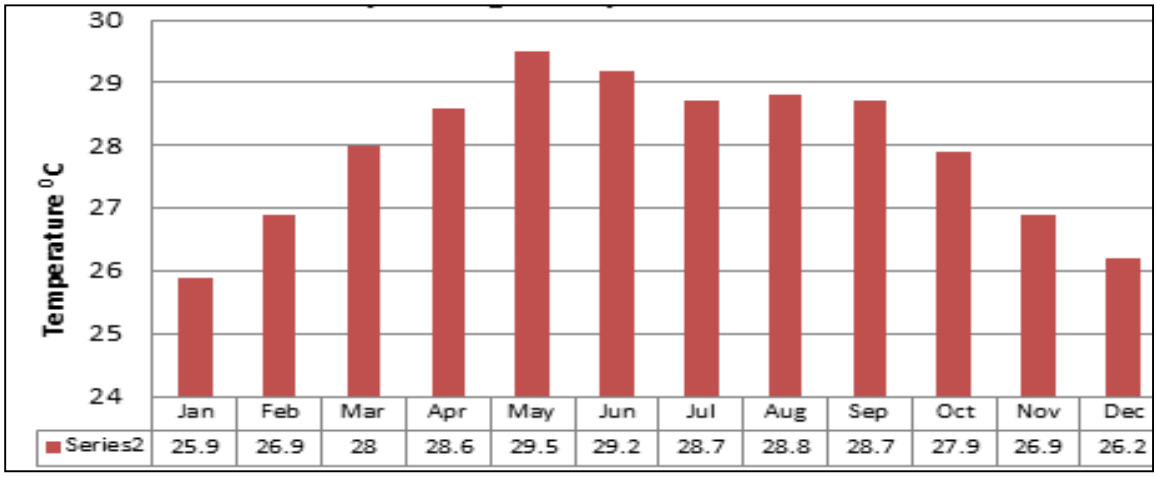


Figure 3.18: Monthly average Temperature records from 1994 to 2010 from Puttalam (Palavi meteorological station)

3.1.2.4.2 Evaporation vs precipitation

Jan-Feb and May-September periods show very higher evaporation than the precipitation in the Puttalam District.

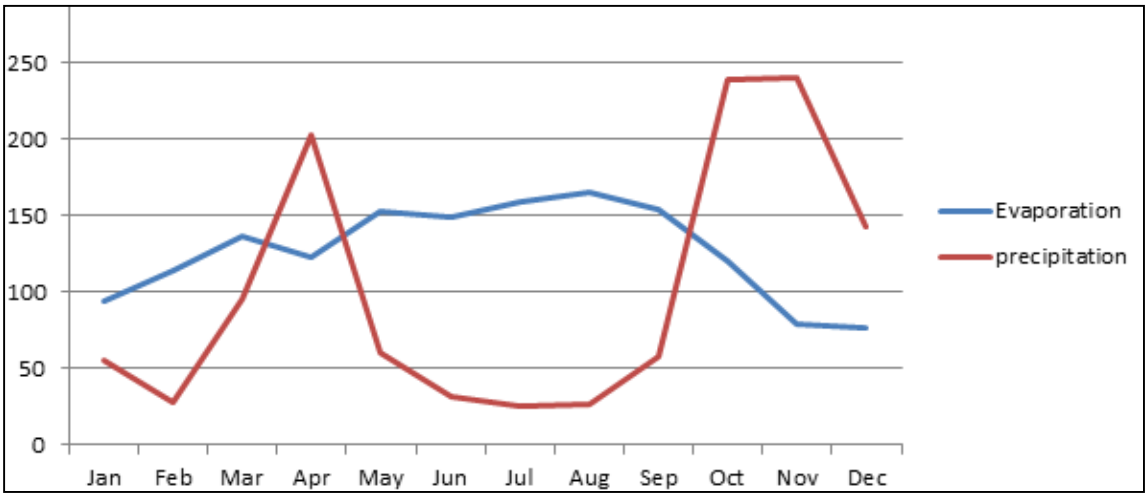


Figure 3.19: Average monthly evaporation and the precipitation

3.1.2.5 Hydrology

Surface water drainage pattern, occurrence of flooding

The newly proposed transfer Station site at Aruwakkalu (hereinafter "ATS") is located within the Holcim's railhead facility. Currently there is a quarry loading station operated by Siam City Cement along with rail lines for the transporting of excavated quarry.

The proposed Sanitary Landfill area is an abandoned limestone quarry located almost 30 km north of the Puttalam City. The site lays to the west of Holcim quarry loading ramp and east of the Dutch Bay. The Project site forms roughly a rectangular/elliptical area, approximately 700 m (East to West) by 670 m (North to South). This abandoned and half-filled quarry site is mainly a concave and undulate feature of about maximum of 30 m depth. The proposed ATS site is located approximately 100 m east to the Sanitary Landfill area (**Figures. 3.20 & 3.21**).

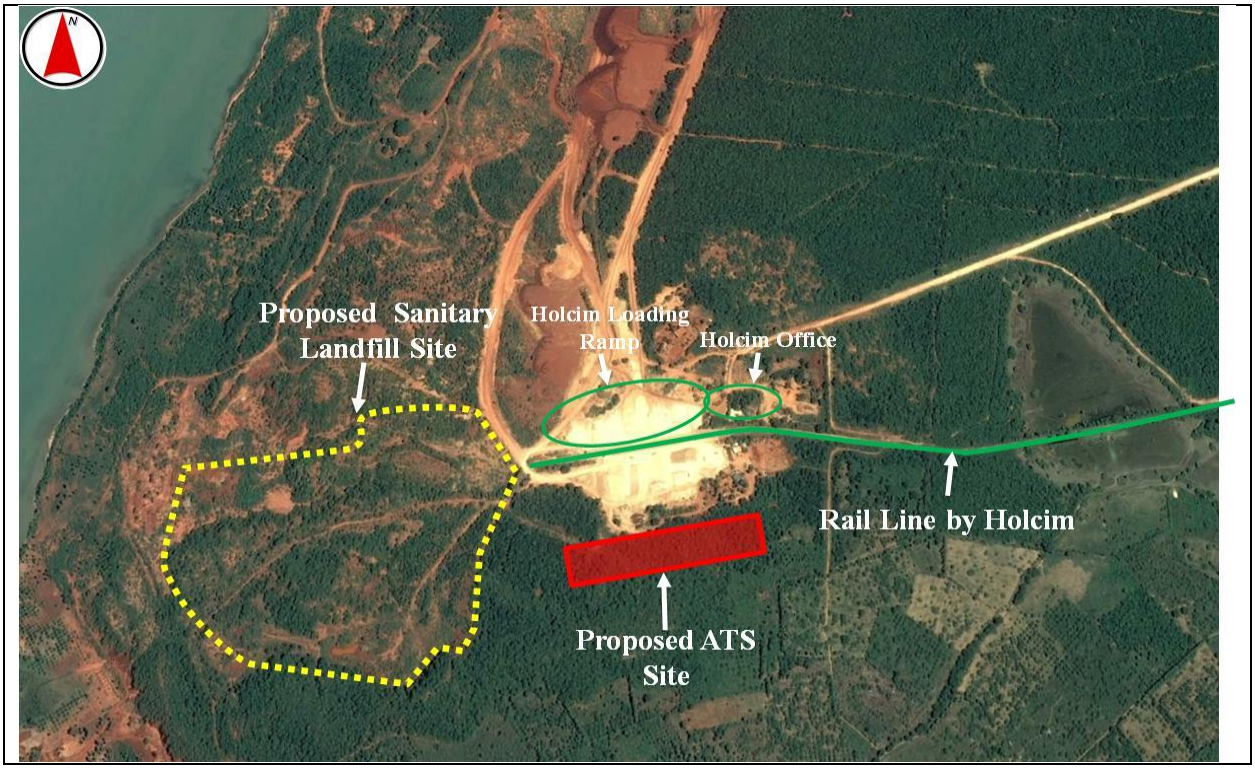


Figure 3.20: ATS Transfer Station Site at Aruwakkalu

The onsite ground elevations vary from 5.0 m ~ 35.0 m MSL according to the land contour survey map attached in Fig. 3-11. The west and north-east end boundaries are relatively low lying (5.0 m ~ 15.0 m MSL) while eastern and southern parts are characterized by isolated ridges/hillocks ranging up to 25.0 m ~ 35.0 m MSL. In general, the topography is a concave undulating landform with a relatively steeper slopes at the northern and southern/south-eastern boundaries (Figure 3-7). Those steeper slopes could be the slopes of the abandoned limestone mine that operated on site 20 years ago. Approximately, 20% of the area lies below 10 m from MSL where possibly the major extraction of limestone had taken place.

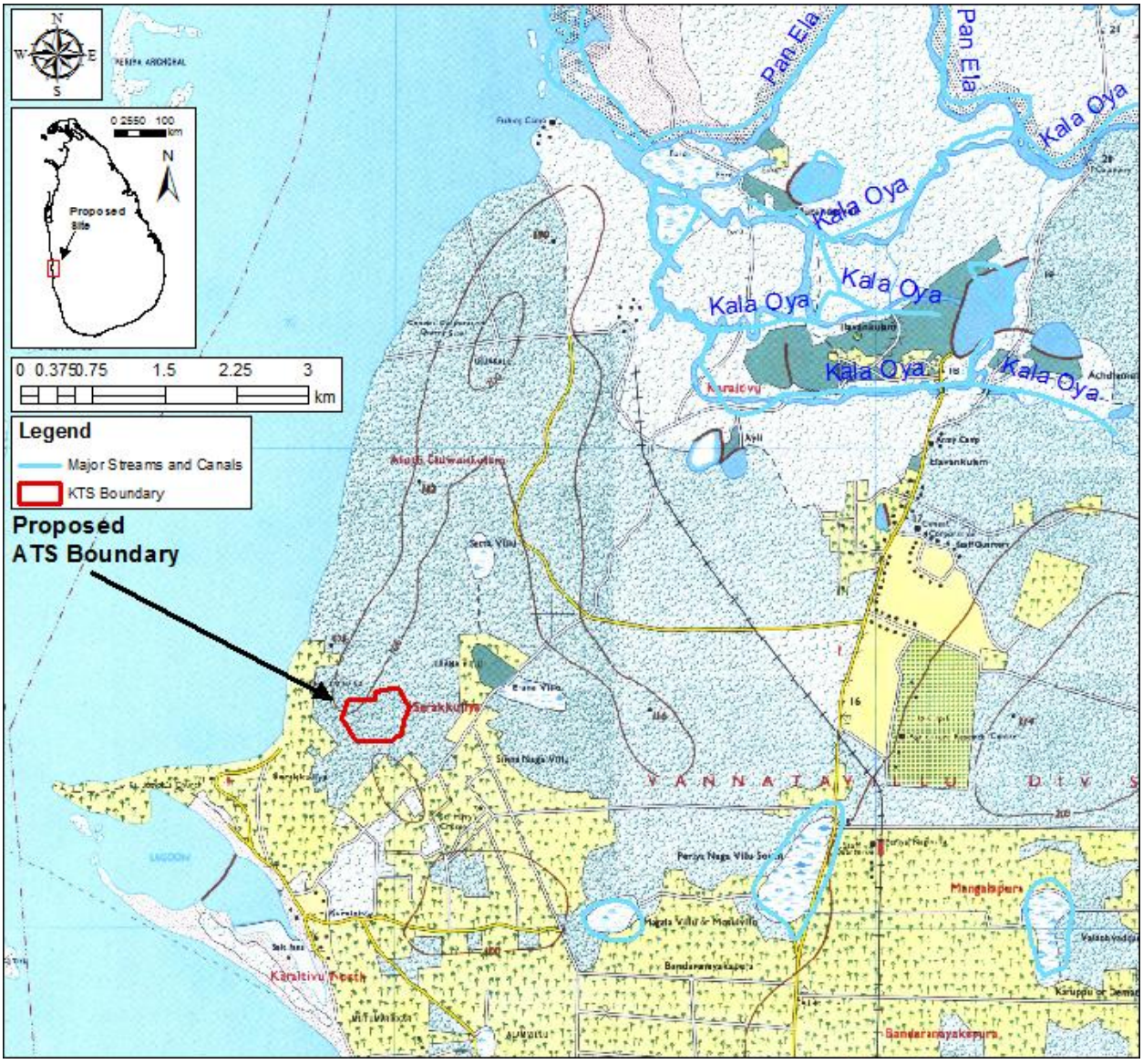


Figure 3.21:: Location Map of Proposed Aruwakkalu Transfer Site with Water Bodies

(Base Map: 1:50,000 Topographic Map of the Survey Department, Sri Lanka)

Lunu Oya (a tributary of the Kala Oya) located towards the east of the Aruwakkalu landfill area (within the Wanathavilluwa DSD) ultimately falls in to the Kala Oya drainage basin. The Project site and the surrounding area is located approximately about 6.0 km south to the outfall of the Kala Oya into the Puttalam Lagoon (Kala Oya provides the largest freshwater volume and it flows in at Gangewadiya – a fishing village with 73 families). Lunu Oya, along with Kala Oya, characterized with numerous species of mangroves is the richest and largest patch of pristine mangrove areas in Sri Lanka. However, seasonal water quality and discharge data for Kala Oya and Lunu Oya are not available for the Project area (No gauge station within 15 km distance from the Aruwakkalu site), though both rivers contribute a low discharge to the lagoon during the drier spells as a result

of the Rajangana Reservoir which has been constructed across the Kala Oya. According to the residence of the Gangewadiya, no major floods being experienced in the area. There had been some minor floods during the spill time of the Rajangana Reservoir (once every 3-4 years time). Flood level is only up to road level of Gangewadiya area which is probably below the contour 3 MSL. (Project boundary area is above 5 MSL) The proposed Engineering landfill site is not flooded from Lunu Oya (Tributary of Kala Oya) due to the bund and the natural topography. The flooding of wetland in close vicinity of the site is happening due to the storm water not draining to the Lunu Oya during the flooding because of the backwater effect.

Further, accumulated drainage flows along minor undulations and valleys have formed rills causing erosion and fines washout in the sloping ground areas. These flows are finally diverted to the abandoned quarry pits in North-west and North side boundaries of the proposed site and stagnant water is presumed to remain for a short duration after rainfall events before vanishing due to seepage losses and direct and soil evaporation. The average annual reference evapotranspiration and potential soil evaporation are relatively high in this arid region and reported to be 1908.8 mm and 1714.5 mm, respectively.

There exist natural drainage flows across and along the periphery of the proposed SWM site. The project proponent is recommended to develop and incorporate a drainage system (the conceptual design) to avoid storm water contamination with wastewater. Moreover, the wastewater and leachate collection system is developed to avoid wash off of waste water into the storm water management system.

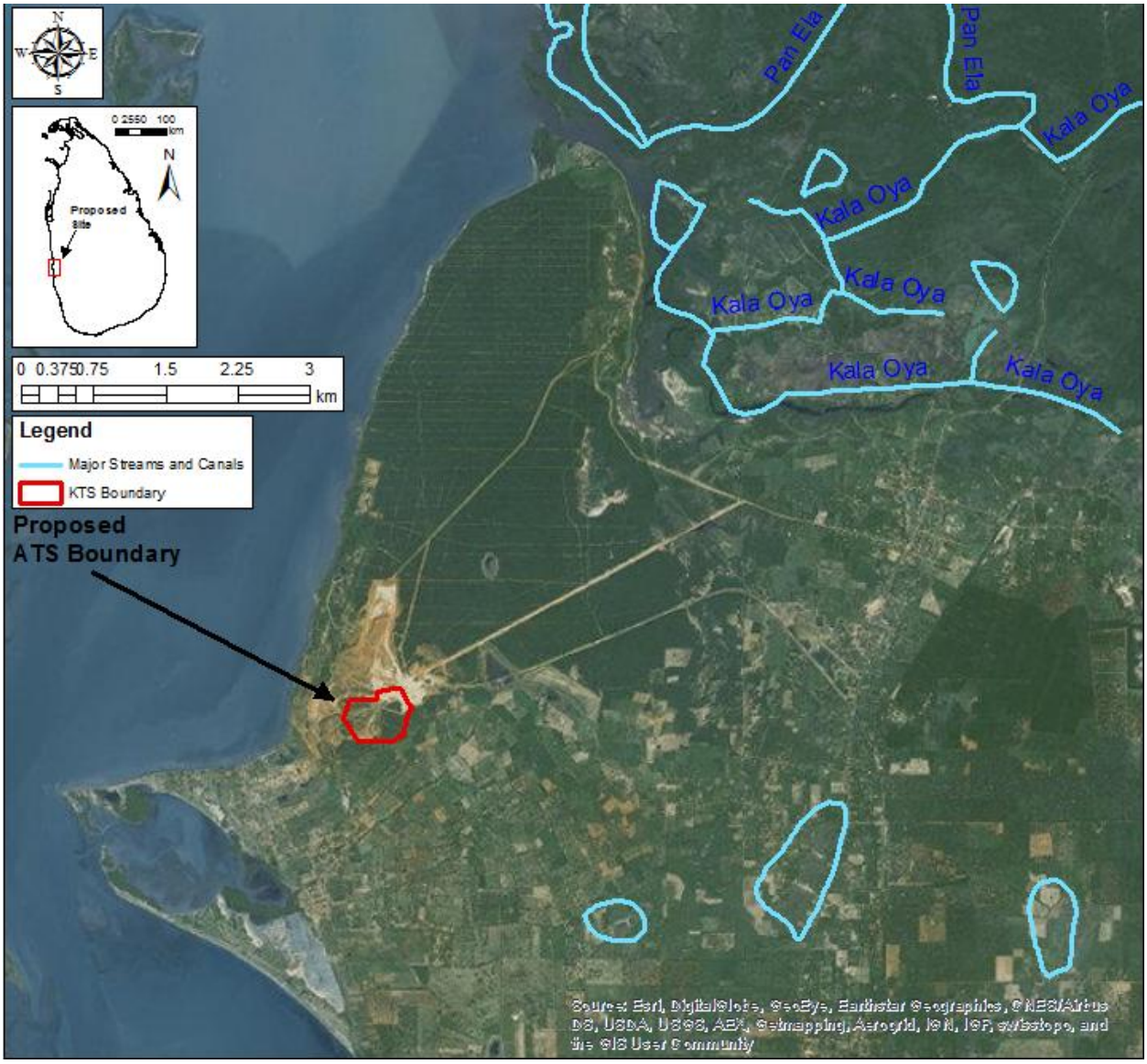
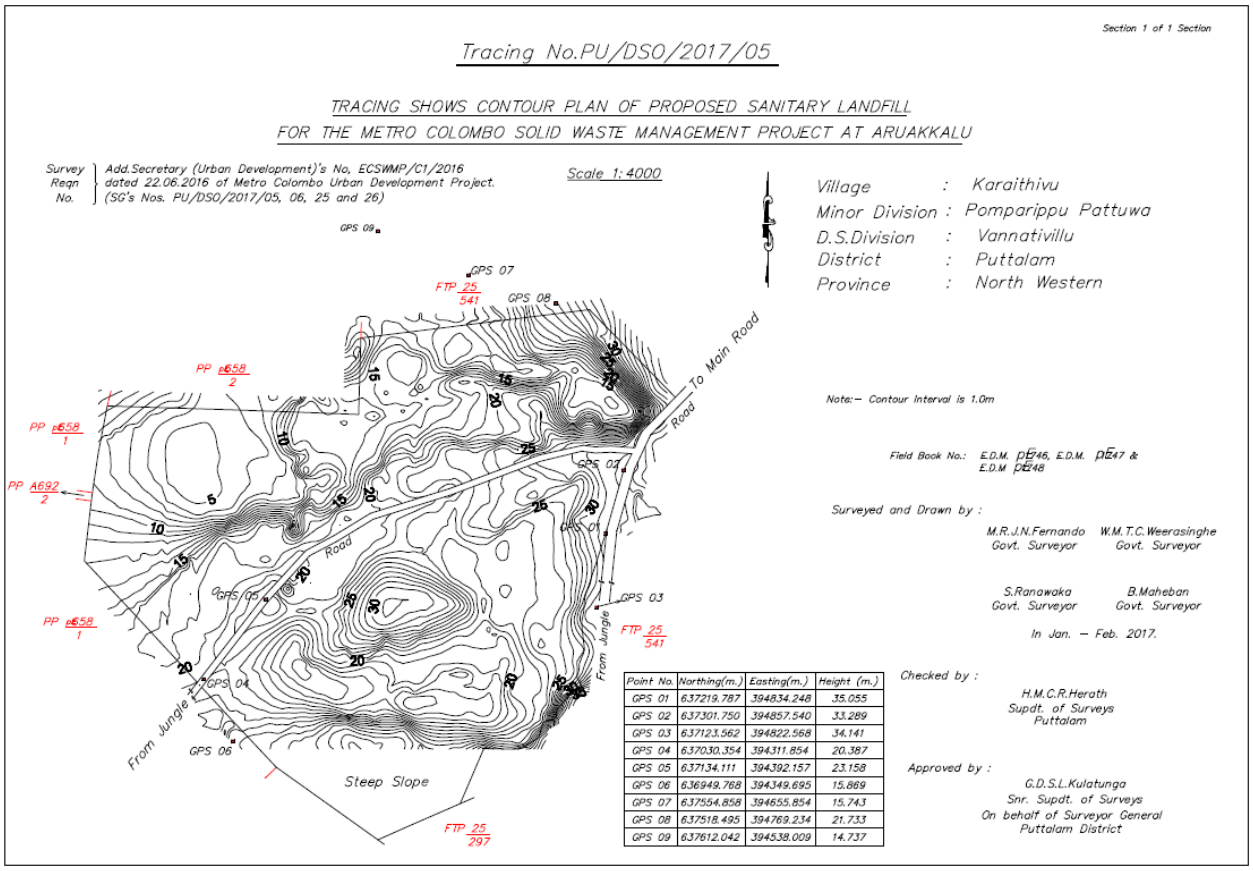


Figure 3.22: Location Map of Proposed Aruwakkalu Transfer Site

(Base Map: Google Maps Inc.)



Point No.	Northing(m.)	Easting(m.)	Height (m.)
GPS 01	637219.787	394834.248	35.055
GPS 02	637301.750	394857.540	33.289
GPS 03	637123.562	394822.568	34.141
GPS 04	637030.354	394311.854	20.387
GPS 05	637134.111	394392.157	23.158
GPS 06	636949.768	394349.695	15.869
GPS 07	637554.858	394655.854	15.743
GPS 08	637518.495	394769.234	21.733
GPS 09	637612.042	394538.009	14.737

Figure 3.23: Contour Map of the Study Site

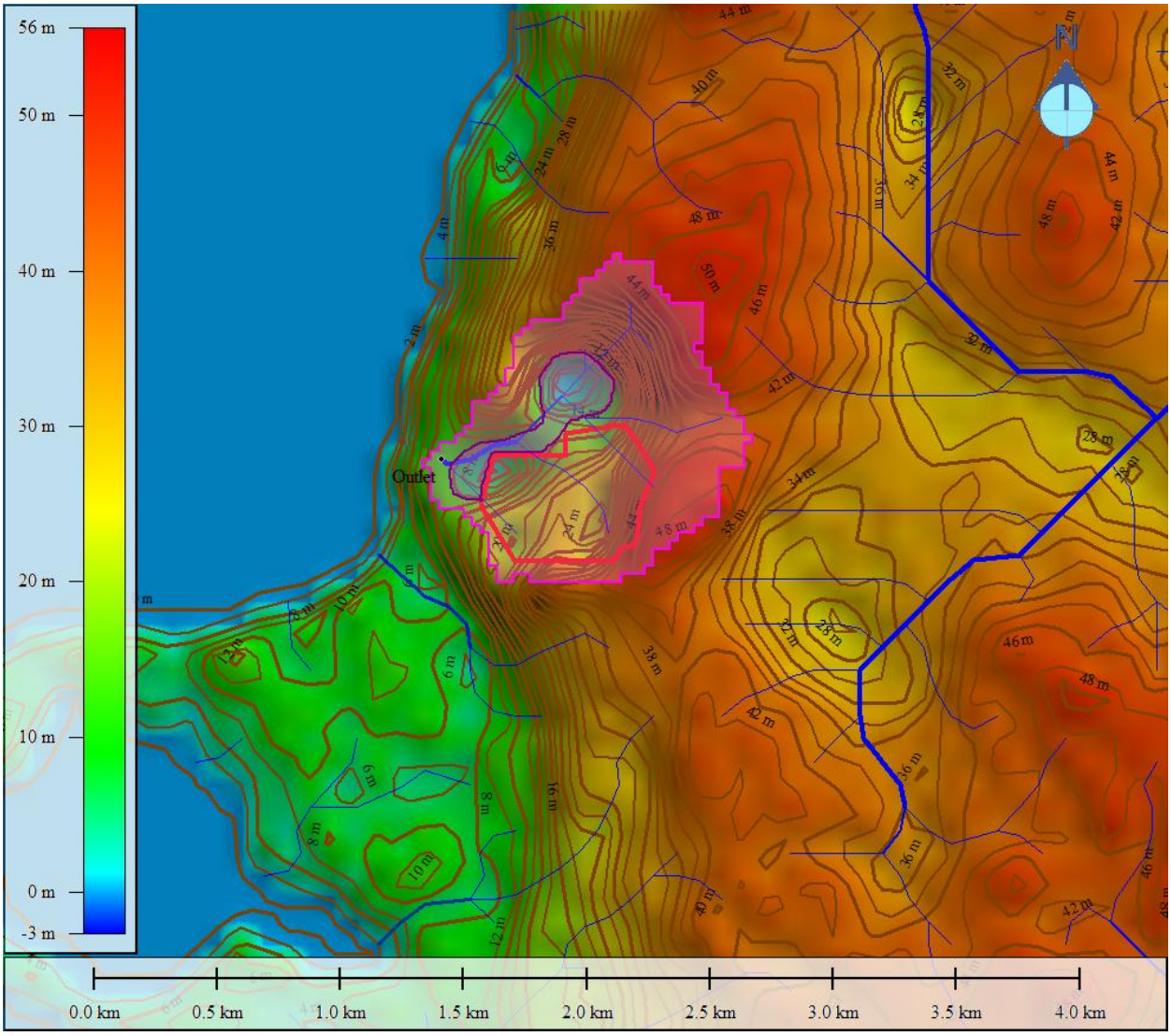


Figure 3.24: The Existing Terrain, Drainage Pattern and Storage Capacity (SRTM/GTOPO DEM)

The existing drainage pattern in the area was studied based on several field visits and the available survey terrain data and SRTM/BTOPO30 Satellite Terrain Digital Elevation Model (DEM) to identify the present drainage and retention-detention bahaviour in the downstream catchment area as reportedly no accumulated storm water runoff is directly conveyed to the lagoon at present due to the storage capacity provided in the abandoned borrow pit areas in the North-west boundary of the proposed SWM Site (**Figures. 3.23 & 3.24**).

Further, the requirement of diversion of flows contributing accumulated flows from the slopes on South and South-east boundaries and also from North-east boundary where the present railway yard and other loading/unloading infrastructure are located were studied in detail. These flows together with the storm water runoff generated in the yards and roads, etc., within the SWM area will have to be diverted along the boundary of the proposed SWM site and incorporated in the available or provided retention/detention areas. Nevertheless, the storm water will not be permitted to add mixed with the leachate from the SWM area under any circumstance, as speculated in the report sections above.

Figure 3.25: The Existing Terrain, Drainage Pattern and Storage Capacity (Google Inc.)

Figures 3.24 and 3.25 show the prevailing drainage pattern in the area and further it was estimated that the entire catchment area including the yard and road areas is approximately 88 ha. The accumulated flow is conveyed to the relatively low lying quarries and pits in the area immediately outside of the North-west side boundary of the proposed ATS site. These pits, Storage 1 and 2 as shown in **Fig. 3.25,** have volumetric capacities of 47,500 m^3 and 58,600 m^3, respectively.

The volumetric flow generation during 50-year and 100-year design return period storm intensity events continuing for over a duration of one hour were estimated and found to be 48,350 m^3 and 52,250 m^3. The presently available capacity of Storage Area 1 & 2 can accommodate these volumetric flows and no direct discharge to the lagoon is envisaged. However, for events with higher intensity or longer duration will cause overtopping and spilling of the storage areas, and it is expected the spill discharge volumes to be released to the lagoon, just as what could have been happening for any extreme event at present or even prior to the planned construction of the proposed SWM facility.

Table 3.10. On-site/Off-site Design Peak Flows and Runoff Flow Volume Generation

NAME/ID: METRO Colombo SWMP-Aruwakkalu Transfer Station Site							
Parameter	Unit	Return Period					
		2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
Peak Flow Estimate [Rational Method]							
A	ha	84					
Lc	m	450.00					
V	m/s	0.45					
Tc	min	31.67					
D	min	31.67					
X		2433	4099	5383	7149	8319	9816
Y		0.87972	0.90789	0.92160	0.93595	0.94140	0.94849
I	mm/hr	68.71	86.98	98.67	113.46	124.67	135.14
C		0.45					
Q_0	**m^3/s**	**7.21**	**9.13**	**10.36**	**11.91**	**13.09**	**14.19**
Channel Design [Manning's Equation]							
Canal Section		Rectangular					
Base W	m	3.00	3.50	3.90	4.30	4.70	5.00
D	m	1.50	1.50	1.50	1.50	1.50	1.50
Top W	m	---	---	---	---	---	---
A	m^2	4.50	5.25	5.85	6.45	7.05	7.50
P	m	6.00	6.50	6.90	7.30	7.70	8.00
R		0.75	0.81	0.85	0.88	0.92	0.94
n		0.035					
S		0.005					
V	m/s	1.67	1.75	1.81	1.86	1.90	1.94
Q_d	**m^3/s**	**7.50**	**9.20**	**10.59**	**12.00**	**13.43**	**14.51**
V_{Q_d}	**m^3**	**27,017**	**33,116**	**38,113**	**43,195**	**48,347**	**52,251**

Height of ground water table and hydraulic characteristic of ground water

The proposed project site is located in an area with isolated hillocks in undulating terrain. According to the bore hole tests carried out, the groundwater levels were not encountered at any borehole pit, even though the bored pits were driven up to a maximum depths of 33.45 m and 58.00 m, respectively. The water table presumably tends to be shallow approaching both the Karathivu Lagoon and Lunu Oya floodplain (Gangewadiya) levels from the south towards the north across the proposed landfill site as the depth to groundwater table increases towards the ATS Site area from both ends due to the elevated ground level in this central part of the hillock/ridge (**Fig. 3.26**).

No details of groundwater movement or groundwater hydraulic is available, but the flows are presumed to be in the seaward direction. Based on previous studies, it is evident that the groundwater is relatively brackish in nature (EAIR Report 2015).

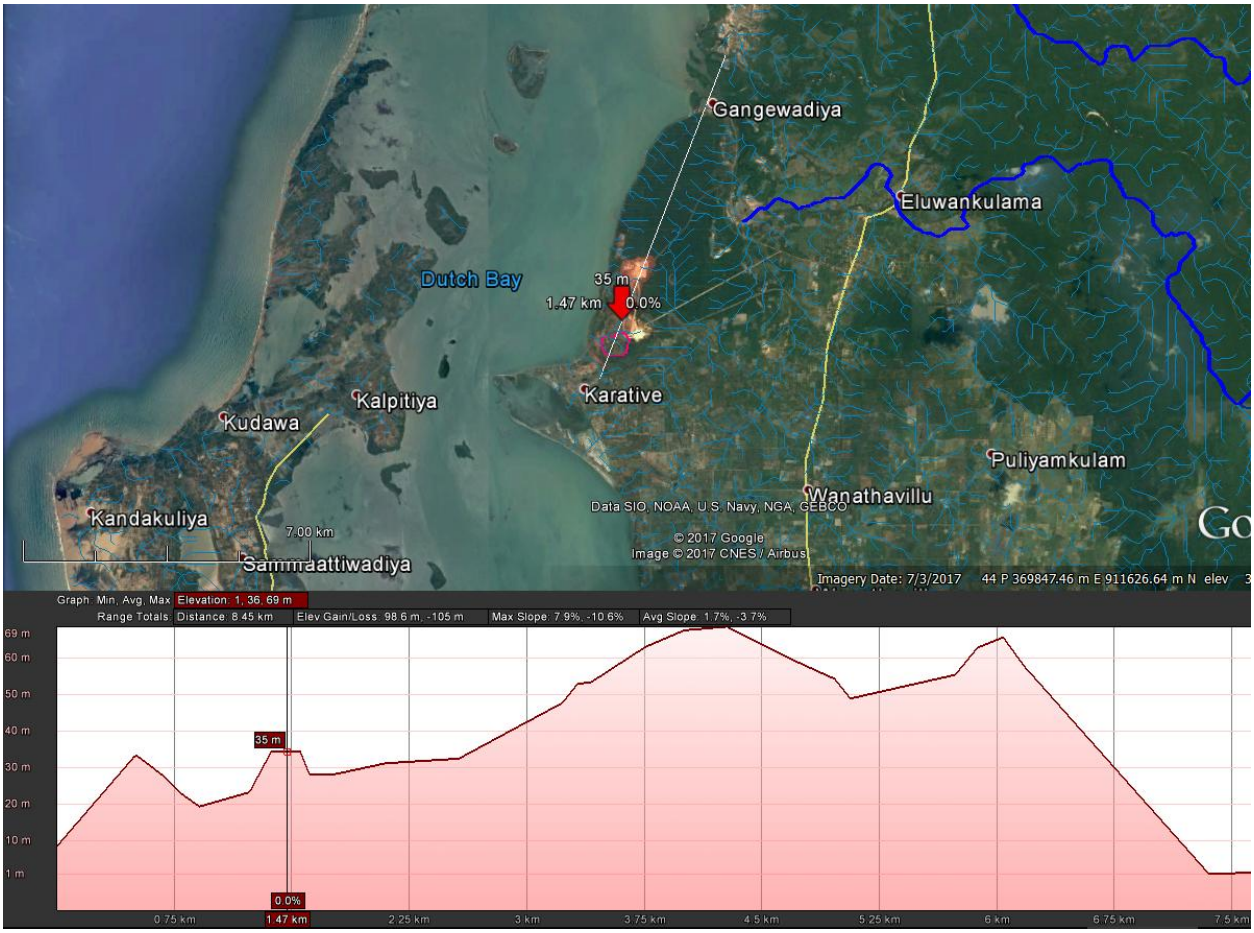


Figure 3.26: The Terrain Elevation Profile in between Lunu Oya Floodplain and Karathivu Lagoon

Existing and planned uses of surface and ground water

There are no specific uses of surface and groundwater from the project site area.

Cleaning purpose water, cleaning wheel water, portable water for management building, chemical water for leachate treatment facility, etc., shall be required for water supply plan. Water shall be supplied by service water and service water tank shall be installed on management building. Cleaning wheel water and portable water is estimated as to be 3.7 m^3/day.

Surface Water quality

The only water body available within the study area is the Puttalam Lagoon. The NARA had conducted a rapid assessment survey to determine current status of water quality in several places Puttalam Lagoon in 2012. The summary of the test results are given in the **Table 3.11**

Table 3.11: The summary of the water quality test results in Puttalam lagoon.

Parameter	Min	Avg	Max	Stdv
Water temp (°C)	21.3	31.0	32.6	2.3491
pH	8.14	8.18	8.29	0.0342
DO (mg/l)	6.32	6.89	8.31	0.4762
EC (mS/cm)	31.50	37.99	44.90	4.0579
Ammonia cal-N (mg/l)	0.11	0.44	0.71	0.2147
Nitrite-N (mg/l)	0.00	0.01	0.05	0.0159
Phosphate (mg/l)	0.01	0.23	1.61	0.3815
TSS (mg/l)	2.00	8.48	17.60	4.2224
Turbidity (NTU)	2.66	6.93	13.42	2.6095
TDS (mg/l)	18.82	23.20	27.90	2.7484
Salinity (ppt)	19.60	24.13	29.10	2.8823
Chlorophyll -a (mg/m^3)	0.35	3.70	19.28	4.3835

The tested values are accordance with the standard pH given for fish and aquatic life, as stated by the Sri Lanka Standard Institute. The Total Dissolved Solids (TDS) in the lagoon varied between 18.82 mg/l to 27.90 mg/l and the mean value was 23.2 ± 2.74 mg/l. The results revealed that, the light penetration in the lagoon is very poor. Also, the amount of aquatic flora and fauna including chlorophyll-a, sea weeds and other dead material deposited at the bottom of the lagoon. Therefore, the decomposition rate in the bottom is very low.

Ground water

Groundwater quality was checked in two locations in the surrounding of the project area one at tube well at tube well at Navy pump house and the other one at the tube well of Holcim office. The test reveals that the groundwater is relatively brackish with Cl^- levels > 250 mg/L (SLS 614: 2003 drinking water guidelines) (**Annex 3.5**). However, the groundwater within the Project site is not polluted in terms of fecal contamination, heavy metals, nutrients, F^-, persistent organic pollutants (POPs) such as organochlorine pesticides and other organic pesticides such as carbamates (**Annex 3.5**).

3.1.2.6 Land use

Land use of the DSD is characterized with dense forests, thorn forests, open forests, sparsely used crop lands for coconut cultivation, cashew, banana and homesteads and water bodies. Land under coconut cultivation is higher than any other land type under other crops. The extent of land covered for quarry of limestone for cement industry extends over 5,000 acres.

3.1.2.7 Air Quality

There are no air pollution emission sources within the 1km radius of the proposed landfill site except the Holcim active mining quarry is located about 1 km southwest to the proposed site. Therefore, air pollutant emissions due to the limestone mining activities and by the vehicle movement in the existing access road to the site which is a gravel road, generated dust during vehicle travelling are contribute to the existing air quality in the area.

Since there are no any air quality database for the area, existing ambient air quality levels measured at two locations around the study area for the Siam City mining activities can be considered as representative data for baseline air quality of the area. According to the air quality measuring results of the report issued by SGS bearing job number 1566109248 dated November 2015 measured for the existing mining activities by the baseline all air pollutant levels were well below the Sri Lanka National Standard for Ambient Air Quality in the area. A copy of the test report is attached (**Annex 3.6**).

There are no air pollution emission sources within the 1km radius of the proposed landfill site except the active mining quarry is located about 1 km southwest to the proposed site. Therefore, air pollutant emissions due to the limestone mining activities and by the vehicle movement in the existing access road to the site which is a gravel road, generated dust during vehicle travelling contribute to the existing air quality in the area.

3.2 Biological Environment

3.2.1 Transfer Station (KTS)

The study area consists with identical vegetation communities as well as marsh, short grassland, scrubland and stream bank floral communities. However, this marshy ecosystem provides a good habitat for many aquatic and watershed refers plants and also for many faunal groups such as freshwater fish, birds, amphibians, butterflies and dragonfly fauna. The land of the proposed project site dominantly covering with *Annona glabra* (Annonaceae) trees. The understory of the proposed project site is mainly consists with *Ludwigia peruviana* (Onagraceae) and *Pandanus odorifer* (Pandanaceae). The Ground is almost covered with several grass species of Cyperaceae and Poaceae. *Eichhornia crassipes*, *Nymphaea pubescens* and *Nelumbo nucifera* are the common aquatic species in the canals.

Figure 3.27: A view of the proposed project site with aquatic habitat and vegetation system.

Figure 3.28: A view of a watershed bank dominated by Annona glabra trees.

FAUNA AND FLORA IN THE STUDY AREA

Identification of key habitats, floral and faunal diversity is crucial in evaluating potential negative ecological impacts of proposed project activities. In order to identify the species in the proposed project area, a rapid assessment on terrestrial and ecological resources was carried out within the proposed project area and surrounded area.

The survey was carried out during late period of Southwest-monsoon season in day time (on 23.05.2017) and aim of the survey was to prepare a detailed species inventory, identify the problems/ issues within and surrounded area (approximately 100m) the existing environment of the proposed project site and identify the possible Environmental impacts due to the proposed project.

Sampling plot method was the main technique used to survey the fauna and flora of the project area and different sampling techniques were used to sample different taxon. Terrestrial fauna observed in around the plots were recorded. Point counts were also carried out for birds except the line transects. A binocular was used to observe birds and butterflies. Some floral and faunal species were photographed using with Nikon D3300 DSLR camera.

No live specimen is collected and night sampling was not conducted during the field study. Species identification and nomenclature of the species present was based on the latest literature published on the fauna and flora of Sri Lanka. The conservation status of the species was determined according to the 2012 Red list of Threatened Fauna and Flora of Sri Lanka by IUCN. Further, relevant secondary information were gathered from people living nearby communities.

FLORA

List of flora recorded during the field survey is given in **Annex 3.7, Table 1.**

A total of 50 species were observed belonging to 28 families, during the field study. Summaries of recorded floral species are given in table 3. Majority of plant species recorded in the study site are trees (22), followed by herbs (15), shrubs and aquatic species (4). Among the recorded species about 50% are introduced, exotic, or invasive to Sri Lanka.

Annona glabra (Annonaceae), Alstonia macrophylla (Apocynaceae), Clidemia hirta (Melastomataceae) and Wedelia trilobata (Asteraceae) species are considers as Alien Invasive Species (AIS) in Sri Lanka.

None of the recorded species are unique or restricted to the project area.

List of flora recorded in the home gardens in surrounded area during the field survey is given in **Annex 3.7, Table 2.**

Out of the total no. of 50 floral species recorded, no any species is endemic to Sri Lanka. One plant species (*Vitex altissima*) recorded on the proposed project site belongs to 'Near Threatened' category (NT) in 2012 Red List.

Fauna

A total of 36 faunal species were recorded during the survey representing dragonflies, butterflies, reptiles, birds and mammals. Among them Sri Lanka purple-faced leaf monkey (*Semnopithecus vetulus*) is endemic to Sri Lanka and 'Endangered' species while others are native species. There are one species of dragonfly (*Orthetrum pruinosum*) in 'Near Threatened' category and Atlas moth in 'Data Deficient' category.

Sampling of fauna was done in parallel to the floral transacts. Visual Encounter Survey (VES) method was used to record the faunal species. Faunal survey was carried out within the proposed project area and 500 m away from the project boundary. Reviewing of published documents and unpublished data was also carried out. In addition photographic records were used to identify the visual aspect of habitats of proposed project area.

Most of the species that observed in the project area are common residents in such kind of habitats throughout the island. A list of fauna observed in is given in **Annex 3.7, Table 4.**

19 bird species, 11 butterfly species, 7 reptile species, 5 amphibian, 5 dragonfly species and 3 mammal species were recorded during the field study within the proposed project area and surrounded 500m neighboring area (approximately). According to the faunal checklist, there are 3 Near Threatened species recorded in the study area (1 amphibian and 2 dragonfly species). Common Pond Snake (*Xenochrophis asperrimus*) was the only endemic faunal species recorded in the study area.

3.2.2 Landfill Site

3.2.2.1 Natural and modified habitats and vegetation categories

In the map provided, the proposed landfill site is marked as a NS aligned and roughly rectangular area of about 1000 X 500 m. A 500 m wide peripheral project influence area which extends to the shoreline of the Puttalam Lagoon on the west is also indicated. The vegetation and floral surveys were conducted in representative sites within this total area.

The original environment of the proposed landfill site, presently the abandoned limestone quarries, was evidently a well-developed forest typical of the major part of the Dry Zone, namely the Dry Mixed Evergreen Forest (DMEF). This is evident from the existing DMEF areas occurring in non-excavated areas lying north of the project area. With the commencement of limestone mining the original physical and biological features of the total landscape of the project area have undergone rapid and extreme destruction resulting in cataclysmic changes in its topographical, geological, hydrological and edaphic characteristics.

The soil erosion has been unintentionally promoted by excavation and overburden deposits which have created large depressions and elevations in the landscape. Erosion has taken place during every rainy season and deposited large volumes of soils in the Puttalam Lagoon, only about 500 m from the near end of the quarries. Concurrently, large and small pools have developed in the depressions holding water, heavily laden with reddish clay. Most of these pools (or small shallow lakes) dry up during drought season exposing highly cracked bottoms. These pools are of immense importance to large and small fauna.

Even in such an extremely human-modified environment, the nature undertakes the responsibility of restoring the disturbed environment. However, this is relatively a slow process during which the landscape undergoes a seriate succession manifested by changes in vegetation features accompanied by floral and faunal compositions. Furthermore, this natural restoration process can be accelerated through human assistance, e.g. restoration (rehabilitation) with selected species. The resultant Environmental improvement becomes apparent in terms of forest cover, soil and water conservation, micro-climatic amelioration and the quality of biodiversity (floral and faunal) including increased animal activity. Different habitats manifested by disparate vegetation characteristics accompanied by variable species composition have developed in the project area.

3.2.2.2 Environmental rehabilitation of mined areas

The Provincial Environmental Authority (PEA) of the North Western Province (WNP) was established in 1991 as per the Section 2(1) of the North Western Province Environmental Statute (NWPES) to deal with the matters pertaining to the protection of environment within the NWP. In order to protect and conserve the environment of the NWP, the PEA is empowered to carry out many activities. These include granting of Environmental approval to development projects via issue of Environment Protection Licenses (EPLs). When Holcim (Lanka) obtained the EPL, it was required that limestone mining is carried out with minimum damage to the environment. One of

these conditions is the rehabilitation of environment of the mined area. In addition, the success of the rehabilitation activities should also be assessed annually. A survey on the fauna and flora in the rehabilitated area and in the natural forests in the neighborhood of the quarry site should be carried out in order to assess the success of rehabilitation program. In this respect, a study was conducted and a report submitted to the NWP (Holcim (Lanka) Ltd., 2013). This study was carried out during 2012 – 2013 through a floral and faunal survey. Objectives of the study were as follows:

a) Determining the growth of the trees replanted from 2002 to 2013

b) Identification of the replanted plant species that have grown well during the period from 2002 to 2013

c) Identification of the natural plant species that have grown in the rehabilitated area.

d) Determining the success of the use of rehabilitated areas by wild fauna.

As recommended by the PEA, the top soil of the overburden had been separated and stockpiled separately and subsequently the top soil was spread over the refilled area in order to establish a fertile top soil layer. Prior to 2006, the top soil layer was about 20 cm, but then increased to about 1m and this has been shown to have a positive effect on the growth of the vegetation.

Early stages of the rehabilitation process have apparently begun in 1999 with planting of only Neem plants. From about 2002 other species have been gradually introduced until about 2012, when there was a total of 48 species in the list, in an area of about 69 hectares. The highest rehabilitation activities were during 2009-2010. The highest number of plants that were planted was Mee followed by Neem and Tamarind. A very useful inference from the results of the rehabilitation programme was the identification of successful and non-successful species and therefore it will be a model for future forest restoration programmes. As noted during a monitoring study conducted in 2012-2013, the most successful species were Neem, Ehela, Madan, Mee, Divul, Palu and Ranawara. The study also indicated that a number of species have failed to survive or performing poorly, e.g. Jak, Coconut, Domba, Weera, Na, Pihimbiya, Orange, Teak etc. and therefore these were not recommended for subsequent rehabilitation of the quarry areas.

The success of the rehabilitation process was further evident by abundant animal activity. Trees damaged by elephants and their dung are a common sight and wild boar digging and deer feeding on ‘Dan’ fruits were observed. Footprints of elephants, wild boar, deer, mongoose were very common, especially near ponds and water holes. Several species of frugivorous birds were attracted to the rehabilitated areas due to the presence of food plants such as ‘Madan’ and ‘Eraminiya’ etc. In addition, pollinating species such as bees and butterflies were attracted by many flowering species such as ‘Ehela’ and ‘Ranawara’ etc. Increasing animal activity had been a certain cause of soil fertility and enrichment of the forest cover.

3.2.2.3 Methodology for plant biodiversity assessment - Gradsect Sampling Method

This method was successfully employed for the National Conservation Review (IUCN & WCMC, 1997) and later followed by several other biodiversity surveys in Sri Lanka. It was used recently for the biodiversity assessment of the proposed sanitary landfill site at Aruwakkalu (EML, 2015). It has been demonstrated that the Gradsect (Gradient-directed Transect) methodology is an effective and reasonably comprehensive method for rapid assessment of the biodiversity. The method essentially consists of a series of 100 X 5m linear plots laid along a transect running through a given site and along an altitudinal gradient, if available. The selection of sampling sites will be mainly guided by the type (forest, thorn scrub and marsh etc.) and the status of the vegetation (primary, secondary or pioneer). Site information such as GPS and disturbance levels and vegetation characteristics, e.g. forest cover, canopy height and forest floor were noted.

Flora: Three main habitats / ecosystems, were observed and main species in them were noted. All plant species (herbs, shrubs and trees etc.) were identified and recorded in Species Inventory Form (IUCN & WCMC, 1997). Samples (herbarium specimens) of those species that cannot be identified in the field were collected and preserved to be subsequently identified in the National Herbarium in Peradeniya. When working along gradsects (transects) is not possible due to time constraints or due to impenetrability of the vegetation, e.g. dense thorn scrub, or cliffy sites, a trek is made along deviated footpaths through the study area and species were noted (**Figure 3.29**).

Figure 3.29: Gradsect (Transect) methodology for sampling vegetation using 100 X 5 m transects

In addition to compiling the species composition (lists of flora), rare species, endemic species, threatened status (Red List status) and successional status were subsequently obtained. Based on

above data, ecosystem diversity and conservation values of the study area were derived and characterized. Following ecosystems / habitats were observed:

3.2.2.4 Naturally recovering Sparse and Open Forest (SPOF) in abandoned quarry area

Area is a shallow to deep concavity with varying widths between 300 – 450 m and located in the vicinity of $8^0$14' 23.72"14 N 79^0 49' 02.29" E and at a minimum altitude of 25m . Area is said to have been excavated in 1990's and abandoned. Area has gone through a natural restoration process through a series of vegetation succession possibly starting with various pioneer species of plants consisting of fast growing herbs and shrubs paving the way to the establishment of more shrubs and trees developing gradually into a secondary forest. The forest canopy reached 4-6 m in height and it provided up to 10 – 50% forest cover at different locations. The forest floor was partly exposed and covered with plant litter to varying degrees and the herbaceous flora was poor, mainly due to prevailing drought (**Figure 3.30**).

A total of 31 flowering species were recorded **(Annex 3.8, Table 1)**. The dominant trees in this secondary forest were 'Kohomba' (*Azadirachta indica*) and 'Ahu' (*Morinda coreia*) and they are fast growing species. 'Andara' (*Dichrostachys cinerea*) is distinctly dominant among shrubs and low stature trees reaching 3-5 m in height. Tree species such as 'Maila' (*Bauhinia racemosa*), 'Kalu habaraliya' (*Diospyros ferrea*) and Jam tree (*Muntingia calabura*) were frequent while 'Katu-pila' (*Flueggea leucopyrus*) and 'Kukuruman' (*Catunaregam spinosa*) were some common shrub species. 'Diva-pilila' (*Dendrophthoe ligulata*) is the only endemic species, while 'Boo-kollu' (*Rhynchosia velutina*) is Critically Endangered species in Sri Lanka.

Nearly all species encountered in this habitat were native species whose propagules (fruits and seeds) have originated in the surrounding vegetation. Only a few were exotic but naturalized in this disturbed habitat; e.g. Jam tree (*Muntigia calabura*) and 'Ganda-pana' (*Lantana camara*). However, these have not reached invasive levels here.

Figure 3.30: A & B. Naturally recovering Sparse and Open Forest (SPOF) in abandoned quarry area – Note Puttalam Lagoon (Dutch Bay) and coastal forest in background

3.2.2.5 Developing Dry Mixed Evergreen Forest (DMEF) on overburden deposits in project influence areas

This lies to the South of the quarry area on elevated grounds above the abandoned quarry in the vicinity of 8^0 14' 33.63"N 79^0 49' 04.88" E. and at a maximum altitude of 40m. Heavy soil erosion was noted. The natural restoration on overburden deposits (un-separated into top and deep soils) seems relatively more progressive than that over abandoned quarries. This is apparently due to relatively higher soil nutrition levels brought about by considerable amounts of excavated top soils. The stature and physiognomy of the forest were approaching the DMEF status with forest canopies reaching 7-10 m and giving a forest cover of 25 to 75 %. The forest floor had an appreciable amount of plant litter, lesser exposed areas and a few more herbaceous plants compared with those in quarry sites.

Furthermore, the species composition showed a positive trend towards the development of DMEF, the most typical vegetation type of the Dry Zone under optimum conditions. It harboured some typical DMEF components, such as 'Buruta' (*Chloroxylon swietenia*), 'Neralu' (*Cassine balae*), 'Hik' (*Lannea coromandelica*) and 'Kaha-penela' (*Lepisanthes tetraphyllea*) etc.

A total of 31 flowering species were recorded. The dominant trees in this forest were 'Kohomba' (*Azadirachta indica*) and 'Ahu' (*Morinda coreia*) and they are fast growing species. 'Andara' (*Dichrostachys cinerea*) is distinctly dominant among shrubs and low stature trees reaching 3-5 m in height and 18 cm DBH. Tree species such as 'Maila' (*Bauhinia racemosa*) and 'Kalu habaraliya' (*Diospyros ferrea*) were frequent, while 'Katu-pila' (*Flueggea leucopyrus*), 'Balal-katu' (*Scutia myrtina*), Kudu-miris (*Toddalia asiatica*) and Heen-karamba (*Carissa spinarum*) were some common shrubs / climbers. No endemic or threatened species were encountered.

3.2.2.6 Rehabilitated Sparse and Open Forest (SPOF) in abandoned quarry area

This area lies to the North of the previous excavated mine which has undergone natural restoration (Section 3.2.2). This site is also a shallow to deep concavity with varying widths between 330 – 430 m and located in the vicinity of $8^0$14' 34.12" N 79^0 49' 04.72" E and between 5 and 25 m altitudes . Area is said to have been excavated since 1990's and abandoned. The process of rehabilitation is described in the **Section 3.2.2.2**.

The site had been rehabilitated in about 2006 with cleaning of the under shrubs followed by planting with native species mainly during the rainy seasons. It was also evident that the species were not carefully selected but for the most part was based on availability at the nurseries or the whims of the suppliers. This is possibly the reason for considerable failure of several species as reported in the rehabilitation report (Holcim Lanka, 2013).

The present survey indicated that the forest canopy has reached 7-8 m in height providing 25 – 75% forest cover. However, the previous monitoring study has recorded Neem trees grown up to 11 m in height and 30 cm DBH in 2013 (Holcim Lanka, 2013). The forest floor was partly exposed and covered with plant litter to varying degrees and the herbaceous flora was poor, mainly due to prevailing drought. Disturbances such as felling of timber, removal of firewood and hunting were not evident.

A total of 29 flowering species were recorded (**Annex 3.8, Table 1**). The commonest trees in this rehabilitated forest were 'Kohomba' (*Azadirachta indica*), 'Madan' (*Syzygium cuminii*), 'Mee' (*Madhuca longifolia*), 'Maila' (*Bauhinia racemosa*), Acacia (*Acacia auriculiformis*), 'Divul' (*Limonia ferronia*, 'Ahu' (Morinda coreia) and 'Hal-milla'(*Berrya cordifolia*) (**Figure 3.31**). There were few individuals of Mahogany (*Swietenia mahagoni*), 'Beli' (*Aegle marmelos*) and Cashew (*Anacardium occidentale*). Among shrubs and vines, 'Katu pila', 'Kudu miris'and 'Balal katu' were common. Apart from planted species, several natural tree species were also observed, e.g. 'Ahu', 'Maila' and 'Neralu'etc. 'Andara' (*Dichrostachys cinerea*) is distinctly dominant among shrubs and low stature trees reaching 3-5 m in height and 18 cm DBH.

Neither endemic species nor threatened plants were encountered in the study area. 'Ganda-pana' was the only naturalized species, but not reaching invasive levels.

Many mature Neem and 'Ahu' trees and some "Dan' trees were in fruit and especially Neem and 'Ahu' showed excellent regeneration with frequent young plants arising from seeds. It is clearly evident that the rehabilitation of the mined area is successful to a considerable extent.

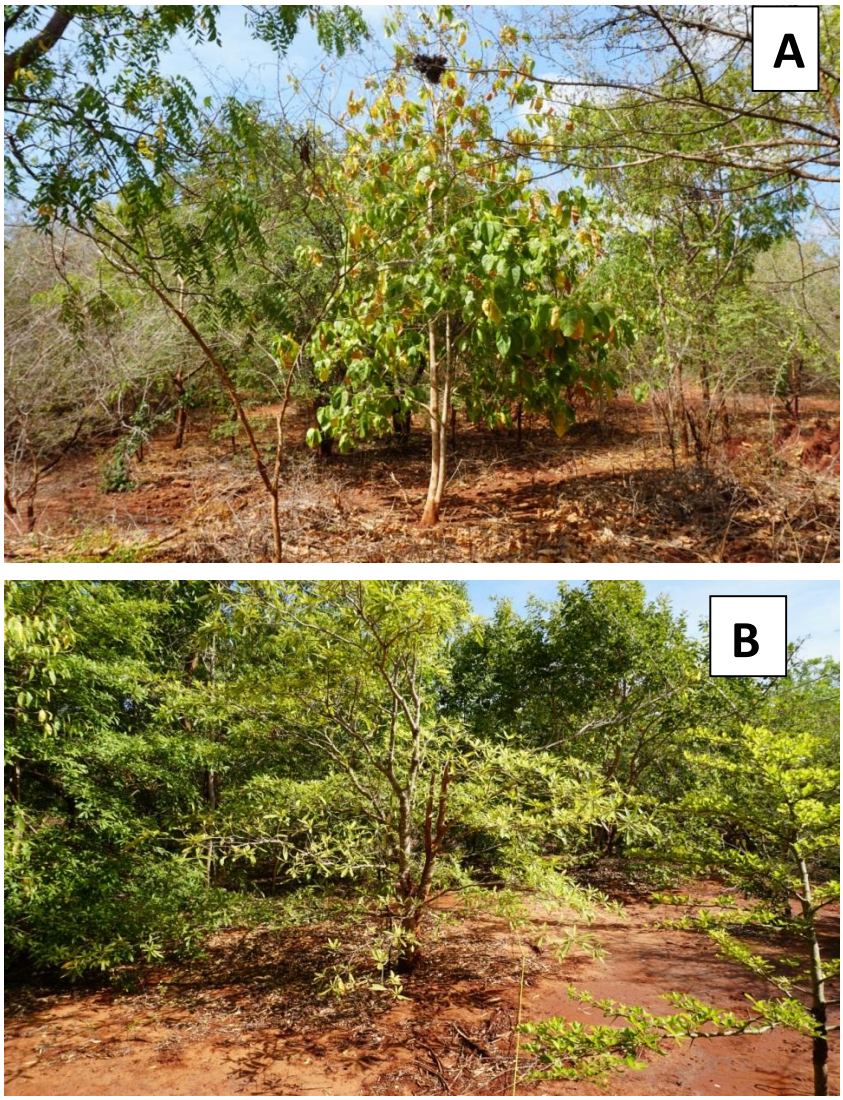


Figure 3.31: Rehabilitated Sparse and Open Forest in abandoned quarry area

Note well-grown 'Hal-milla' (Berrya cordifolia) sapling (A); Similar 'Mee' (Madhuca longifolia) sapling (B).

3.2.2.7 Thorn Scrub in project influence area

Thorn scrub, technically known as Dry Deciduous Thorn Scrub (DDTS), occurs at lower altitudes in the coastward periphery of the project area. The habitat is generally undisturbed physically without any overburden deposits and ecologically without any evidence of destruction of vegetation etc. Area lying in between $8^0$14' 42.09" N 79^0 48' 44.02" E and $8^0$14' 25.17" N 79^0 48' 40.79" E was trekked to observe the vegetation and ecological features.

DDTS at this study site was essentially a low (3-5 m), open to close, un-stratified woodland dominated by thorny species which are mostly deciduous and distinctly xerophyllous (Jayasuriya et al. 2006). The vegetation was very dense forming impenetrable thorny thickets tangled with frequent climbers and lianas and some open grounds (**Figure 3.32**). In some places DDTS formed mosaics of vegetation with patches of low forest or isolated trees emerging above the scrub canopy.

The vegetation was dominated by 'Andara' (*Dichrostachys cinerea*), a large and viciously thorny shrub. It is also a very drought-resistant and reproduces freely by suckers that are produced by long roots spreading beneath a large area around the main stem and forming colonies that appear as dense thickets. In addition, it is also a prolific seed producer enforcing its dominance in such habitats.

Although the species composition of this vegetation was not fully inventoried, seven species encountered in this habitat given in **Annex 3.8**. Some of the common species were 'Kukuruman'(shrub) and 'Maila'(small tree), while in somewhat disturbed sites, e.g. along gravelly roads and foot paths, small populations of Lantana, 'Wara' (*Calotropis giganteum*), 'Kuttu-karasmatti' (T) (*Indigofera oblogifolia), "Pey-muruddi' (T) (Anisomeles malabarica)* and 'Kapu' (*Gossypium arboreum*). 'Wara' was often seen as a pioneer and a colonizer species in gregarious populations on highly disturbed areas such as freshly laid overburden deposits in the project area and its influence areas.

Figure 3.32: Thorn scrub in project influence area – note mosaic of dense thorn scrub and open grounds.

3.2.2.8 Coastal forest in project influence areas

The Puttalam Lagoon, lying on the West of the project area, is only between 240 and 350 m away from the western periphery of the project area and therefore the terrestrial coastal zone is well within the project influence area.

The terrestrial coastal zone within the project influence area was trekked for a distance about 1.25 km and the vegetation was observed at several points. It was noted that, depending on the gradient, Thorn Scrub on high grounds changes to coastal / lagoon shore, gradually when the gradient is low, and abruptly when it is steep (**Figure 3.33**).

The vegetation indicated a low stature generally not exceeding 4 m in height. Most trees were leaning landward water and strongly anchored in sandy soils. The plant biodiversity was relatively high, but a feature of special interest was the existence of an assemblage of species representing distinct ecosystems such as sea coast, mangrove and thorn scrub. This is evidently in response to drastic physical heterogeneity, i.e. terrestrial and marine interphase, gentle to abrupt gradient of interphase and variation in salinity levels. 24 species were recorded **Annex 3.8.** One special find was the presence of 'Moodu-delun' (*Xylocarpus rumphii*), a Critically Endangered species in this ecosystem.

Figure 3.33: Coastal forest in project influence area

3.2.2.9 Pioneer vegetation on overburden deposits and roadsides

These highly modified habitats are poor in soil structure and nutrients, exposed to wind and rain and therefore subject to erosion which is intensified with increased gradients. A majority of species are unable to establish in such harsh habitats; however there are some species that can grow on them. These species, known as **pioneer species,** have special adaptations such as efficient seed dispersal mechanisms, rapidly germinating seeds and fast growth, thus enabling them to grow rapidly and colonize the landscape and also pave the way for the establishment of follower species. The most prominent pioneer in such habitats is 'Wara' (*Calotropis gigantea*).

3.2.2.10 Palmira Grove

A dense grove of Palmyrah (*Borassus flabellifer*) was found within the project influence area, centered around $8^0$14' 48.41" N 79^0 48' 44.46" E. It was a coastal grove roughly in an area of about 0.5 hectares. As the canopy of the palm Grove is mostly closed, the undergrowth is sparse with a few species such as 'Midi' (*Premna obtusifolia*) **(Figure 3-34).** Many palms were in fruit and they were sustaining a population of Grey Langur *(Semnopithecus entellus*).

Figure 3.34: Palmyrah grove in project influence area

3.2.2.11 Remnants of a coconut plantation

A discontinuous grove of coconut palms numbering to about 20 were seen in the vicinity of $8^0$14' 28.47" N 79^0 48' 40.99" E and within the project influence area. These palms appear to be over 70 years of age and remnants of a neglected plantation. The matrix of the area consists of mainly the Thorn Scrub vegetation has been provided.

3.2.2.12 Endemic, threatened, rare and useful species

The project area was extremely disturbed due to mining, deposition of overburden, roadways and soil erosion etc. (**Section 3.2.2.2**). This is believed to be the main reason that the project area is notably poor in endemic, threatened and rare plants. However a few of such species were observed, especially in the project influence areas and in the coastal forests.

Endemic species: 'Diva-pilila' (*Dendrophthoe ligulata*) is an aerial hemi-parasite occasionally seen growing on shrubs in the project area and it is **vulnerable (Figure 3-35)**. 'Neralu' (*Cassine balae*) is a tree species that was encountered in the developing Dry Mixed Evergreen Forest

(DMEF) on overburden deposits in project influence areas. However, only a few individuals were seen and they were small trees, indicating their recent origin in this habitat.

Figure 3.35: 'Diva-pilila' (Dendrophthoe ligulata) – An endemic, threatened (vulnerable) and rare species.

Figure 3.36: Kuttukarasmatti' (T) (Indigofera oblongifolia) – a threatened (vulnerable) and rare species

Threatened species: A single very small population of 'Bu-kollu' (*Rhynchosia velutina*), a **critically endangered** species in Sri Lanka, was found in the naturally recovering Sparse and Open Forest (SPOF) in abandoned quarry area . This is an extremely rare species in Sri Lanka, known only from three collections. A recent collection from Aruwakkalu is the only and the first gathering from the West coast of Sri Lanka (Jayasuriya, 2014); (**Figure 3-37**). 'Moodu-delun' (*Xylocarpus rumphii*) is also a **critically endangered** species found occasionally along the lagoon coast (**Figure 3.38**).

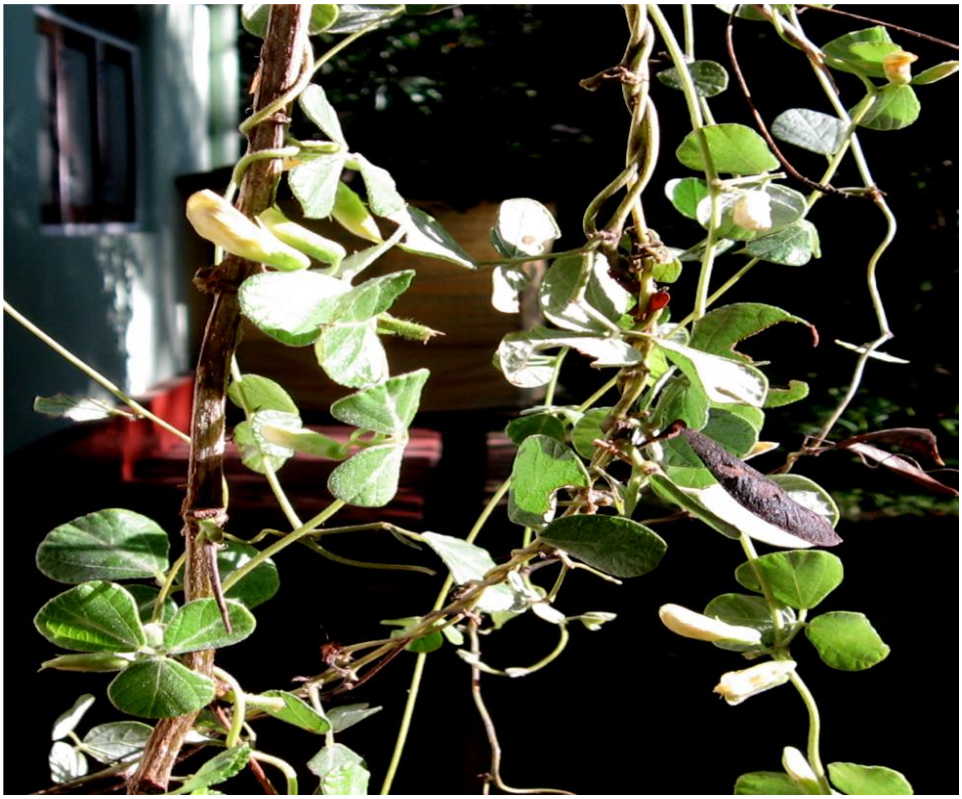


Figure 3.37: Rhynchosia velutina ('Bu-kollu')

Note twining habit, pinnately trifoliate leaves, un-opened yellow flowers and a dried pod (collected in Aruwakkalu, 29 April 2014- Jayasuriya (2014)

Figure 3.38: 'Moodu-delun' (Xylocarpus rumphii), a critically endangered and very rare species

Rare species: Above mentioned endemic and threatened species (except 'Neralu') are very rare, known only from a few locations in Sri Lanka. 'Diva-pilila' (*Dendrophthoe ligulata*) is an aerial hemi-parasite in the North and North-western coastal areas of the island. In the project area it was occasionally seen growing on shrubs and the species is considered **vulnerable**. However, it was observed to occur in many areas in Aruwakkalu and seems to prefer disturbed sites where gregarious populations were sometimes noted. 'Kuttukarasmatti' (T) (*Indigofera oblongifolia*) is a leguminous shrub, considered **vulnerable**, rare in Sri Lanka, previously recorded only in the Jaffna and Mannar Districts until it was recorded recently in Aruwakkalu where it was sometimes found in gregarious populations in disturbed habitats. At the Holcim quarry sites it was found frequently in open disturbed habitats, as a pioneer species.

Medicinal plants: There were 41 medicinal species among the total of 77 species recorded at the project area, indicating a high level of medicinal plants (53 %); however, none can be considered rare in Sri Lanka. The medicinal plants were determined according to Jayaweera, (1981-1982).

3.2.2.13 Methodology for faunal biodiversity assessment

Information stated here was obtained from the IUCN reports submitted to Holcim (Lanka) Ltd. (2014, 2015 & 2016). These reports were based on work conducted to estimate the success of restoration activities on areas that were previously mined for limestone. This process is known as assisted regeneration of degraded forest sites. As this area more or less overlies the present study site, except the project influence areas such as coastal forests, the fauna is expected to be greatly similar. Further, unlike the flora, the faunal species are mobile to a great extent.

The study site was sampled by several permanent belt transects (5 X 50). The fauna were recorded by direct (visual sightings) and indirect observations (e.g. bird calls, foot prints, scratch marks, faeces, body parts and nests etc.). Detailed methodologies used to records different groups of fauna and specific publications used to identify them are given in the IUCN reports (2014, 2015 & 2016).

3.2.2.14 Faunal biodiversity

A total of 150 fauna species was recorded during the sampling of the permanent plots in the restored / rehabilitated areas of the Aruwakkalu Quarry site. This included 10 land snail, 9 dragonfly, 55 butterfly, 8 reptile, 47 bird and 21 mammal species. No amphibians were recorded. A summary of the faunal species recorded during the 2016 monitoring survey is presented in

Table 3.12: Summary of faunal species recorded in 2016.

CR – Critically Endangered; DD – Data deficient; EN – Endangered; NT – Near Threatened; VU – Vulnerable;

Taxonomic Group	Fauna species				Conservation Status (Red List 2012)				
	Total	Endemic	Migrant	Exotic	CR	EN	VU	NT	DD
Land snails	10	4	0	1	0	4	2	0	1
Dragonflies	9	1	0	0	0	0	0	1	0
Butterflies	55	1	0	0	0	0	2	5	0
Reptiles	8	2	0	0	0	0	2	5	0
Birds	47	4	0	0	0	0	0	2	0
Mammals	21	2	0	0	0	1	0	2	0
Total	150	14	0	1	0	5	5	11	1

The faunal species surveys conducted between 2009 and 2016 have indicated a genuine rise in the species richness of the restored areas that clearly shows that biological /ecological environment in restored sited have improved,

3.2.2.15 Endemic and threatened species

The fauna included 14 endemic species: *Euplecta layardi, Glessula ceylanica, Beddomea trifasciatus, Aulopoma itieri, Ictinogomphus rapax* (Rapacious Flangetail), *Appias galane* (Lesser Albatross), *Hemidactylus lankae* (Termite Hill Gecko), *Sitana devakai* (Devaka's Fanthroat Lizard), *Gallus lafayetii* (Sri Lankan Junglefoul), *Treron pompadora* ((Pompadour Green-pigeon), *Tephrodornis Pondicerianus* (Sri Lankan Common Woodshrike), *Macaca sinica* (Sri Lanka Toque Monkey) and *Moschiola meminna* (Sri Lanka Mouse-deer).

Among the species recorded there were domestic Humped-backed cattle (*Bos indicus*) and one exotic land snail species, *Bradybaena similaris*. No migrant birds were observed; however, the

survey was conducted during the non-migrant season. Ten Nationally Threatened species: *Euplecta layardii* (EN), *Glessula ceylanica* (EN), *Cyclophorus invovulus* (EN), *Aulopoma itieri* (EN), *Cryptozona semirugata* (VU), *Beddomea trifasciatus* (VU), *Papilia crino* (Banded Peacock) (EN), *Deudorix epijarbas* (Cornelian) (VU), *Sitana devakai* (Devaka's Fanthroat Lizard) (VU) and *Elephas maximus* (Elephant) (EN) were observed. In addition, eleven 11 Near Threatened (NT) species, *Indothermis camatica* (Light-lipped demon), *Euphloea sylvester* (Double-banded Crow), *Coladenia indranii* (Tricolour Pied Flat), *Hasora taminatus* (White- banded Owl), *Pelopidas agna* (Little Banded Swift), *Pelopidas mathias* (Small Branded Swift), *Geochelone elegans* (Indian Star Tortoise) and *Francolinus pondicerianus* (Grey Francolin) were also recorded in the restored area. Furthermore, one land snail species, *Rhachistia pulcher*, listed as Data Defficient (DD) was also recorded.

3.2.2.16 Present threats to faunal biodiversity

Frequent hunting of animals was observed / reported. These were carried out by people from adjacent villages. e.g. Heratkuliya and Karathivu on the South of the Holcim areas. A method of hunting, known as "Kotu atta", was observed in the vicinity of a pool of water within the project area. Here, several meters away from the edge of a pool and among shrubs a concealment is made with branches from where animals coming to drink are ambushed and shot.

Figure 3.39: "Kotu atta": A hide with a pile of branches used by a hunter to ambush animals visiting a pool of water (dry).

3.2.3 Habitats and species destroyed by the proposed project activities

The habitats that will be directly impacted by the project activities are: Naturally recovering Sparse and Open Forest (SPOF) in abandoned quarry area and Rehabilitated Sparse and Open Forest (SPOF) in abandoned quarry area. The two sites (Sites A & C) lie between 8^0 14' 41.41"N 79^0 48' 54.79" E and 8^0 14' 15.14"N 79^0 48' 54.64" E and entire project area at the two sites will be expected to be destroyed.

The natural restoration that took place during the past fifteen or so years at the former site and assisted habitat restoration at the latter site during the last ten years will be lost. Further, expenditure incurred for environment rehabilitation and progress monitoring at the latter site will be a lost investment.

In the project area all faunal habitats will be inevitably lost. These include terrestrial landscape with its vegetation cover and aquatic habitats such as large and small pools of water.

Some faunal groups, especially the land snails and less mobile fauna such as amphibians (not recorded in the surveyed areas) are destined to be destroyed during project activities. Mobile groups such as dragonflies, butterflies, most reptiles, birds and mammals are not expected to be impacted. Besides, in a given region, such as Aruwakkalu forest area, these faunal groups, including endemic and/or rare species, are reasonably well dispersed and therefore any particular group cannot be expected to be confined only in the project area. In the event that some individuals in the project development sites get destroyed, those species in sufficient populations are expected to be present in the general area in order to sustain those species.

3.2.4 Proximity to protected areas

The nearest protected area to the project area is Wilpattu National Park lying NE of the former at a distance of approximately 6 Km. Furthermore, the Puttalam Lagoon coastal zone, an Environmentally sensitive zone, lies at a distance of 300 – 500 m.

3.2.5 Ecological functions and values of the area

Environmentally and ecologically, the project area had been completely destroyed by the mining process and since its abandonment; the nature has gradually taken over its Environmental restoration through a series of vegetation succession. At present, the forest cover has developed into a stage of **Sparse and Forest** in naturally restored sites. Comparatively, the process has taken place relatively more rapidly in rehabilitated sites due to human assistance. On overburden deposits the forest cover has further progressed into a forerunner stage of the DMEF, perhaps due to relatively higher soil nutrients and elevation. Therefore, it is clear that the forest cover in the project area is of considerable value in terms of Environmental amelioration such as control of soil erosion, improvement of water retention, control of lagoon pollution and siltation and improvement of biodiversity values.

3.2.6 Human-elephant conflict

Elephas maximus (Asian Elephant) were observed as small resident groups (4 to 10 individuals). But some migrate seasonally from the Wilpattu National Park area crossing the Thabbowa Sanctuary and are hence observed as large herds (Kumarasinghe et.al. 2013). Elephants move freely within the Holcim areas and adjacent forests, especially in search of water. During droughts water is mostly scanty and only available in a few ponds that were artificially created excavation of limestone quarries. Human-elephant conflicts were not reported in the quarrying area and the peripheral forests as far as Kala Oya River near Gangewadiya. A few years ago, an elephant fence was noted in the Gangewadiya preventing the entry of elephants from Wilpattu National Park. However, at present, this fence is not operational.

3.3 Socio Economic and Cultural Environment

3.3.1 Kelaniya Transfer Station (KTS)

The site of the Kelaniya Transfer Station (KTS) is located very close to the present waste open dumping site close to Wanawasala Railway Station in Kelaniya area of the Western Province bordered by the Colombo Railway Main Line and the Colombo-Kandy Highway. The estimate terrain elevation above sea level is 4 meters. The distance from **Wanawasala to** Colombo is approximately 6.8 km. The currently operated dumping site named Kelaniya Dumping Site is located in a section of the marsh land which was previously under SLLRDC. This land was vested to Kelaniya Pradeshiya Sabha to be used as a landfill area.

3.3.1.1 Population centers and settlements in and around the project site:

Wanawasala is a populated GN Divisions and is located in Western, Sri Lanka. The area falls within the Kelaniya DS division of Gampaha District. The proposed site can be accessed from Manelgama to Wanawasala Road or the Waragoda Road which under passes bridges sections of the Colombo-Kandy Highway

Total land extent of Kelaniya DS Division is 21.9 sq. km. and most of the low lying lands in the marsh area is maintained by the SLLRDC as part of the Greater Colombo Flood Management Programme and are considered to be reserved state land.

3.3.1.2 Population characteristics, their income sources and livelihood dependency

The population (2011) of the DSD Kelaniya was around 137,339. The male population (2012) is 67461, and the female around 69,878. The number of GND is the DSD is around 30. Population density in the DSD is 6867 inhabitants per sq. km.

The project area falls within Wanawasala GN Division (No 257 B). The surrounding villages including Manelgama, Delgahawatta, Jambuwatta, Gotabaya Road, Duwawatta; Sudharma Mawatha and the railway village fall within 1-2 km radius of the propose transfer site) .

Manelgama which is the closest to the Open dumping site and the KTS, is a settlement which was settled with 45 families several decades ago (In the year 1984) where each family received about 15 perch of land for the development of hoses. All occupants have title and deeds. The present number of houses in the village exceeds 60 with the expansion of families. This is, as in the case of many villages in the surroundings, is low lying area and even in the slightest rain it is inundated with storm water. The access roads become impassable. There is a road network connecting to several villages but all appear to be flooded during rains.

All the houses in the village look permanent (except a few temporary houses built on the verge of the marshy areas) and the residents seem to be middle income earners. The adjacent villages called Duwawatta has about 18 families which have acquired land from a land sale and are occupied for the last 10 years. The surrounding areas s canal and the middle of the area is reclaimed and has been used for housing purposes. 10 years after when the land was purchased, Mr. Dahmmka Wijesingha, a resident in Duwawatta told that, the price was only 400,000 a perch and still after 10 years the land price has not appreciated much due to several reasons. There's no access to the man road unless it is through the railway line, the floods and the area is surrounded by the canals which is the property of LLRDC.

The railway village is totally an encroached area for housing which is located on either side of the railway line about 50 m towards north of the Wanawasala railway station. This is also in the close proximity to the Kelaniya dump site. All the houses look as if they are made for temporary purposes. According to the residents there are about 200 families (houses) with a population of about 900 in the railway village who are engaged in mostly labor work in the tea processing actress nearby.

3.3.1.3 Present water supply and water uses should be identified

Pipes water and electricity is available for all the houses and for some HHs, there are shallow wells. In the case of the people living on either side of the rail track (Railway Village) although they have received pipe water and electricity, the land is the property of Railway Department (Railway Reservation). They show interest in shifting any suitable locality provided the government will give them a piece of land elsewhere. As the houses are located on the low lying area, the houses are inundated during slight rains. Even at the time the inspection was made, houses here had been flooded.

The ground water appears to be not so deep when observing the water level of these wells. In all the surrounding area of the proposed project is populated and due to the low lying nature and the canal networks together with the marsh, the people experience numerous issues specially during rains and. These issues have been further exacerbating due to the state of the existing dumping site.

The Villager of Manelgama, S. M. W Perera said that the community in the area sued against the Kelaniya Pradeshiya Sabha once requesting to stop the dumping of waste into the current place,

but with several suggestions to improve the site the judgment was made to the favor of the PS. But none of the suggestion such as the proposal to prevent leachate coming into the water ways was never implemented. Although motorable access to these villages is now possible with concrete laid Class "D" roads, most roads are inundated during rains

3.3.1.4 Schools

There are two Schools where the children in the project area mostly attend for education. They are Nagasena Maha Vidyalaya which provides education upto grade 11 and Wedamulla Maha Vidyalaya (which provides education upto Grade 13). At least 500 students from the area attend the Nagasena Maha Vidyalaya and another 1000 students are attending the other.

3.3.1.5 Health and safety

Due to not having direct access to the man highway road where people attempt to travel along the railway line, a resident said that last year alone there had been 30 deaths due to rail accidents. There are three existing railway lines passing this area and all three lines are busy in the morning and evening during week days, according to the residents in Duwawatta and Railway village. It appears that people have been

3.3.1.6 Cultural, historical, protected resources and archaeological aspects

No cultural, historical, protected resources or archaeologically important structures in the close vicinity.

3.3.1.7 Sensitivity of the public to the proposed project components

The open dumping site appears to be a major concern to the people of the area. They complained during discussions that due to the leachate of the dumping site the wetland swamp is polluted and during storm water inundation, roads are impassable with polluted water. Dengue fever in Dalugangoda and Wanawasala, the prevalence of Filaria are major health concerns due to industries in the area, blocked water ways, waste dumping in the landfill in Manelgama, ad-hoc reclamation of low lying areas and unauthorized buildings. Further the odor spreading from the dumping site is unbearable but people are used to living with the odor.

The community members, during brief discussions with them, showed interest in the project as a way to get rid of the existing dumping site. However, they were of the opinion that further filling of the marshy land can aggravate seasonal flooding and can obstruct the canal network. They also said that the area is having intensive railway traffic during the morning and evening hours and those additional trains to start from Wanawasala station can increase intensity of the rail movement. This is particularly a concern because of the increased use of rail tracks by the people to walk to their homes and to the highway.

3.3.1.8 Consultation with affected people in the areas where the transfer station, landfill and other facilities will be located

Limited number of discussions had with the people around the proposed KTS indicated that people would be glad to see that the Kelaniya Waste Dump will be gradually eliminated from this location. Most of them welcome the idea of the Waste Transfer Station, but they did not show previous knowledge of the proposed activity. However, those in the Railway Village (in the low lying areas on either side of the railway track close to the Dumping area, said that they would be affected if the marsh area will be reclaimed for the project. In that case they need alternative land for leaving the area. The Summary of the community consultation is given in the **Annex 3.9.**

3.3.2 Land Fill Site

Project site

ASL falls within the areas influenced by lime quarrying for the Cement Factory in Puttalam within the administrative boundary of Wanathavilluwa DSD, in the Puttalam District. The site is located about 41 km from the Puttalam Town and will have a distance of nearly 160 km by rail from KTS (Kelaniya Transfer Station).

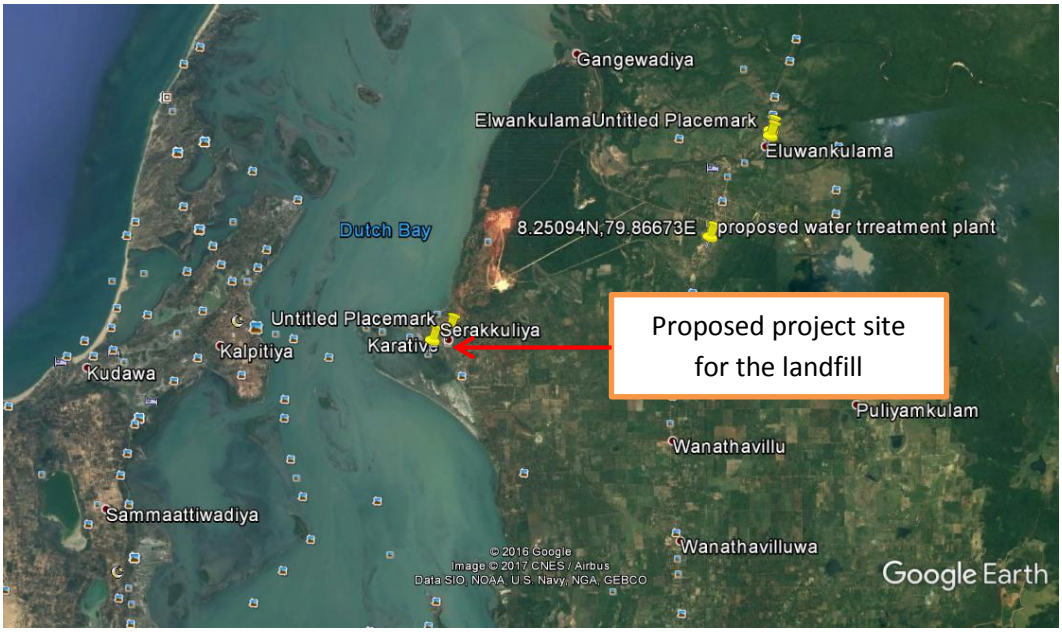


Figure 3.40: Proposed project site

Identify any population centers and settlements in and around the project site.

There are 17 GN Divisions and forty-five villages in Wanathavilluwa DS Division and about 05 GNDs lying very close (within a radius of 2-3 km) to the ATS. They are:

- Karative North;

- Karative South;
- Mangalapura;
- Serakkuliya and
- Ralmaduwa.

Though in a distance, the project's indirect influence area will constitute above GN Divisions. Socio economic baseline information was studied in respect of those GNDs as they are important as neighboring communities. These GNDs fall outside a radius of around two to three Km of the ATS. The striking feature has been that Gangewadiya (in Eluvankulam GN Division), which was previously to be influenced due to the project, is far away from the current location (about 10 km).

Wanathavilluwa DSD is bounded to the north by Wilpattu (a national park) and Thabbowa (a forest reservation), to the east by the Kalpitiya lagoon, to the south by the Puttalam DS Division and to the west by the Kala Oya (a river). The DS Divisions has a land area of 710 sq. km. perhaps the largest of all the DSDs in Puttalam District in terms of the size of the land. Aruwakkalu cement quarry land extending over 5141 acres is also situated in this DS Division. The GN Map of the DSD is given in **Figure 3-41**.

Wanathavilluwa comprises ancient villages (with village names such as Karative, Eluvankulam and Nagamaduwa dating back thousands of years) as well as new settlements or colonies (such as Bandaranayakapura, Samagipura, Wijayapura). The Divisional Secretariat, Pradeshiya Sabha (the local political administration unit), the agricultural office, the main bus stand and a hospital are located in Bandaranayakapura. A new water supply project is under construction.

Population characteristics, their income sources and livelihood dependency of such communities should be determined.

The total population of Wanathavilluwa is around 19,537 and the number of houses in the DSD is around 5482. The population when disaggregated by gender is 9728 males. The number is slightly higher among the female population (9809).[1] The present day ethnic composition of Wanathavilluwa DSD is Sinhalese- 61.14%, Muslim- 31.31% , Tamil- 7.54% and Malay- 0.01%

In terms of average family size and in terms of population density, the DSD (Wanathavilluwa) is the lowest compared to the rest of the DSDs in Puttalam District with average family size in the DSD remains at 4 people in a family and the population density is remains at 24.6. For example, the population density in Kalpitiya DSD stands at 524 and the average family size is 6.8. The DSD has the largest extent of land (715 sq. km) as compared with any other DSDs in the District.

Income and poverty

People have a range of income sources from coconut and paddy cultivation to fisheries and aquaculture. Cultivation practices are determined by the weather conditions, the availability of rain water and the lasting droughts which are commonly experienced in the District. According to data

[1] DSD Information

from the Divisional Secretary however, only 34.7% of the population in Wanathavilluwa are farmers or fishermen while 39.9% are day-wage laborers, mainly on coconut and cashew estates. Chena cultivation is a predominant livelihood strategy adopted by the farmers. The DSD Wanathavilluwa is one of the most backward in terms of growth and poverty prevails significantly among the population living in those rural villages in the neighboring GNDs.

Below is the GND map of Wanathavilluwa DSD.

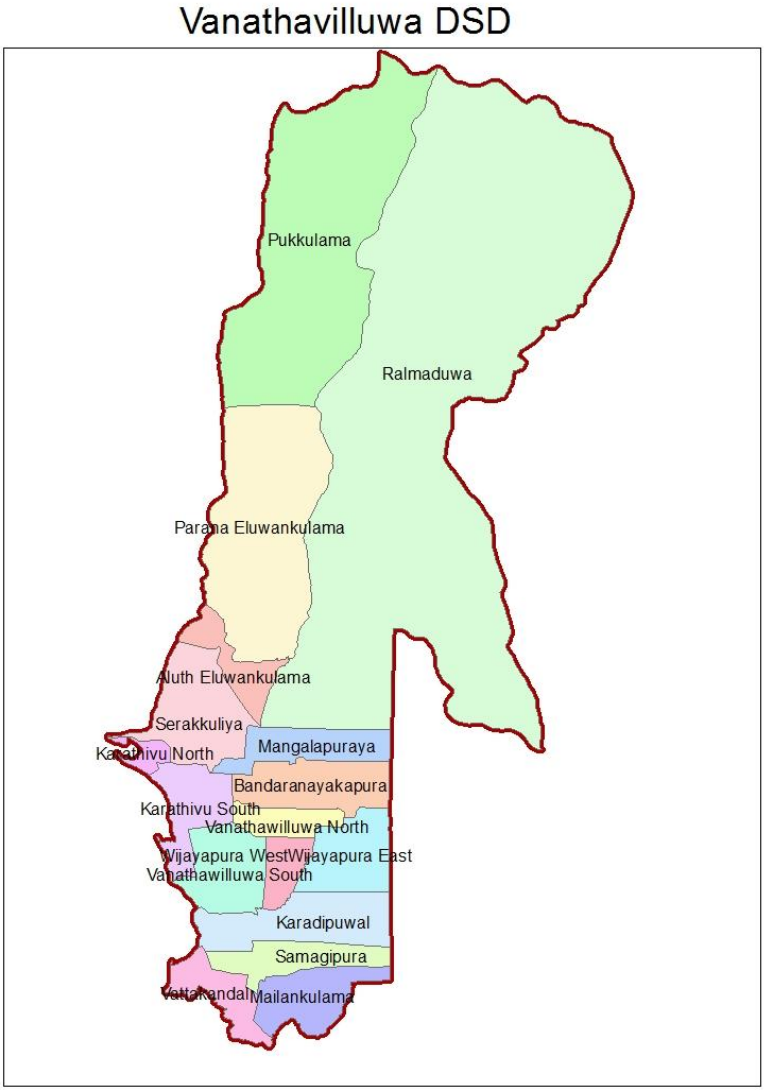


Figure 3.41: The Grama Niladari Division Map of Wanathavilluwa DSD

The only industrial site in Wanathavilluwa is in Aruwakkalu, which has the country's largest limestone quarry, supplying limestone for the cement factory in Puttalam and employing a considerable number of people as laborers. (300-400) Limestone from quarry located in Aruwakkalu is transported to Puttlam Cement Factory – located about 41 km away - by rail for cement operations. No people living near the Aruwakkalu limestone quarries.

The official Government website describes Wanathavilluwa as "the most vulnerable and backward one among the 16 Divisional Secretary Divisions of the Puttalam District in the Northwestern Province". It continues to state that, "Almost 80% of the people here suffer from lack of steady income sources and solely depend on cultivation and menial jobs…. most of the people of the area receive the dole through the Poverty Eradication Scheme of the Government called Samurdhi Sahanadhara".

Serakkuliya GN Division:

Western boundary of the quarry land is bounded to Serakkuliya Fishing area, where the vegetation is characterized with palm trees and coconut trees. Serakkuliya GND has a population of 1,723, in 389 households. (Female population is around 843 and male 880). The population is mostly Sinhala speaking Christians engaged in fishing. Almost all are directly or indirectly dependent upon fishing activities (lagoon and off shore). Fishing communities are poor as they receive low prices for their fish produce. The income of about 186 households is less than Rs. 2,000 per month. High valued species such as large-sized crabs are found in the area. However, villagers are exploited by fish vendors as they lack bargaining power without access to marketing facilities and formal credit.

Karthivu North:

The GND has 706 families and 2793 population. 99% is Muslim. Population is divided between male and female respectively as 1325 and 1468 leaving the female population a slightly exceeding that of male population. The water sources close to the reservation areas is used for drinking water purposes. The area is having dug wells, unprotected wells and springs.

Mangalapura GND

There is a population of 1213 in 361 houses. Majority (99%) being Sinhala speaking and the population is divided between male and female as 630 and 583 respectively. Community water supply schemes provide water to 95% of the population. 96 families receive Samurdhi benefits. There is no treatment of water before being provided to them

Ralmaduwa GND

The GND has 267 families and a population of 953. Population is divided between male and female respectively as 449 and 504 leaving the female population a slightly higher that the male population.

Quarrying Operations:

Although there are around 300 people working in the limestone quarry, the majority of people who are employed by the quarry have been outsourced and not from within the immediate surroundings. Majority of the government officers working in different government institutions in Wanathavilluwa are also from other parts of the country. The discussions with key informants in the GNDs of the neighboring villages revealed that there is no substantial contribution to the local economy by way of the quarry operations contribution to employment creation.

The quarrying operations by Holcim (now Siam Cement Company) are being undertaken by a work force of about 350 staff engaged by the Company. While majority of them are being provided transport provided by the Company, 75 to 100 workers use their own motor bikes. The roads are gravel roads and that dust during dry and windy spells of the year are considered issues confronted by the motorists.

Present water supply and water users

Water is a scarce resource in the DS Division for a number of reasons. Availability of drinking water of acceptable quality and quantity is one of the serious limitations encountered in the project area. It is reported that local water contains limestone substances and is therefore not suitable for drinking. A new water supply project is under construction which will be extending up to Chilaw and Kalipinya. The source for the water supply scheme is Kala Oya.

There is one hospital and one dispensary (the hospital in Wanathavilluwa and dispensary in Karative) although they are understaffed. In addition, the other utility services are provided through the police station, the Divisional Secretariat, the post office, Agrarian Services, Wild Life and Forest officers, the Samurdhi Bank Association, the Irrigation office, the Agricultural Services office and the Pradeshiya Sabha. There are 12 schools in the DSD of which 02 are up to A/L education and 09 are only up to grade 11. While transport infrastructure and transport services in the Wanathavilluwa DS Division is poor as compared to the other DSDs in Puttalam District, particularly water sources (pipe borne water) is not accessible to a large number of houses.

Water Supply scheme under ADB

The ADB funded dry zone urban water supply and sanitation project which is under construction envisages providing treated drinking water to urban and peri urban areas covered by Puttalam and Chilaw. The raw water intake for the project is located in Eluwankulama, Achchimolia tanks. Component (1) of the project covers the rehabilitation, expansion, and development of water and sanitation infrastructure for major towns in the northwestern dry zone (Chilaw, Mannar, Puttalam, and Vavuniya), including urban and peri-urban water supply, and septage management and sanitation. However, the people in Serakkuliya and Karative (north) are skeptical that they would get the connection from this project as they are located interior.

Figure 3.42: Location at the Achichimoli tank

3.3.2.1 Other projects in the area:

The project entitled "Enhancing Bio Diversity Conservation and Sustenance of Eco system Services in Environmentally Sensitive Areas" is an ongoing project implemented by the Bio Diversity Secretariat of the Ministry in charge of Environment[2] in collaboration with the United Nations Development Programme (UNDP). This is a five-year pilot project, jointly funded by the Global Environmental Facility (GEF). The overall objective of the project is to improve the country capacity to manage environmentally sensitive areas in the Kala Oya basin and to replicate the approach for other river basins later. The project activities are extended into several DS Divisions of Kala Oya River Basin in Puttalam and Anuradhapura Districts to cover Kalawao region in the North Central Province covering Kekirawa, Ipalogama, Palagala, Galnewa Divisional Secretariat (DSs) and Wilpattu region in the North Western Province within **Wanathavilluwa** and Karuwalagaswewa Divisional Secretariat Divisions. (DSDs). A Communication Strategy & Action Plan was prepared by the which is now under implementation

3.3.2.2 Cultural, historical, protected resources and archaeological aspects

There are no significant cultural or historically protected resources in the project vicinity.

3.3.2.3 Sensitivity of the public to the proposed project components

Several discussions with the GNs and the DSD indicated that the people in the area were previously against the project on the grounds that the project would degrade the water resources in Kala Oya Region. They also had pointed out the impacts on the wetlands had the project been sited in the previously planned location. However, the officials as well as the community members did not

[2] The Ministry of Mahaweli Development & Environment

have sufficient knowledge on the revisions made tin respect of the siting of the project at the new location. Below is the summery of discussions that the consultants had with key officials.

3.3.2.4 Consultation with affected people in the areas where the transfer station, landfill and other facilities will be located

The details of the consultation is given in the **Annex 3.10.**

CHAPTER IV

4 ASSESSMENT OF ANTICIPATED ENVIRONMENTAL IMPACTS

4.1 Prioritization of Impacts

The impact identification method is given in the **Annex4.1**

4.2 Constructional Impacts

4.2.1 Transfer Station Site Kelaniya (KTS).

4.2.1.1 Impacts on Physical Environment

The PTS will be constructed on stilts reaching down to the bed rock. The normal construction related impacts such as noise, vibration and dust related Environmental problems and safety risks for workers will be experienced and necessary precautions to reduce the impact should be adopted. The proposed site is located in a residential area. There are several houses located near the proposed site. The location of the structures in respective to the project activity and the project influence area are given in the **Figure 4.1.**

Figure 4.1: Location of the structures in respective to the project activity and the 100m project influence area

Noise

Noise will be generated from the following constructional activities.

Operation of machineries and equipment

Geological Investigation and pilling activities

Operation of Machineries and equipment

As per the Sri Lankan standards for noise, maximum possible noise level at boundaries of the land in which the source of noise is located in L_{aeq}, T for construction activities for day time is 75 dB (A) and night time is 50 dB (A).Excessive noise exceeding these limits will have an impact on the public living very close to the project site. (This is addressed under social impacts as well)

Heavy vehicles and machineries that could be utilized in the construction phase will have potential of creating excessive and irritative noise levels exceeding permissible level. Mainly the pilling, construction of foundation structures, installation of rail head facilities and rail tracks, constructions and machinery installations in KTS are such possible sources of exceeding noise limits.

Improper handling and cutting of steel in construction of rail heads and rail facilities and other building structures would also create irritating noise. Increased noise levels would disturb the people in close by surrounding and areas sensitive to extreme noise.

Activities such as site clearing, land preparation, construction of offices, contractor huts and other temporary buildings together with infrastructure facilities, assembly of super structure and construction of other ancillary structures will have significant impacts related to noise pollution and vibration induced noise.

Most of the equipment and machinery used in clearing the site, excavation, paving, and concreting and other construction works are also known to generate moderate noise levels**. Table 4-1** presents typical noise levels of some of the machinery used in construction works.

Table 4.1: Relative range of noise levels for some common types of heavy construction machinery

Machinery	Noise levels at distance of 16 m
Compactors (rollers)	71-75
Front loaders	70-83
Backhoes/excavators	70-85
Tractors	78-95
Trucks	83-93
Concrete mixers	75-88
Jack hammers and drills	82-98
Crow bar	115
Compressor	109
Pile drivers (drop hammer type)	110

Machinery	Noise levels at distance of 16 m
Pneumatic drill	85
Excavator	112
Loader	112

Significant impacts could be expected to the community in the PWTS as the proposed site is located in a very close to the densely populated areas.

Geotechnical investigation and pilling activities

During the construction period, there could be several high noise level generating operations that will take place. Noise levels may far exceed 75 dB(A) due to various construction activities including geotechnical investigations and the construction of foundation works and other construction activities. The piling activities are the major noise generating activities. The piling activity will result in the temporary (anticipated as half a day to one day) increase in the noise level in the vicinity of each boring. The range of expected noise levels during different methods of drilling operations and piling operations are provided in **Tables 4-2 and 4-3.**

Table 4.2: Typical drilling rig noise levels (dB (A)) by Drilling Method

Distance from rig (m)	HSA Auger	Mud rotary/Core (includes Platform Rig)	ODEX with Air Compressor	Sonic
3	87-96	80-97	89-99	84-96
8	81-88	75-91	76-90	81-88
16	<75	<75	<75	<75

Table 4.3: Noise levels of piling machinery (from BS5228: Part 2: 2009)

Piling machinery	Noise source level dB (A)	
	Source	At 10 m away
Double acting diesel hammer (37 kJ)	135	120
Double acting air hammer (5.6 kJ)	134	120
Enclosed drop hammer (3 t)	98	70
Hydraulic drop hammer (60 kJ)	121	95

Note: Noise source level, S_{ource} (dB (A)) and at 10 m away from the machinery

As in **Table 4.2 and 4.3** geotechnical investigations and pilling activities would lead to minor impacts as the noise level abates at a distance of 16 m to levels less than 75 dB(A), which is the permissible noise levels during daytime as per Schedule III of the National Environmental (Noise Control)Regulations No.1 1996. However, drilling related to piling creates considerable levels of noise and vibration.

The impact of noise for the population living around the area could include constant disturbance to the ambient noise level that can result on higher stress and health deterioration to some of the community members such as children, students, patients and older people who need peaceful,

noiseless environment. Such impacts could be minimized by adopting Mitigation as given in **Chapter V.**

Impacts due to Vibration

Vibration induces from drilling and piling activities, moving heavy vehicles, operation of machineries and construction activities have potential to create negative impact on the surrounding environment. Ground induced vibration and shocks could damage nearby building structures and other unstable and sensitive constructions depending on the distance and ground condition of the area. Moving of heavy vehicles could also induce intermittent vibrations as well. Since the surrounding area is highly populated, mitigation measures for the vibration control should be appropriately applied.

Dust

The activities that are very likely to generate dust during the construction phase include geotechnical investigations, site clearing / cleaning and land preparation, construction activities of infrastructure facilities (offices, contractor's huts and other temporary buildings together sanitation etc), and transportation (materials, machinery and equipment). The cumulative impact due to dust if uncontrolled can directly impact the nearby, household living and goods, patients with respiratory disorders and other weak and vulnerable community members.

Air pollution created by hardware material such as cement, sand, rubble could also can occur during construction phase and these could be minimized by adapting mitigation measures. However these impacts are stationary and exist only for shorter period of time.

Gaseous Pollutant from construction vehicles:

Emissions of gaseous pollutants from the exhaust of the vehicles and operation of the machineries are the potential sources of gaseous emissions in the form of SO_2, NOx, CO, HC and O_3 further to these major pollutants, emissions in terms of diesel smoke from heavy vehicles and the machineries may contribute to the air pollution during the construction phase.

However, the contribution from mechanical equipment and vehicular emission are insignificant since the activities are restricted to a shorter period and adequate dispersion is generally available for such emissions.

Air pollution created by hardware material such as cement, sand, rubble could also can occur during construction phase and these could be minimized by adapting mitigation measures. However these impacts are stationary and exist only for shorter period of time.

Impacts on Natural Drainage Pattern and Hydrology of the Area.

Since the proposed Kelaniya Transfer Station is to be constructed on a marshy land, negative impact on existing drainage pattern and hydrology of the area are not that significant. The loss of retention/detention and flood storage capacity in the downstream part of the basin can lead to minor increase in flood levels. There can be a potential of increasing quick runoff due to paved yards, roads and roofing covers and paving extensions in the operational area and also there is a possibility to increase the water levels of peripheral canal as a result of storm event in various return periods due to peak runoff from catchment area of the project site. This is minor in nature and difficult to be quantified.

Construction of railway connection between KTS and the existing Kandy- Colombo railway line is on pillars (columns) to maintain an adequate space between railway track and the existing ground level without disturbing the natural water flow particularly during the rainy season. Therefore, flooding situation will be arise and the impacts are minimal due to construction of railway connection.

Siltation of Water Bodies

There is a possibility of siltation of the peripheral canals and associated marsh due to land clearing, dredging, and other construction activities. As there is a slight slope towards the canal there is a possibility of washing out of stored waste material/debris in to the peripheral canal resulting siltation.

Impact on canals and flood retention

To facilitate construction it will be necessary to fill the marsh to the construction equipment to reach work location. This will disrupt flow, increase turbidity in waterways, can result in siltation and reduce flood retention capacity.

Impact of transport of construction machinery and supply trucks

Transport of Construction Equipment along Manelgama Road - this can result dust, traffic problems in this narrow road and will be an inconvenience to residents and road users.

4.2.1.2 Ecological Impacts

There are no significant ecological impacts during the construction period of the KTS. The vegetation that will be cleared is only those species which have no significance in terms of their Environmental status. Some of the trees are invasive species.

However the project will result clearing and converting a section of the limited marsh areas in the DSD thereby helping to reduce the footprint of a wetland eco-system. These ecosystems very often serve as a flood retention area and a habitat for the faunal species whose nesting is made on such habitat. However, it is the behavior of the species to find another suitable habitat when the existing habitat is disturbed.

The aquatic species in this canal system or in the marsh area will not be affected and therefore there is no significant impact

4.2.1.3 Social Impacts:

There will be several important positive social impacts which need to be enhanced. They are as follows:

Improvement of the aesthetic beauty and flood relief:

The construction of the platform for collection of waste and the transfer location in the marsh can enhance the aesthetic beauty when the existing Kelaniya Dump Site will be removed. This is a long felt need of the people living in the GNDs in the close vicinity. There will be some amount of dredging of the marsh in order to create a flow velocity for the treated effluents that will be discharged into the canal network. This will allow smooth relief of storm water and the foods that will happen in slightest rain will not occur.

It is also expected that the seasonal flooding of the access road along Wanawasala road can be arrested due to the dredging of the marsh and cleaning of the canal.

It is envisaged that for the quick and efficient transport of the waste trucks, tractors and Lorries which are reaching the transfer station there will be a programme to widen the existing community roads. This will help increasing the value of the market price of the lands in this area.

Employment opportunities

Along the railway village, there is community already engaged in hiring labor. The construction activities as well as operational activities will allow some of them to have employment opportunities, enabling them to increase their HH income.

Health & Safety

With the elimination of the open dump site, the people in the area will not have the issue of odor and the incidences of vector borne diseases which are a major concern to the people in the area.

With the improvements to the rail track, it is also envisaged that more safety will be assured for those using the rail track for crossing to highway and other close destinations. This may help saving the lives otherwise lost due to rail accidents.

The negative Impacts are explained as follows:

Impacts of air quality on the community:

The noise that will create during the construction of the platform for the waste transfer and the railway section will be heard by the adjacent neighbors living close to the construction site. This will be a nuisance if they continue to hear the noise day & night. The impact of noise to the community members has been discussed even under section dealing with the Physical Environment.

Constant plying of the construction vehicles which will carry aggregates and construction equipment may affect the people using the roads in the construction area. The aggregate and other material loads if stockpiled along the small narrow roads, it will create further traffic congestion. The other impact will be the dust which will toss up from the aggregate stockpiles during the dry and windy periods.

Obstructions to drainage paths:

The construction area is congested on one side with the rail track and other with the marsh. Surrounded by the construction site are villages around which there is marsh land. The accessibility to them is only through very narrow lanes. The area is flooded even in a slightest rain and the roads will become impassable

The excavation work as well as the clearing activities can cause obstruction to the existing drainage paths if they are stockpiled along the bunds of marsh area and along the narrow roads. The equipment that will be used in the marsh area for the clearing of the marsh, drilling piling etc. can temporarily obstruct the flow paths and can lead to small flood situations if the rain continues.

Any stockpiling of the Water Hyacinth (Diya beraliya) and debris of other tree species such as Wel-Attha after their felling may be stockpiled along the narrow lanes which can further restrict the space for motorists to drive this area.

Safety Issues

Due to the disturbances to the marsh area, the invertebrates such as serpents, snakes can creep into the land areas and enter into home gardens around the site in the close vicinity increasing the incidences of snake bites.

Possible physical displacement of the people in the project area:

Total land area in the KTS is about 25 Acres. Although there is no detailed survey still carried out as to identify the land area required for the project, it is assumed that the proposed rail track will be constructed to the left of the Wanawasala exiting railway line to the interior along the marsh land until it meets the present dump site. On the left side of this trace, there are houses and private property. In case the rail track and the feeding roads need to be further improved / established, sometimes the private property of these people will be affected.

4.2.2 Landfill (ASL)

4.2.2.1 Impacts on Physical Environment

Impacts can occur during construction of the Sanitary Landfill site, unloading Transfer Station (Railhead facility) and the railway tracks up to unloading area.

Only existing source of air pollution in the area, is lime mining activities carry out by Siam City. During the construction phase aforesaid sources of air pollutants may cause negative impacts to the surrounding environment other than pollution caused by existing lime mining activities.

Dust

Emission of dust at the project site due to construction activities and emission of gaseous pollutants from the exhaust of vehicles engaged in construction activities are the two major potential sources that can cause adverse impacts on air quality.

Construction activities such as geotechnical investigations, land preparation, structural constructions, construction vehicle movements etc. have potential to generate airborne dust particles in term of Suspended Particulate Matter (SPM), Particulate matter with aerodynamic diameter less than 10 micron (PM_{10}) and less than 2.5 micron ($PM_{2.5}$).

These form of dust causes nuisance in and around the project site especially during dry weather conditions particularly due to the depositions in nearby Siam City administration office, surface water and vegetation etc. However the deposition of airborne dust as a consequence of construction activities from the site on the residential areas would be likely. However, this impact depends on

the prevailing wind condition in the area. Further, the existing road used by the Siam City has to be used by the project until a new road is constructed as there is no separate access to the site. The movement of the construction vehicle could generate excessive fugitive dust. In the same time, the vehicle operated by the Siam City also generates considerable amount of fugitive dust particularly during windy period. The cumulative impacts could be significant to the operation of the Siam City administrative office. Therefore, proper mitigation measures should be followed.

Gaseous pollutants emission from the exhaust of vehicles

Contribution from mechanical equipment and vehicular emission are insignificant since the activities are restricted to a shorter period and adequate dispersion is generally available for such emissions.

Impacts due to Noise

Except for the noises and vibration generate in mining activities and moving vehicles engaged in the lime mining, entire area is very calm and currently no any significant noise generating source available at the surrounding environment of the project site.

Impacts due to Vibration

Vibration induces from drilling activities, moving heavy vehicles, operation of machineries and construction activities have potential to create negative impact on the sensitive surrounding environment. As many of the faunal species in the surrounding habitats may highly sensitive to the vibrations induce during the construction activities.

The interim Standard on vibration pollution control for Sri Lanka provides guidelines for operation of machinery, construction activities, vehicular movements, acceptable human exposure to vibrations depending on the length of vibration period defined as continuous, intermittent and impulsive.

Impacts on Natural Drainage Pattern and Hydrology of the Area.

Since the proposed ASL is to be constructed on an already partly disturbed lime quarry site, negative impact on existing drainage pattern and hydrology of the area are not that significant. Due to the low-lying parts of the existing terrain, and concave/basin shape of the existing terrain, it is anticipated that water stagnates during storm events.

However there can be a potential of increasing quick runoff due to paved yards, roads and roofing covers and paving extensions in the operational area and also there is a possibility to increase the water levels of peripheral canal as a result of storm event in various return periods due to peak runoff from catchment area of the project site. This is minor in nature and difficult to be quantified.

Impact on Surface and Groundwater Quality

Peripheral canal of the proposed site and part of the associated marsh are highly polluted and the inflow of pollutants and the leachate of the existing open dump site is significantly high. During the construction phase, especially due to dredging and reclamation related activities, turbidity of the canal caused by soil particles and fines could be increased. This might be significant during rainy seasons, due to washout of fines.

Impacts on borrow areas and transport routes

The soil balance for the project indicates that Phase one is – 130,000m3 and Phase II will be – 160,000 m3. The additional soil requirment will be fullill utilizing the soil available in the Siam City lime quarry. No significant impacts could be anticipated as the soil is extracted from the same site and also from the Siam City lime quarry located nearby. The other impacts noise and dust are discussed in the relevant section.

4.2.2.2 Ecological Impacts

Impacts on the Forest Cover

The forest cover in an area of about 40 hectares is expected to be covered or destroyed with the landfill over a certain period of time. Additional areas will also be destroyed due to approach roads and other infrastructure developments associated with the landfill.

According to the calculations based on transect studies where individual trees and shrubs over 10 cm DBH were recorded, approximately 5040 and 10,800 trees / shrubs at Site A (naturally restored) and Site C (rehabilitated) respectively and thus a total of 15,840 individuals are expected to be destroyed. This will be in addition to numerous small shrubs and herbs that were not inventoried. Effects will be direct, long-term and negative.

Impacts on plant biodiversity

There were 44 species recorded in the combined area of the Site A and Site B and they are expected to be lost. Among them, following species are of importance in terms of plant biodiversity:

***Rhynchosia velutina* (‘Bu-kollu’):** A single very small population of this plant, a **critically endangered** species in Sri Lanka, was found in the naturally recovering Sparse and Open Forest (SPOF) in abandoned quarry area.

***Dendrophthoe ligulata* (‘Diva-pilila’)**: This species, considered **vulnerable**, is occasionally seen growing on shrubs as an aerial hemi-parasite in the project area.

Indigofera oblongifolia (‘**Kuttukarasmatti**’ (T): This species is also considered **Vulnerable** and found frequently in the project area (Section 3.2.2).

Impacts on Fauna

Existing wildlife population on the project development areas will be extremely impacted. Although adequately mobile species / individuals can escape and move into adjacent safe areas, less mobile species will be vulnerable.

Land snails, scorpions, amphibians and some reptiles, e.g. Star tortoise, Black turtle, Flapshell turtle and perhaps geckos, skinks and less mobile snake species are some of these vulnerable groups. Fish, if they exist in pools, will also perish.

In the quarry sites there are some large and small pools and water holes that are visited by animals including elephants. Their loss will affect the animal population and the moving patterns of the animals. The result of all these events may have a negative impacts in faunal populations at the site,

Impacts on aquatic habitats

Mining at the two sites has created some pools that collect rain water and plenty of clay sediments. They are of various sizes and therefore hold various amounts of water that diminishes with the onset of the dry periods; however the deepest pools holding some water at the heights of drought. These pools are of great service to the wildlife including elephants and therefore the faunal densities are clearly influenced by them. When these pools disappear with the expected landfills, faunal species and their densities will be expected to be change and this will be a negative effect in terms of faunal biodiversity.

4.2.2.3 Social Impacts:

No land acquisition will be necessary and no economic displacement will be envisaged.

The community members in the surrounding GNDS have previously opposed the project thinking that the wastes are brought from Colombo to Puttalam. There is a complaint from the DSD and other GNS that they are not aware of the project, its nature and the time schedules.

However it appeared from the recent discussions with the GNDs that there is no strong opposition now and that the people in Serakkuliya and Karative need to know the project details. In fact they live far from the project site and it is not expected that any impacts of air quality change can have influence on them.

However they have skepticism about the success of these projects. In case of the component for Puttalam, this can be attached to the already initiated social marketing programme by UNDP and the CEA under Kala Oya sensitive area declaration project.

Although there will be no direct impact on the communities due to construction noise, there will be increased traffic in the area due to transport of construction materials. The safety of the children who are attending schools need to be ensured from the speeding drivers

The water is a scarce resource in this area. If the limited water available is used for the construction activities there can be paucity of water for the community especially during the long dry spells.

Since there is already a complain that the community members are not provided with any benefits from the projects implemented in this area (by way of getting employment opportunities) there can be further community frustration, which may culminate in agitations.

Operation of Lime quarry by the Siam City

In view of the closeness of the dumping sites to the quarry operations, several concerns have been raised by Siam City Cement, Lanka (SCCSL). Among the issues are:

- Possible contamination of limestone deposits, if the engineered landfill is not properly done, which will have a significant impact on the quality of Cement.
- The blasting operations carried out by SCCSL blasting operations , induced vibration which will potentially impact the geo membrane of the landfill, that may result in leakages, that may again contaminating the lime deposits;
- Dumping areas proposed are considered to be once rehabilitated with forest plantations;
- Fourthly, the dumping site is so close to the operational and workers' daily work as such there could be health risks; further with the influx of the trucks and train operations, it will impact of the efficiency and productivity of the mining operations.

However, these issues have been addressed both in the Design of the Landfill and in the mitigation actions in the respective chapters.

4.3 Operational Impacts

4.3.1 Transfer Station (KTS)

4.3.2 Impacts on Physical Environment

Impacts on Air Quality

Possible atmospheric emission sources identified during the operational phase of the Transfer Station include, air emissions from the rail transport system, air emissions and fugitive dust generation from transportation of solid waste and air emissions by fresh solid waste during handling and compacting to the rail carts.

It is expected that considerable number of solid waste trucks such as compactor trucks, tractors, trucks are coming to the Transfer Station during the operational period. Fugitive dust and air emissions in the form of CO_2, SO_2, NOx, CO and unpleasant diesel smoke are the anticipated air pollutants emit by waste tracks. These air emissions would contribute to increase air pollution levels in the area during the operational phase of the project. However, fugitive dust and exhaust gas emission from the solid waste transporting vehicles do not lead to substantial air pollution in the project area. Proper mitigatory measures need not arise.

During operational phase in the tipping area, unloading of fresh garbage, moving activities, compressing operations of garbage in to the rail carts could generate unpleasant odorous gaseous emissions leading to air pollution. Mainly methane (CH_4), Volatile Organic Compounds (VOC),

Hydrogen Sulphide (H_2S), Bio aerosols and odor compounds such as alkylbenzenes, limonene and certain esters etc, are the possible pollutants.

As the unloading and loading operations are to be carried out as indoor operations air emissions could be mitigated by installation of proper air collection and purification system, the impact would be insignificant. However, collection and purification system should properly design to control odor emission and pathogens in the KTS.

Noise

Major noise pollution that is likely to occur during operational phase is due to transportation of solid waste. Mainly the sounds generate in operating locomotives, trucks carrying solid waste to the Transfer Station will make the significant contribution in noise pollution.

Further to this, some localized sound sources like unloading garbage, compressing machineries, folk lift movements may also generate noises. However these operations are carried out as an indoor operation and with the effective reduction of the boundary wall noise impact would not significant to the surrounding environment.

Vibration

The operation of heavy machinery and equipment generate fairly high vibration in the vicinity of the operation. Heavy machinery like cranes, trains and movement of heavy vehicle are some of the activities which generate excessive vibration in the area. The vibration may damage the nearby property mainly causing fissures / cracks in the buildings and in the long run damage may occurs to such buildings.

Unloaded waste on the platform is expected to be pushed by especially equipped shovel vehicles and these will be operating on the concrete platform. As this operation will take place on a floor above the ground level the noise and vibration generated will affect a greater distance of the neighborhood and it may be necessary to curtail vibration pollution using suitable techniques.

Additional vibration level is possible when operating locomotives and compressing machineries.

Impact on Ground Water Quality:

The leachate emanating to surrounding environment either from the solid waste dumps to be transferred or possible leaking through the proposed liner system could have adverse consequences to groundwater and receiving surface water.

The treated effluent to be discharged to the environment could have an impact on quality of receiving waters, especially during dry seasons when the water in the canal and marsh system is almost stagnant or flowing only at minimal velocities due to flat terrain.

There is a possibility of contaminating peripheral canal as a result of washing activities of vehicles and operation floors.

Waste Water

Type of waste water is:

- Waste compression leachate
- Tyre washing wastewater(contained oil)
- Tipping Pad wash water
- Sewage

According to the Feasibility Study, that about 120 m3 of wastewater will be generated during the operation of the KTS. These wastewater will be treated using Chemical and Biological treatment System to achieve the permissible level to the National water quality standards stipulated under the National Environmental Act (Gazette Extra Ordinary 1534/18 dated 1st February 2008) prior to discharge to the environment. The wastewater will be treated to the Tolerance Limits for the Discharge of Industrial Waste in to Inland Surface Water as prescribed in the above Gazette notification. The treated waste water will be discharged in to the canal located nearby. As the canal water is already polluted, the impacts will not be anticipated.

Traffic congestion

Around 400 RCVs are expected daily. Although they will enter through new access road and exit via Manelgama Road significant traffic problem is expected at the turnoff point to the entry and exit roads and also when merging with the traffic along Kandy-Colombo highway.

Odor due to entering and leaving vehicles

Since large number of solid waste RCVs travel along the entry and exit roads constant odor problem is expected along these roads.

4.3.2.1.1 Ecological Impacts

No significant ecological impacts envisaged during the operational phase of the project.

However, the eco system services provided by the wetlands, it is necessary not to expand the construction foot print of the project further. Impact in the form of further degradation to the existing bio diversity in the area could be possible due to increased land prices and the possibility of land grabbing for related development purposes.

4.3.2.1.2 Social Impacts

Impact of odor and noise, traffic when wastes are transported to the Transfer Station:

The number of vehicles laden with waste entering the area throughout the day will be very large. They are expected to come from all the LAs in the MCR. One cannot expect that the truck will be fully covered. The odor will be an issue the public will have to bear when there is a large number of waste trucks converge and line up until they are unloaded. Although other operations such as loading and compressing are done closed doors, the odor will prevail due to transportation of waste in open trucks.

Accompanied with order, the possibility increasing the population of flies and birds such as crows will be imminent as they are attracted to wastes. Perhaps if not regulated properly, the new issues will be worse than that of the issues arising from the existence of an open waste dump site.

Flooding and possible inundation due to construction on the marsh lands:

There are already complaints by the community that this area is low lying and that there houses are inundated with water in smallest rains. This may be aggravated during the construction of the railway track and the KTS, as the usable land for flood retention will be further reduced. The immediate affected people will be those who are living in the railway village.

Noise, Dust and Gaseous

The impact of noise, dust and gaseous will not be a significant issue as the operations are mostly done in the closed buildings. But the noise from the rattling sounds of changing track of the railway, the noise from the vehicles entering in and out of the site will be significant, which need to be mitigated through appropriate means.

Health and Safety of the workers engaged in the operations:

The workers will be exposed to the odor, the pathogens and other bacterial infections if they are not properly rotated, if no personal protective equipment is provided and if they are not checked regularly for health and hygiene. Since most of the work will be automated, the impact can be made less significant, but due to system shut down and the manual work will be needed, the impact will be very heavy.

4.3.3 Landfill– ATS

4.3.3.1 Physical Impacts

The potential impacts on air quality associated with landfill are the generation and release of landfill gas from the fill site and odors reaching to nearby communities, waste water, and smoke and dust from fires and the activities of on-site machinery at the landfill site. There is the potential for odors from waste material in the landfill to reach future adjacent facilities in the surrounding of the landfill site when days are calm.

Dust

The operation of the landfill facility may create considerable dust resulting from vehicle movements, usage of covering materials including excavation, transportation and handling; this activity is a continuous operation. Further, the landfill area also falls under the dry climatic zone of Sri Lanka with long spell of dry season and strong wind. These will aggravate the dust emission

in the surrounding area. The excessive dust in the air could deposit on the adjacent forest area make less aesthetic of the natural forests.In the mean time, there are houses located around 300-400 m away from the landfill site and dust could be reached these areas during the heavy windy season when height of the landfill is increased. Therefore, proper mitigation measures should adopted to reduce such impacts.

Litter

There is a possibility of spreading of light weight litters to the surrounding area, particularly the polythene (lunch sheet) could fly even more than one km depending on the prevailing wind conditions. The plying objects could deposit on the Siam City operational quarry site and the surrounding forest area. This could be minimized by proper mitigatory measures.

Landfill Gas.

It has been explained in Section (2) that due to the continuous flaring, the light during night may attract insects from the surrounding area, causing nuisance to the surrounding area and the people who are involved in the landfill operation.

It further describes that Methane, Hydrogen sulphide, Carbon Monoxide and other gases are produced at landfills and these gases could cause fires if not safely handle.

Landfill gas, mainly Carbon Dioxide and Methane and it also contains varying amounts of nitrogen and oxygen gas, water vapor, hydrogen sulphide, and other contaminants. Most of these contaminants are known as "non-methane organic compounds" or NMOCs. Some inorganic contaminants, such as mercury, are also present in the gas of some landfills. The non-methane organic compounds usually make up less than one percent of landfill gas. These non-methane organic compounds, including toxic chemicals like benzene, toluene, chloroform vinyl chloride, and carbon tetrachloride and at least forty one of the non-methane organic compounds are halogenated compounds (chemicals containing halogens, such as chlorine, fluorine, or bromine). Also smoke from fires and dust from the activities of machinery at the landfill are other possible irritants to nearby communities.

It is possible for explosion and fire due to LFG release. In particular the safety precausions shall be availbale for dry period.

Impact of odor and air-borne pathogenic micro-organisms

Odors from decaying waste material are produced at sanitary landfills, particularly when waste high in organic material (e.g., animal waste, domestic waste, faecal waste) is disposed. It is noted that there is no existing development located within two to three kilometers downwind of the site from the proposed landfill. However, it is possible and quite feasible to prevent odors from being

a problem to downwind residents and facilities by applying adequate cover material sufficiently, frequently and effectively

Impacts due to Vibration

Vibration impact during operation phase involved heavy vehicular movement with loaded waste and covering soil, due to operating of locomotives and compressing machineries etc. Facility operator shall take necessary precautions to maintain the vibration level according to the National Interim Standards for Sri Lanka. **(Annex 4.2)**

The landfill is expected to operate over 10 years whilst the mining operations in the areas adjacent to the landfill will continue for a much longer period. The results on Measurement of Ground Vibration and Air Blast over Pressure carried out at the existing quarry of Holcim Lanka (Pvt) Ltd in September 2015 is given the following **Table 4.4**. A copy of the report is given in **Annex 4.3.**

Table 4.4: Results on Measurement of Ground Vibration and Air Blast over Pressure

S.No	Distance from the Blasting Point (m)	Peak Velocity Sum (PVS) (mm/sec)	Air Blast Over Pressure
1.	3404	0.0870	104.0
2.	4330	Not detected	Not Detected
3.	2369	0.178	88.0

Further, a test blast measurement was conducted in respective to the proposed site. It was noticed the ground vibration and the air blast over pressures at the proposed during the blasting are below the detective limit of the equipment. A copy of the test report is attached. **Annex 4.4.**

There is no specific standards proposed in the Proposed Air Blast Over Pressure (ABOP) and Ground Vibration (GV) Standards for Sri Lanka by the CEA. Therefore, the Type 3 Category of the structure of building "Single and two storey houses and buildings made of lighter construction, using lightweight materials such as bricks, cement blocks etc, not design to resist earthquakes" could be considered for the comparison. The standards for ground vibration and air blast over pressure for Type 3, category of the structure of building for the multi borehole with delay detonators are 5 mm/sec and 120 dB(L) respectively. Therefore, the ground vibration and air blast over pressure are well below the proposed standards. Therefore, the possibility of rupturing of liners in the landfill is minimum.

The blasting operation is carried out in three levels in the lime quarry by the Cement Company. Level 1, the upper part of the lime rock up to 5 m, Level 2, middle of the lime rock (actual lime) up to 10 m and the Level 3, is the bottom or base rocks up to 5m. And the no. of bore holes also differ time to time based on the rock formation. The GV and ABOP are vary according to the

blasting level and the no. of borehole selected. Therefore, continuous monitory is necessary to ensure that the blasting operations will not affect the liner system of the landfill site.

Impacts due to Noise

Major noise pollution that is likely to occur during operational phase is due to transportation of solid waste. Mainly the sounds generate in operating locomotives, trucks carrying solid waste to the Transfer Station will make the significant contribution in noise pollution. There are two types of vehicles used in landfill operations. One type is vehicles for transporting solid wastes and the other type is vehicles used in landfilling and soil cover works.

Impacts due to the design of the landfill

The possibility to spread light material from the dump site from the strong wind and can causes erosion. They can be deposited far away on homesteads and on the water ways.

Leachate and other Waste Water escaped from the Landfill.

Several options were considered in the Feasibility Report, and proposed to treat up to Tolerance Limits for treated effluent discharge to inland waters. This option will not be a feasible option as the discharge of treated effluents into the Puttalam lagoon will create social objection as large no. of fishers are depending on their livelihood in the Puttalam Lagoon. Therefore, it is proposed to consider a suitable option such as maintaining a wastewater pond after treating the wastewater to the Tolerance limit for the discharge of wastes in to Inland Surface waters as prescribed in the above NEA and retain in a pond (**Annex 5.1**). The leachate generation during the dry season could be recycled in the landfill itself and during rainy season, the treated wastewater may be hold in a pond and kept for the evaporation during the dry period and could be used for the reforestation area.

Air pollutants by vehicular emissions

No significant impact is envisaged as vehicular emissions will be restricted to bear minimum due to mass transportation.

4.3.3.2 Ecological Impacts

Loss of Biodiversity:

The loss of some populations of endemic, rare and threatened plant species will not be expected to be critical as they have been found to occur elsewhere in the peripheral areas. The populations of ***Rhynchosia velutina*** **('Bu-kollu'),** ***Dendrophthoe ligulata*** **('Diva-pilila')** and ***Indigofera oblongifolia*** ('**Kuttukarasmatti**' (T) have been recorded in the Wedipitiya in Aruwakkalu

Encroachment of landfill site by wild animals such as elephants, birds

As the landfill will be a new source of food for some animals, including elephants, it will be a certain possibility that many such animals will visit these sites accompanied by change of their food habits. This could cause undesirable health problems and even death to some animals.

With regard to elephants, such novel feeding sites can attract more and more elephants from the Wilpattu National Park that could cause increased incidences of human- elephant conflict in nearby Serakkuliya area and elsewhere.

Landfill will certainly attract many bird visitors such as crows, cattle egrets and pond heron etc. Crows are generally alien in this area and an explosion of their population can be expected. Further, populations of invasive species such as rodents will due to be increased.

4.3.3.3 Sociological impacts

No significant sociological impacts are envisaged.

However the adjacent forest area of the proposed landfill is being used by the community members in Serakkuliya to graze their cattle and find fuel wood from this locality. With the project coming on board, the accessibility to this forest area will be restricted.

There will be a shortage of grazing land in the close vicinity and the economic loss due to not having adequate grassland for cattle and restriction on fuel wood gathering will be significant impact to poor HHs.

The communities members are already under the impression that the former Siam City Cement Company, though continued for a long time in lime quarrying operations in the nearby area, did not extend corporate social benefits to the community members in the surrounding GNDs. Therefore this skepticism is still in their minds. They seek a few employment opportunities from the project. If so their HH income will be increased.

Increased wildlife threat due to wildlife being attracted to the landfill in search of food is another concern that they raised. This issue has already been surface in the section dealing with ecological impacts.

The community will also be impacted by outbreaks of diseases during the rainy season. Possibilities are that the waters contaminated with landfill can be drained into the wells downstream. Another possibility is that mosquitoes and other agents can carry viruses and pathogens from the land fill to areas of human habitation.

4.3.4 Impacts due to Transportation of Solid waste

Leachate

The transportation of waste is done in closed containers. However, in the case of leakage of gases or leachates from the container (accidentally or due to lack of maintenance) have a possibility to spread pathogenic organism along the railway line.

In general, the municipal waste emits strong smells due to the anaerobic degradation of organic materials. However, the transportation of the compacted waste will be carried out in closed containers by rail. There is a possibility for leaking gases to escape from closed containers through door gaps. This may cause a nuisance to the residents along the railway line and to people that use the railway stations. Therefore, this impact needs to be mitigated.

Safety from the new rail tracks:

The new tail track which will be extended from the rail terminal to Aruwakkalu will be around 15 Km long. The people in this area are not used to the rail movements. The rail track unless is equipped with signals, crossing for pedestrians etc.

CHAPTER V

5 PROPOSED MITIGATORY MEASURES

5.1 Construction Impacts

5.1.1 Transfer Station Site (KTS).

Dust due stockpiling of aggregates and their transportation

For the mitigation of air emission by hardware material such as cement, sand, rubble etc., they should be stockpiled in a way to avoid unnecessary dust emissions. They can be stockpiled within temporary huts or stockpiles can be covered.

Spraying of water to areas which have potential for emitting dust need to be closely monitored.

When carrying out unloading operations drop heights could be properly managed in order to minimize possible dust emissions.

Mitigating impacts of Gaseous Pollutants from construction equipment and vehicles:

It is recommended to use machinery that generates less gaseous pollutants wherever possible. The vehicles / equipment that will be used in the water ways should not produce any oil and pollutants which may mix with waters of the canal.

All equipment / construction vehicles should be properly maintained and serviced. The wash bay of vehicles should not be in the close proximity to the water ways. The effluents from the wash bay should have necessary sediment filters.

All vehicles used for servicing should be in compliance with the National Environmental Air emissions, Fuel and Vehicle Importation standards published under Gazette Extra ordinary 1295/11, 30th of June 2003.

Noise

Construction noise can be controlled by practicing correct and accurate operations, proper maintenance etc. effectively. No piling activities should be undertaken during night times. Operator awareness is essential. In addition, following actions can be taken in order to minimize the adverse effects created by noise.

- Keep equipment in good working condition and practice accurate working modes, and carry out appropriate maintenance practices as much as possible.
- Machineries and vehicles should have adequately sized exhaust silencers and utilizing of silenced equipment where ever possible.

- Operational time of high noise generating equipment could be limited as much as possible and working periods could be scheduled in order to minimize exposure to high noise levels.
- Low noise generating equipment could be used as much as possible and sound barriers can be applied to the places of where sound generates in the equipment.
- Avoid using of high noise generating equipment closer to noise sensitive areas and use alternative methods as much as possible.

As the back ground noise levels are lower at the night time heavy construction works which create high level noises should be avoided as the surrounding area is highly populated and sensitive to noises in the night.

Vibration

Adaptation of control methods for excessive vibration levels by temporary ground separations where the places having high vibration activities. Use of equipment with low vibratory mechanisms and provided of safety equipment to workers and frequent monitoring of the nearby buildings and structures in order to investigate any instability or damage.

Mitigating the impacts on Natural Drainage Pattern and Hydrology of the Area.

The transfer station is oriented to avoid diverting of the existing water canals, to minimize negative effects.

In order to minimize the loss of retention/detention and flood storage capacity in the downstream part of the basin which can lead to minor increase in flood levels, it is recommended to use ramps and elevated platform where possible.

Mitigating the impacts due to Siltation of Water Bodies

Silt barriers and membranes are to be used to retain silt and fines during all dreading and site clearing related activities that may lead to water quality degradation during fines washout.

Construction activities should be planned and executed during dry periods to minimize erosion related fines washout.

A detailed storm water drainage system has been provided by the project proponent to manage storm water both inside and outside of the Transfer Site area with a storm water drain installation to safely drain the storm water from the site area to its outskirts.

Mitigating the impacts on ground water quality

There are two systems proposed: the internal drainage system and the external drainage system. The internal drainage system has installed water sewer network underneath the groundwater liner to drain both the internal and external storm water from the transfer landfill area; while the external drainage system, which deals with the outskirt storm water, employs a side ditch for outer storm water and the raised barrier (which functions as side gutter) for the inner storm water to drain the surface water.

The treated effluent discharge to the environment should be properly monitored to ensure that required dilution ratio is maintained even during dry spells.

Waste water and effluent coming from washing bay for containers shall be transferred to leachate treatment facility located within Transfer Site and shall be then properly treated.

A frequent and regular leachate test program should be implemented to monitor the groundwater contamination that can be caused by the underground erosion, lining system damage, and leachate outflow.

Impact on canals and flood retention

Prepare a construction plan that will carryout filling progressively and will allow to remove the filled material progressively so that at the end flood retention capacity is retained and temporary reduction of flood retention capacity during construction is within manageable (extent of filling during construction need to be planned as part of construction planning)

Ring fence construction area so that siltation and loss of fill material to waterways is avoided.

Impact of transport of construction machinery and supply trucks

Construct the access road from the Kandy-Colombo highway first to reach the site and not use Manelgama Road during construction.

Railway Transport

- Construct adequate number of loops in the railway stations in Puttalam Line so that delay in stations is minimized as best as possible.
- Use watertight and air tight containers with air release valves to safeguard against excessive pressure built up
- Coordinate railway operation between Palaviya and Aruwakkalu with Cement Company

Ensure that waste trains operation is only during night to both sides (when passenger trains are mostly not operating

5.1.1.1 Mitigating Ecological Impacts

The ecological study has observed several floral and faunal species will be affected during the clearing of the vegetation in the area. Effort should be restrict the footprint of vegetation clearance to bare minimum. KTS will not have significant ecological impacts as in the case of ATS.

5.1.1.2 Mitigating Social Impacts

Possible involuntary resettlement:

The KTS require at least 25 Acres of land which can be from the Marsh area as well as from the land area. Since the land area is already inhabited by people, they may be given alternative land if the survey proves that the land should be acquired.

When dealing with the land it is e3ssential that the community members are made well aware of the project and provide reasonable alternative following the principles of National Involuntary Resettlement Policy (NIRP).

Flooding due to construction Activities

The people living in the low lying areas of the rail village are affected by the floods already. In the event the construction will obstruct the flow of water in the canal network, there is again danger that they will be affected by the waters, where their houses can be inundated. Therefore necessary construction practices should be adopted to ensure relief of waters in the irrigation canals.

Increase the awareness of the people about the project;

The people should be made aware of the pros and cons of the project beforehand without waiting until the impacts are felt by them. A suitable communication strategy should be prepared and implemented by the PMU in this regard.

Safety of the people in the locality:

During construction stage it is necessary to ensure that traffic is properly managed by the Civil Contractors when transporting the construction materials and other equipment to the site. All stockpiles of the construction materials should be kept away from the roadsides enabling free movement of the traffic. Necessary hoardings, signs and road humps should be installed to prevent any accidents. There should be a mechanism to register the grievances of the community members. Such a Grievance Redress Mechanism should be set up enabling the community representatives to take part in the decisions of grievances resolution.

5.1.2 Mitigation of impacts at Landfill (ASL).

5.1.2.1 Mitigating impacts on Physical Environment

Noise

As there are no houses in the vicinity of the proposed landfill site, no major impacts to the community is anticipated. However, the proposed site is located near to a sparse forests...

Dust

All construction material such as cement and sand brought to the site need to be stockpiled carefully to avoid unnecessary dust emissions. Such material need to be adequately covered and stored in temporary sheds that are well protected against rain and wind also stockpiled in locations not subjected to floods. Sheeting of vehicles during transportation of construction materials to the site and enforcing of speed limitations to vehicles are also recommended to minimize dust emissions.

It is recommended to use machineries that generate low gaseous pollutant where possible. All vehicles and machineries shall comply with the national and local regulations (National Environmental Air Emissions, Fuel and Vehicle Importation Standards, Extraordinary Gazette No.1295/11, 01 June 2003).

Proper personal protective equipment has to be provided to the workers such as gloves, masks, and boots. Temporary toilet facilities equipped with hand washing basins and with sanitation soap should be provided.

Mitigating the impacts due to pollution of ground water quality:

Waste water and effluent coming from washing bay for containers shall be transferred to leachate treatment facility located within Transfer Site and shall be then properly treated.

A frequent and regular leachate test program should be implemented to monitor the groundwater contamination that can be caused by the underground erosion, lining system damage, and leachate outflow.

Design and build a treatment plant that is robust to withstand the large fluctuations of water-water flow and character. Re-sue treated effluent for dust control, achieve desirable moisture content in waste and to not allow treated effluent to lagoon.

Flooding / Stormwater Flow

Implement storm- water management plan as the first step in construction preventing any runoff coming to the designated landfill by diverting the storm water to an adjoin depressed area created by mining (see the storm water management plan)

Road safety

Develop internal road network in consultation with Cement Company to prevent any chance of collision of heavy machinery and trucks used by the two parties. This should continue during operations

Worker safety

Locate labor quarters securely considering wild elephant problem. Protection of wild animals against poaching by workers through strict measures. Advice workers not to venture to the forest area unnecessarily and when elephant movements are expected

5.1.2.2 Mitigating Ecological Impacts

The ecological study has already identified plants and animal species which are of importance in terms of their vulnerability. The land clearance under Phase (1) and Phase (2) will allow complete removal of the sparse and forest areas which are being naturally occurring after the miming activities.

The clearing of vegetation should be preceded by translocations of any vulnerable species to locations elsewhere as recommended.

It is also essential to restrict the areas to be cleared enabling the full grown up trees to survive, which will serve as natural wind barriers when the site is in full operation.

Translocation of vulnerable fauna

A programme to rescue and translocate vulnerable faunal species from areas earmarked for excavation was conducted in 2009 by Holcim Lanka (Pvt.) Ltd. (Kumarasinghe et.al. 2011). A total of 141 vertebrates and 85 arthropods and mollusks including endemics threatened species were captured and were translocated to Setthavilluwa area. This project is claimed to be the first ever initiative in Sri Lanka aimed at reducing impacts of quarry operation on biota through rehabilitation and rescue operations.

A similar project is recommended to be implemented at the present project site including some of its influence areas. In order to minimize the cost and efforts involved in such an exercise, it is suggested to prioritize less mobile threatened / rare species in rescue operations. Some of the fauna recommended for translocation are listed in **Annex 3.4 Table 3.**

Although some of them have not been recorded in recent surveys conducted in 2014-2016, they were listed in the survey conducted in 2009. Therefore, intensive surveys are recommended to be carried out so as not to miss any of these vulnerable individuals in the project areas.

Forest cover

The loss of forest cover can be mitigated by restoring it in two ways depending on the process of the landfill. If the total excavation area is filled gradually up to the previously existing surface level, the restoration has to start after the completion of the landfill. It is important to consider natural elevation, contours and drainage during the filling. If overburden top soil is available, one to two meters of overlaying with such soil will be useful for a relatively rapid rehabilitation of the forest cover.

The best source of top soils will be such deposits from current excavation sites, rather than from older sites where considerable levels of vegetation have already developed as this would incur damage to already existing vegetation.

If the filling process will be in parts, each part completely before moving to the next, the restoration can follow the sequence of filling

5.1.2.3 Mitigating Social Impacts

No significant adverse social impacts are envisaged during the construction phase.

- However, the civil contractors should ensure that the water that they will use for construction should be sourced outside the area without causing any shortfall of water to the communities in the area.
- During construction stage, there should be safety for the community from speeding drivers who are transporting construction materials. Necessary sign boards, road humps etc. should be placed at appropriate places in consultation with community representatives.
- A grievance redress mechanism should be put in place where the community representatives should be able to participate. Grievance Register should be introduced and it should be reviewed and action should be taken periodically to investigate the complaints and ensure that justice is meted out.
- Sensitization of the community is essential. It is recommended that a sensitization programme to be carried out at the DSD on the project through a proper social marketing strategy.

5.2 Operational Impacts

5.2.1 Transfer Station Site (KTS)

5.2.1.1 Mitigating Physical Impacts

Noise

The proposal to operate the plant over 24 hours x 365 days should also be revisited as this could mean continuous movement of trucks in and out of the site, continuous loading and unloading.

To minimize the noise and vibration impacts on the neighborhood it is important that the entire operation is enclosed under a roofed building and walls and floors are made vibration and noise proof to reduce the impact levels to the acceptable standards.

A narrow but thick tree line will help to reduce the dust and noise impacts outward.

Noise abatement actions should be adopted to control the noise levels at the boundary - 55 dB (A) in day time and 45 dB (A) at night time, since the area is categorized as a low noise area. However,

the existing noise level in the area is relatively high and even before any project activities have started; some locations exceed the above levels.

In accordance with the national noise regulations, the noise level at the boundary of the project (where existing noise level exceeds the above maximum permissible levels) during the operation period can only be raised to 3 dB (A) over the existing level.

The following structural designing and best practices are proposed in order to maintain the recommended noise levels at the boundary of the intended project.

- Totally enclose all waste-handling operations to attenuate noise.
- Use concrete walls and structures, which absorb sound better than metal structures.
- Install double-glazed windows which attenuate noise better than single-glazed windows.
- Install shielding or barriers, such as trees, berms, or walls, around the facility to block and absorb noise. Size of the shielding, distance to receptors, and shielding materials all determine effectiveness. Walls can be made from concrete, stone, brick, wood, plastic, metal, or earth. Vegetated berms with grasses, shrubs, or trees mitigate noise largely through absorption and increase aesthetics. Barriers should be continuous, with no breaks, and long enough to protect the intended receptors.
- Wing walls, usually constructed of concrete, on transfer buildings can also block noise from trucks entering and exiting the building and noise from interior operations.
- Insulate transfer building walls with sound-absorbing materials such as acoustic panels (having mineral wool or fiberglass inside)
- Locate administrative buildings between sources of noise and community.
- Keep doors closed during operating hours, except when vehicles are entering or exiting.
- Use the lowest allowable setting on vehicle backup alarms, or use visual warning devices if state and local regulations allow.
- Establish operating hours that avoid early morning or late-night operations.
- Set facility noise level limits (e.g., 55 decibels at the site boundary) and adhere to them.
- The shovel movement on the concrete platform will generate noise and vibration. The potential impacts will require the designs to ensure that the area is fully covered from all sides and impacts are contained as much as possible. The entire platform need to be under a roof and covered from all sides with concrete or noise absorbing material rather than tin foils.
- Closely monitor operations such as tipping, unloading of fresh garbage, moving activities; compressing operations of garbage in to the rail carts area are within a close building.

Ensure that air suction system which directed exhaust air to the deodorization system is in order at all times;

- If not the noise of unloading and the odor could be spreading far and wide and this need to be avoided. The floor cleaning measures may need to be installed on the platform as it is necessary to regularly clean the place to avoid fermentation of left over garbage and generating odor.
- There are alternatives that can be adopted for tipping and packing garbage into the containers.
    - One of the options would be raise the material received at the site to the height of the container to be loaded with hydraulic powered conveyors that operate from the pit where the waste is tipped.
    - The conveyors may be placed in such a way to directly help load the containers on rail track or containers on transferring trucks that can be compressed using horizontal compressors. This will avoid the need to construct a huge structure as well as maneuvering vehicles on ramps and on the platform creating constant noises, vibrations and burnt fuel emission.
    - Such implementations will greatly reduce the operational cost of heavy vehicles as well as the dependency on workers handling the arriving garbage to a minimum.
    - Option of direct loading has also been considered and compared. Similar operations are found in many parts of the world where the cost of operation is effectively minimized.
    - This direct loading system will be beneficial as no garbage is dumped in the open to be moved by land vehicles into the container hence minimum stench is produced. The other advantage is the less noise pollution in the area due to no land vehicles operating on the platform except the unloading trucks.

Vibration

- Waste compression activities are carried out as an indoor operation and the building could be constructed by applying appropriate techniques to control vibration. Regular maintenance schedule could be implemented in order to assure better working conditions of the locomotives.
- Facility operator shall take necessary precautions to maintain the vibration level according to the National Interim Standards for Sri Lanka. **(Annex4.2)**

- Use low vibratory equipment where possible, keep equipment in good working order by scheduling a planned maintenance programme using manufacturers instruction, enclosure correctly, using vibratory equipment during daytime with minimum operational times, positioning of equipment as far as practical away from vibration sensitive receivers and provide workers safety equipment.
- Maintain the Proposed Interim Standard on Vibration prepared by the CEA.
- It is important to declare the minimum distance to be free of blasting operations in future to safeguard the liner of the landfill due to the ground vibration generated by the blasting.

Mitigating impacts due to Dust

Dust from Vehicles

- Pave all roads on the site, or lay gravel as a less expensive option.
- Clean facility roads frequently with street-sweeping equipment (sweeping also should be done after spraying water on open areas on dry days).
- Wash waste collection vehicles before they leave the transfer station to remove dust-generating dirt and debris.

Dust from Waste Handling Operations

- Locate building openings to minimize exposure to prevailing winds.
- Install plastic curtains over building openings.
- Keep station doors closed during operating hours, except at times when the trucks are entering or exiting.
- Install misting systems over tipping areas to "knock down" dust particles. Misting system operations should be adjusted seasonally or as the dryness of the waste dictates.

Litter

- Require all incoming and outgoing loads to be covered.
- Ensure that all incoming and outgoing trucks are leak-proof to avoid leachate spills on public streets.
- Implement daily litter inspections and pickup at the facility and along the surrounding streets.
- Install a perimeter fence to prevent windblown litter from leaving the site.
- efforts should be made to gaseous emissions and air-borne pathogenic micro-organisms
- Provide proper air emission control systems in the tipping area.
- Provide personal protection equipment to the employees.

Mitigating the impacts on the water bodies from Effluent Emission

- The possibility of using this treated wastewater for the vehicle and container washing could be considered.
- All wastewater derived from the vehicle and container washing, may be reused after necessary treatment. If discharge of this wastewater is envisaged, it should be treated up to the TOLERANCE LIMITS FOR INDUSTRIAL WASTE DISCHARGED IN TO INLAND SURFACE WATERS WHICH IS THE ACCEPTED STANDARDS:
- Any excess of treated wastewater could be sent through constructed wetlands without directly discharge in to the any of the water bodies.
- Sewage generated by the workforce should be treated using septic tanks coupled to soakage pits and these infrastructures should be designed as per SLS 745: Part 1: 2004 & SLS 745: Part 2: 2009 standards.

It is strongly recommended to provide the workers with appropriate PPE including respirators against malodor emissions (VOCs & semi-VOCs from acidogenesis in equalization tank), though the collected leachate has a low BOD_5/COD ratio.

As per the NEA, the sludge removed from the treatment plant (which may contain adsorbed metals along with putrescible) is a hazardous material. Generally, such material after proper dewatering requires chemical fixation or immobilization (for example, with different proportions of cement)[3] with different proportions. Mobility of different metallic contaminants has to be determined by conducting the USEPA's Toxicity Characteristics Leaching Protocol (TCLP) test, prior to disposal in to a secure landfill. In this respect, further advice should be sought by the Project Proponent from the NWP-PEA regarding the disposal of hazardous sludge.

Traffic congestion

Widen Manelgama Road, Smooth management for merging of exit vehicles to Kandy-Colombo highway traffic. Not to allow vehicles to cut across the Kandy-Colombo road when entering the KTS or leaving the KTS right in front of the entry and exit roads but redevelop road network for better and smooth traffic flow. Need a good traffic management plan and redevelop the roads accordingly.

Odor due to entering and leaving vehicles

Establish a tree buffer along the entry road on both sides.

[3] This procedures is practiced in developed countries such as Australia, USA and Canada

5.2.1.2 Mitigating Ecological Impacts

No significant ecological impacts are envisaged thus no requirement of mitigation measures

5.2.1.3 Mitigating social impacts

Odor from the RCVs will be a continuous issue for them and that needs to be mitigated. Las should use covered vehicles at all times. The PHI should undertake rounds of visits to monitor odor and take /advise appropriately to the management on the me4asure to be taken.

At the initial stage, flood events should be closely monitored. Necessary advice (early warning should be given to the affected communities and thereafter suitable action should be taken to prevent occurrences of that nature.

It is necessary that employees should be recruited in a transparent manner to ensure that every GNDs in the periphery has a chance to get selected for jobs.

Implement a proper Grievance Management procedure with the community to access to a Grievance Register. Let the members from the community to serve on the Grievance Committee.

Ensure the safety of the people during the operation as there is an increased traffic load in the peripheral roads. Safety boards, road humps etc. needs to be put in place.

It is necessary to engage the community on a regular basis through awareness / sensitization the process of which will enable conflict resolution. A communication strategy will be necessary in order to engage them as part of the project.

5.2.2 Landfill Site and ATS

5.2.2.1 Mitigating Impacts on Physical Environment

Noise & Vibration

During operation mainly the movement of heavy vehicle within the site and around the site will be monitored. The night time operation with excessive noise and bright illumination may induce behavioral disturbances in fauna. Therefore, heavy noise generating activities should be restricted to day time.

No major impact is observed in terms of Vibration. No additional mitigatory measures are required

Ordour:

- It is possible and quite feasible to prevent odors from being a problem to downwind residents and facilities by applying adequate cover material sufficiently, frequently and effectively.

- The methods for applying daily cover, intermediate cover and final cover (when the cell or landfill is permanently closed) will help in reducing obnoxious odors. There is an ample supply of soil (clay, silt, sand and mixtures thereof) existing on the site, which can be used as cover material. It is proposed to utilize the additional earth materials available at the existing Holcim mining quarry sites
- Additionally, it is recommended that the active face (area of uncovered wastes placed during the daily operation) of the landfill at any given time be minimized.
- It is absolutely essential that even at remote sites the above provisions be implemented at the landfill facility, if problems with odors impinging on neighboring facilities are to be avoided.
- Proper action shall be taken to avoid the spillages and emission dust during the transportation.

Communications with future development and monitoring of odors by the landfill operating staff can help to prevent significant problems from occurring.

Dust

Provision for dust suppression in the design and operating plan is essential. This involves the gravel surfacing of the access road and service roads within the site, as well as using water to suppress dust that does arise.

Landfil gas

The actual quantities for a landfill gas of this size, however, are very small compared to the emissions from diesel engines and automobiles along the highway for example. A portion of gases that would vent to the surface from a municipal waste landfill would be absorbed by the green foliage of broad leaf plants in the buffer zones.

- With the natural buffers and state of the surrounding areas this would reduce the problems offsite, at the Aruwakkalu Site.

- The option of using the LFG for energy utilization also could be considered.

Fire at the Landfill

Fires could occur at the landfill, which requires vigilance to extinguish them quickly. Fires are usually the result of hot loads being received at landfills. These hot portions can be ash covered charcoals.

With the use of transfer stations for a large portion of the Municipal Solid Waste the hot loads should be greatly reduced. Loads that are directly hauled to the site could also pose a problem and site operational staff should be on the lookout for these wastes.

Ideally, when a hot load is encountered it should be isolated in an open area and extinguished with water before being considered for incorporation in the fill area. Clearly, smoke irritation can be avoided through the prevention of fires at the landfill.

Fire prevention procedures which should be adhered to at all times throughout the operational life of the landfill should be prepared. Good communications with neighboring facilities and surveillance for fires and dust by the landfill operating staff can prevent significant problems from occurring. Quick reaction to any observed blazing loads will also reduce these problems.

Disposal of wastewater including leachate:

Following activities are recommended.

- Recycling the raw leachate (as a source of water and nutrients) back to the landfill cells by separating before mixing with other wastewater, would enhance biodegradation as water is a scare resource in Aruwakkalu. The equalization tank could be utilized as a leachate collection sump.
- Recycling of leachate is not possible during the rainy season, therefore, it should be treated to confirm to tolerance limits for industrial and domestic wastewaters discharged into inland surface waters under the Provincial Environmental (Protection and Quality) Regulation No. 01 of 2010 of the North Western Provincial Environmental Statute No. 12 of 1990 (Extraordinary Gazette No. 1685/11dated 21st December 2010) and should be reused in the reforest area.
- The possibility of using this treated wastewater for the vehicle and container washing could be considered.
- All wastewater derived from the vehicle and container washing, may be reused after necessary treatment. If discharge of this wastewater is envisaged, it should be treated up to the accepted standards:
- Any excess of treated wastewater could be used for irrigating the Siam City Rehabilitation area

As per the NEA, the sludge removed from the treatment plant (which may contain adsorbed metals along with putrescible) is a hazardous material. Generally, such material after proper dewatering requires chemical fixation or immobilization (for example, with different proportions of cement)[4] with different proportions. Mobility of different metallic contaminants has to be determined by conducting the USEPA's Toxicity Characteristics Leaching Protocol (TCLP) test, prior to disposal in to a secure landfill. In this respect, further advice should be sought by the Project Proponent from the PEA- NWP regarding the disposal of hazardous sludge.

Pollution of the surface and groundwater from the Landfill

[4] This procedures is practiced in developed countries such as Australia, USA and Canada

Leachate collected must be removed from the liner as quickly as possible to reduce any pressure on the liner (leachate head should not > 30 cm). Therefore, there should be some leachate collection wells (made of perforated concrete cylinders with appropriate thickness to withstand stress caused by waste fill)[5] installed close to the edge of the waste fill with each well installed with adequate lift pumps.

In the event of liner failure, the maximum leachate head above the liner should be reduced such that all of the leachate lift pumps should be actuated. Based on the need, number of lift pumps should be increased. Since there is a possibility that all the leachate lift pumps will not be functioning at the same time, the pumping capacity needs to be increased to maintain a very low head. This will be the most practical solution in such emergencies (Abans Cleantech Pvt Limited, 2006).

It should be noted that repairing the liner may be costly and the possibilities of remediation are very low depending on the place and extent of failure. Tracer detection methods should also be used in the event, that there are difficulties in using simple techniques of detecting the leakage (Abans Cleantech Pvt Limited, 2006).

The boundary of the landfill should have enough culverts[6] installed with silt traps and directed to sedimentation ponds with the overflow diverted to collection pond. The silt traps and sedimentation ponds should be regularly cleaned and the silt and sediments should be removed to the landfill.

Mitigating the impacts due to wind carrying waste materials

To minimize the impacts the following measures are recommended.

- The height of the landfill should be reduced as much as possible to avoid the blockage of wind and the spreading of materials
- Necessary screening should be provided to stop dust blowing
- Waste should be covered by the soil immediately once it is dumped. Daily cover is recommended.

The buffer zone along the boundary of the landfill site should be maintained with suitable tall growing trees

Mitigating the impacts of leachate emitting from the railway wagons. / Containers:

The leakage can happen from the doors that are fixed to the container and it is necessary to spell out the ways to prevent the spillage the doors as the seal that prevents leakage may frequently wear out and need to be replaced regularly. The work shop of the project should be equipped to repair

[5]To prevent entering of wastes, animals and accidental falling of workers, the top of the leachate collection wells should be closed by a wire mesh.

6 The culverts should be designed for a 10 year return flood period since culverts do not last for more than 10 years (Jayaweera pers. comm..)

such leaking containers immediately upon inspection on regular basis. The possibility of introducing a reserve leachate tank to the containers to ensure that any leakage will not remain in the main compartment of the containers could also be looked into. This will mitigate the order problem.

CEA guidelines describe the specifications for a collection vehicle. According to the guidelines the vehicles should be fully covered and to have a leachate collection box and be prepared to prevent leachate spill during transportation. Similar guidelines may need to be stipulated for the rail transportation of the waste since the waste in the containers will also be oozing out leachate during transportation and all necessary precautions have to be taken to prevent the leakage and spills while transporting by rail.

5.2.2.2 Mitigating impacts on Biological / Ecological Environment

Wild life

The construction of an electric elephant fence to protect the sanitary landfill and parts of the project influence area is recommended. It will be relatively more cost-effective if the fence is built along Kala Oya – Lunu Oya borders starting from Gangewadiya village area where elephants enter Aruwakkalu forest area. Subsequently, establishment of a live fence with elephant-repellent shrubs is also recommended to supplement the electric fence.

It is strongly recommended the construction of a suitable wire-net fence to prevent the entry of other animals to the landfill area.

Rehabilitation of the lost forest cover:

It is recommended in order to promote rapid rehabilitation of the environment. This method will also minimize fast-spreading weedy flora including several invasive species establishing over the landfill areas.

The selection of species for forest restoration should suit local climatic conditions, growth rates of selected species and sustenance of wildlife and in consideration of experience gathered from the previous rehabilitation process. Prior establishment of a plant nursery for this purpose is recommended.

Planting should be carried out at the onset of the Maha season rains and started with pioneer tree species and with every annual planting season species could be changed progressively from soft-wooded fast growing species to relatively slower growing hard- wooded species. It will be important that the rehabilitation process is conducted under expert advice and supervision.

Undertake gradual rehabilitation of the forest cover, in parts, over the landfills, based on annual Maha rains. This will have many advantages such as the process will involve rehabilitation costs in installments, instead of spending massive initial costs.

The growth of tree species, at least the main ones, used for forest cover rehabilitation should be recorded, at a given time of the year, preferably March-May. This can be technically and accurately performed using semi-permanent plots and mapping the individuals and recording their heights and DBH values on annual basis.

The results will be helpful to change selected species based on their local performance in later years. Spontaneous regeneration of forest species, i.e. appearance of natural forest species, especially hard-wooded primary forest species, should be closely monitored. If this is performed regularly and scientifically the site will, in the future, serve as a model for forest rehabilitation in extremely human-modified sites in the Dry Zone.

Biodiversity

The monitoring of the plant biodiversity can also be combined with that on the forest cover and environment in general. The rehabilitated sites can also be used to introduce some rare / endemic / threatened species of plants, e.g. ***Rhynchosia velutina*** **('Bu-kollu')** and ***Dendrophthoe ligulata*** **('Diva-pilila').**

Implementation Responsibility:

The total Environmental restoration process will be the responsibility of the project developer and long-term and sufficient funds should be allocated. The project developer has to engage required human resources to carry out environment rehabilitation and monitoring programme under advice and supervision of carefully selected experts.

Assistance may be requested from the Department of Forest Conservation, associated experts and other researchers. It is also recommended that a committee may be appointed to monitor the success of the programme and this committee should also consider the future protection and legal aspects of the total project area and its influence areas.

It is recommended that the project implementation phase and adoption of mitigation measures are observed by a committee of Environmental experts that will advise the project developer in order to ensure that the proposed mitigation measures are satisfactorily followed.

Mitigation of impacts on fauna – from Fauna Expert

5.2.2.3 Impacts on aquatic habitats

The filling of existing pools in excavated sites will not be expected to impose notable impacts on existing flora.

5.2.2.4 Mitigating Sociological Impacts

No significant social impacts are there for mitigation.

In case the people in Serakkuliya finds it difficult to graze their cattle and find fuel wood from this locality, special attention should be paid to allow the people do find space for that

It is necessary that employees should be recruited in a transparent manner to ensure that every GND in the periphery has a chance to get selected for jobs.

Implement a proper Grievance Management procedure with the community to access to a Grievance Register. Let the members from the community to serve on the Grievance Committee.

Occupational Health & Safety

Sewage generated by the workforce should be treated using septic tanks coupled to soakage pits and these infrastructures should be designed as per SLS 745: Part 1: 2004 & SLS 745: Part 2: 2009 standards.

It is strongly recommended to provide the workers with appropriate PPE including respirators against malodor emissions (VOCs & semi-VOCs from acidogenesis in equalization tank), though the collected leachate has a low BOD_5/COD ratio

Community Awareness

A comperehncive social awareness programme will be conducted to the local community, politicians and other interested social groups.

5.3 Identification of institutional needs to implement EIA recommendations

5.3.1 Institutional Analysis

Legal background:

As per regulations gazetted under the Part IV C National Environmental Act No. 47 of 1980 (NEA), the Environmental Impact Assessments are carried out by the project proponents. The project approving agency provides the Terms of References to prepare the EIA report. The Provincial Environmental Authority (PEA) of North Western Province has its own statute, which guides the Environmental Impact Assessment Process for projects that are implemented in the Province.

The project proponent in this instance is the Ministry of Megapolis and Western Development, while the project approving agency is the CEA. The MCSWMP implemented under the Ministry of Megapolis and Western Development. The project as planned has three components which are to take place across two provinces, namely in Western Province where the Transfer Station is located and North Western Province where the Landfill site is located. The transportation by rail will take place from Western Province to North Western Province on daily basis. The Western Provincial Council has a separate unit; Western Province Solid Waste Management Authority, for coordinating matters related to solid waste management work, established with legal authority under the Provincial council. Further NATIONAL SOLID WASTE MANAGEMENT SUPPORT CENTER (NSWMSC) was established under the Ministry of local Government and Provincial Councils, which assists local authorities to improve the solid waste management problems in Year 2007.

The solid waste management is a subject specifically handled by the local authorities which function under the Provincial Councils and that are coordinated by the central government's Ministry of Local Governments and Provincial Councils. The 13th Amendment to the Constitution of the Sri Lanka, which established the Provincial Councils in the Country, has listed the subject of Environment and solid waste management as a subject under the provincial list.

Current Institutional Arrangement for Solid Waste Management in Colombo:

Colombo city is under the Colombo Municipal Council. There are no proper disposal sites within the Colombo Municipal Council area.

Colombo Municipal Council (CMC) is the largest Local Authority in Sri Lanka and one of the oldest in South Asia. Established in 1865, it has grown into a large organization catering to the needs of a resident population of 647,100 (2001 census) and an additional floating population of nearly 500,000 (estimated). (WWW.cmc.lk)

Today the council with 15 Departments is mainly responsible for the provision of services public health and curative services, solid waste management, maintenance of roads, Lands and Environmental Development, street lighting, water and drainage, and veterinary services. In addition to these there are number of Departments providing social services, sports and recreation, library services together with finance, rates, secretarial and training departments.

Solid Waste Management section comes under Municipal Engineer's department and is headed by the Director Engineering (Solid waste Management)

The organizational chart for the MSW management department is given below.

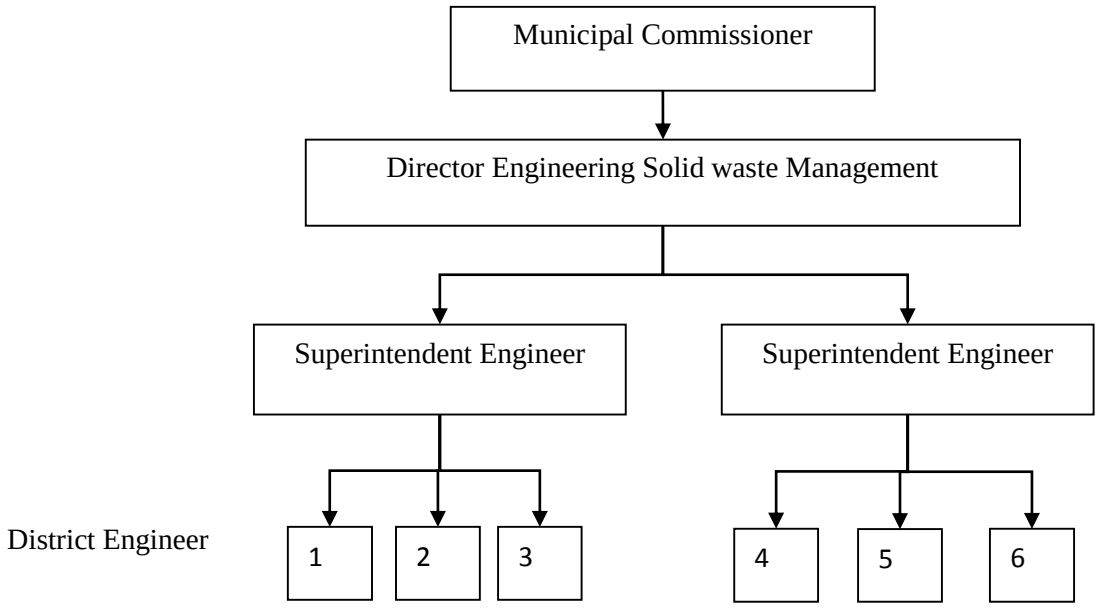


Figure 5.1: The organizational chart for the MSW management department

The total staff of the Solid Waste Management section is 649 in all levels. (In all 6 Wards).

The council has no previous experience in managing landfill operations since there are no such sites that come under their supervision. Hence no experience or skills are available for managing and operating transfer stations are found within any of the agencies that are currently responsible for solid waste management, either at the national level or subnational level organizations.

Central Environmental Authority

The Central Environmental Authority (CEA) was established in August 1981 under the provision of the National Environmental Act No: 47 of 1980. The Ministry of Environment and Mahaweli Development which was established in December 2001 has the overall responsibility in the affairs of the CEA with the objective of integrating Environmental considerations in the development process of the country. The CEA was given wider regulatory powers under the National Environment (Amendment) Acts No: 56 of 1988 and No: 53 of 2000.

Central Environmental Authority consists of 7 divisions.

1. H RD, Admin & Finance Division
2. Environmental Pollution Control Division
3. Environmental Management and Assessment Division
4. Environment Education and Awareness Division
5. Planning and Monitoring Unit
6. Legal Unit
7. Internal Audit Unit

Waste Management Unit (WMU) which comes under Environmental pollution control division deals with the regulatory aspects in relation to the Hazardous Waste Management (Scheduled Waste Management), Solid Waste Management and Chemical Management under the provisions of the National Environmental Act and the other related regulations.

Apart from all these functions WMU also provides necessary awareness and educational assistance for the general public.

The Central Environmental Authority (CEA) has a division that coordinates Solid Waste Management under a Deputy General Manager. This division attends to all the complaints received with respect to solid waste management and also implements the Pilisaru project which is a grant assistance, under the South Korean Government to improve the solid waste management capabilities of the country.

Waste Management Authority of Western Province

Waste Management Authority of Western Province was established as per the Waste Management Statute No: 9 of 1999 of the Western Provincial Council.

The Waste Management Statute, is a statute to provide for the establishment of a Waste Management Authority for the Western Province for the Management of Collection, transportation, treatment and disposal of the waste of the Western Province. The establishment of a fund for the management of the relevant affairs for the delegation of certain powers to local authorities of the Western Province in connection with the implementation of the aforesaid functions

Since SWM is one of the major responsibilities of an LA and a serious issue in the Western Province. The Western Province Provincial Council established the Waste Management Authority in 1999 to assist LAs in the management and control of all categories (municipal, hazardous and healthcare) of their waste collection, transportation, treatment and disposal needs, as per the Waste Management Statue No. 9 of 1999 of the Western Provincial Council.

Urban Development Authority (UDA)

The UDA is a national agency responsible for urban development in the country under the UDA Act. The UDA has full authority on all towns declared as UDA areas. There are 150 UDA areas in the country. The UDA provides the following assistances to the LAs:

- Technical assistance in the development of town planning;
- Enforcement of standards and regulations for development projects;
- Assistance for LAs to coordinate with other government authorities; and
- Project planning for small scale projects (even free of charge) and large scale ones (may impose a charge)

North Western Provincial Council Provincial Environmental Authority

The North Western Provincial Council has a separate Provincial Environmental Authority which oversees all the Environmental management aspects in general within the province and has sufficient staff to monitor the Environmental complaints and industries compliance. However the neither the authority nor the council in the North Western Province have experience or skills in managing or monitoring the landfill operations.

The movement of solid waste from collection points to dump site takes place in dump trucks and tractor and trailers which are operated by private contractors who are hired by the CMC or by the council itself. There is no rail transport of solid waste that takes place in the country and the Railway department which operates the entire railway network in the country has experiences in transporting goods and passengers. The railway department had been responsible for transporting cement clinker and limestone along the same track in the past. The department is also transporting petroleum along its lines to various locations in the country during the past 50 years. However, goods transportation is undertaken by the railway department as the second priority to passenger

transportation which is its main mandate. The railway department has no previous experience in transportation of solid waste. The proposed operation will involve maintenance that include daily washing and cleaning of the specially build containers which are to be leak proof and mounted on railway wagons.

Investigation of the Institutional arrangement for solid waste management revealed that there is no clear institutional arrangement or provisions currently to undertake the proposed operation. This will be a major impediment and should be addressed forthwith since the operation involves two different provinces and activities are taking place beyond jurisdictions of any one local authority.

There are several institutional challenges that will be posed by the solid waste management project, proposed by the Ministry of Megapolis and Western Development that should be addressed as part of the project and cost of them should become part of the Operation and Maintenance cost of the project.

Issue	Status and Challenge	Recommendation
Legal jurisdiction to manage the entire operation needs to be defined	As several agencies at national and subnational agencies and the private sector are involved in management of solid waste flow, it is important to coordinate the operation for effective implementation	Need to develop an institutional arrangement to meet the coordinating roll.
Lack of experience and skills in managing Transfer Station, transportation and landfill operations	As there are not enough skills and trained staff to be recruited and unavailable at all the agencies that are to be involved in managing and operating the landfill it is important to train the staff by the time the operation is ready	Need to identify staff to be designated to the operation to undergo the training. Commence training and the cost of such training and capacity building should be identified in the project budget.
Monitoring of the Transfer station, transportation and Landfill operation for Environmental compliance	Both CEA and PEA staff need to be trained on Environmental compliance and monitoring to ensure that the project satisfy the Environmental monitoring requirements.	An Environmental Action plan with monitoring parameters need to be implemented as an independent operation to the management of the operation
Railway department has to be aware of the challenges and risks associated with the operation	The railway department will be responsible for operating the timely train service that will carry this cargo that should be delivered to landfill site with minimum delay. Any delays due to accidents and industrial disputes need to be addressed under a risk mitigation plan	The railway department should consider designating and training several officers that will be responsible for implementing the project transportation. A risk mitigation plan should be prepared and the cost of this operation need to be part of the O & M cost of the total project.
Continuous monitoring of operations and facilities for such activities	Currently none of the agencies have laboratory and other facilities or the manpower necessary to conduct continuous monitoring of the effluents and other impacts of landfill and transfer stations. The project should have in house capabilities	It's important to identify and recruit analytical and monitoring staff to the two sites where activities including leachate treatment and provide sufficient analytical facilities including instrumentation and testing

Issue	Status and Challenge	Recommendation
	to carry out these tasks as part of the daily routine practices	necessary. A budget provisions should be made for the monitoring and testing operations.
Social interactions and complaints from the community	The community lives around the Kelaniya are extremely sensitive to the management interventions. It is important to hold regular consultations and involve the community representatives as much as possible in all planning and monitoring activities at both sites.	It is recommended that community participation and consultation be incorporated to both sites where the work during construction and operations need to be monitored for compliance.
Staff and visitor facilities for the compliance monitoring and facilities at Aruwakkalu	The Landfill site in Aruwakkalu is located in a remote area and needs to provide residential facilities or transportation from the nearby township to people working at the site. Required staff facilities including office and sanitary facilities for the workers need to be provided at the site	These facilities should be designed as part of the project capital and operational costs.
Overall budget for Environmental compliance and monitoring	The cost of operations of the sites and transportation should consider Environmental and risk mitigation costs as part of the operation costs. It is also necessary to provide regular training and also conduct awareness program to the stakeholders including public about the operations of both sites	The budget for Environmental and social safeguards and monitoring should be part of the cost estimates prepared.

As explained in the Chapter 2, a project of this nature where several stakeholder agencies are involved to ensure that items move rapidly through the chain of interconnected actions, it is important to form an independent body with legal provisions to manage and operate the facility.

While such independent institution is primarily be involved in carrying out the day to day management and maintenance of the facilities with inputs of necessary skills and equipment, it is important to ensure that the project complies with all the Environmental regulations and take necessary precautionary and mitigatory measures recommended in the EIAR and other guidelines

that will be developed by other agencies. In this regard, it is important to set up an Environmental monitoring unit that will be directly reporting to the head of this institution. The monitoring unit should be well equipped with the necessary skills training and other facilities to carry out the work entrusted to them.

However at the time of construction of the sites there will not be such unit or an institution. Therefore the Waste Management Project should entrust this responsibility to qualified staff recruited for such activity.

The monitoring needs to be carried out during the construction and operation of the proposed Transfer Station at Kelaniya and the land fill site at Aruwakkalu. As there are considerable impacts during the construction stage it is necessary to have a proper monitoring system to ensure that there are no violations of the regulations and that conformity to the national standards and guidelines pertaining to Environmental protection and management are maintained. Therefore, two qualified Environmental officers should be appointed by the project management to ensure Environmental compliance during the implementation and the operation of the project. The local community's satisfaction over the implementation is very important for the sustainability of the project. Therefore, the following monitoring committee has been suggested for the implementation of the project. This committee brings together key personnel from all stakeholder groups involved with the project and its implementation.

It is strongly recommended that a monthly report be prepared by the project during the construction phase to monitor and report the progress and compliance to the relevant authorities such as CEA and PEA who are in charge of ensuring the Environmental compliance at the two sites.

CHAPTER VI

6 CONTINGENCY MANAGEMENT PLAN

As part of the project development, a Contingency Plan (Emergency Response Plan) to face the emergencies effectively and efficiently will be prepared. The plan outlined here is only the framework of the contingency plan. A detailed contingency plan to meet the emergencies will be prepared during the detailed design phase. The contingency plan will be incorporated into the Operation and Maintenance Plan. The Managers in charge for the Kelaniya and Aruwakkalu Transfer Stations, Transport Operation, and the Landfill Operation are responsible for the implementation of the Contingency Plan. Contingency Plan covers the following operations.

a. Kelaniya Transfer Site (KTS)
b. Rail Transport System
c. Aruwakkalu Transfer Station (ATS)
d. Aruwakkalu Landfill Site (ALS)

In each of the above four operations, the possible contingency situations were identified. Not all these contingencies could not be categorized as significant threats to operations. Some contingencies are of extremely low probability of happening and therefore allocating resources would not be economical. There are also contingencies, where the impacts are not much of significance to the operation. Such contingencies could be managed through regular operation plans. Thus, only the contingencies where adequate preparedness is of merit are taken and admitted in the framework. These contingencies are adversities that can happen and of significance. These likelihood and high significance contingencies are identified through a Risk Analysis exercise. The risk analysis process provided the guidance on actions to be taken and resources to invest to recover from the emergency. Therefore, the contingency plan is an organizational response to ensure the continued operation. To ensure the preparedness to contingency situations the developer will take following steps with regard to operationalization of the Contingency Plan through the operator. This is achieved through contractual arrangements, pricing/payment structure and monitoring.

- Ensure that a Contingency Plan exists as part of the operation plan;
- Ensure that the Contingency Plan is communicated to the employees;
- Ensure that Contingency Plan is tested regularly
- Ensure that adequate resources are allocated to meet the Contingencies
- Ensure that contingency planning is institutionalized in the O&M setup

6.1 Contingency Management

The significant emergencies during the operation of the project are given the **Table 6.1, Table 6.2, Table 6.3, and Table 6.4** for the above-mentioned operational areas.

Table 6.1: Contingency Plan - Kelaniya Transfer Station

No.	Type of Emergency	Possible Reasons	Impacts	Framework for the Management Plan
1.	Breakdown of arrival of waste to the KTS	Due to heavy traffic Strike by RCV operating crews	Delay in train loading Delays in train operating schedule Could affect the schedule of SLR operations and Cement Company operations Signed up LA face waste collection problems	Develop alternate train schedule for implementation in such situations Establish procedures for rescheduling of the waste carrying train schedule with SLR Develop & adopt line of communication with the railway and the landfill operational teams; Establish communication arrangement with RCV drivers/operators inform traffic conditions to use alternative roads Encourage LAs also to have emergency disposal options ready
2	Breakdown of operations at KTS (fully or partially)	Work stoppage by the workers Break down of main machinery Flooding Prolonged Power Failures Fire	Delay in train loading/ schedule Waste and RCVs pilling up at KTS Threat of pollution	Develop alternate train schedule for implementation in such situations Establish procedures for rescheduling of the waste carrying railway running times with SLR Coordination with LAs and RCV operators to stop delivery of waste Plan emergency power Provide enhanced reliability to key machinery through good maintenance, operator training, adequate spare parts, Identify evacuation routes/locations for workers and neighborhood people Prepare and educate nearby residence on how to respond in a situation of fire Provide and maintain reasonable firefighting capability at site

No.	Type of Emergency	Possible Reasons	Impacts	Framework for the Management Plan
				Encourage LAs also to have emergency disposal options ready
3	Public Protest	Breakdown of odor control system Breakdown of treatment plant Conflict with RCV operation	Prevent RCVs reaching the site Court orders to stop operations Unrest	Provide enhanced reliability to odor control and effluent treatment systems through good maintenance, operator training adequate spare parts Establish excellent public relations Temporary halting of waste transfer operation until the contingency situation is taken under control Encourage LAs also to have emergency disposal options ready

Table 6.2 Contingency Plan - Aruwakkalu Transfer Station

No.	Type of Emergency	Possible Reasons	Impacts	Framework for the Management Plan
1.	Breakdown of operations at the Transfer stations	Mechanical failure of transfer crane(s) Heavy rains Work stoppage by the workers	Delay in train operating schedule Could affect the schedule of Cement Company	Provide enhanced reliability to transfer cranes through good maintenance, adequate spare parts, alternate power, continuous performance monitoring Inform KTS not to send waste trains if the breakdown repair take extended time Improve the internal roads and other infrastructure to allow operations to continue during bad weather Encourage LAs also to have emergency disposal options ready
2	Train stuck at ATS	Locomotive failure at ATS	Waste arrival will be affected Long duration failures may affect operation at KTS	Provide enhanced reliability to locomotives through good maintenance, adequate spare parts Enhance repair capability at Aruwakkalu

Table 6.3 Contingency Plan - Aruwakkalu Sanitary Landfill

No.	Type of Emergency	Possible Reasons	Impacts	Framework for the Management Plan
1.	Gas explosions	Migration of gases outside the fill area and getting collected in building etc.	Threat to life, causes injuries Could result in fires	Install effective gas collection system Regular monitoring for gases at critical locations and take corrective measures if necessary to reduce threat of explosions Increased firefighting capability at site including adequate storage of water
2	Fire	Gas explosions Fire due to methane released from the fill	Air pollution Threat to wild forest fires during dry periods Interruption to the landfill operation	Effective gas collection system Increased fire-fighting capability at site including adequate storage of water Provide adequate buffer between the site and the adjoining forest Evacuation plan for workers including Cement Company staff
3	Leachate Treatment Failure	Built up of toxic material in the fill Over loading if stormwater management and rainwater cut off arrangements fail	Pollution and associated liabilities and legal issues Public protest if lagoon is threatened	Continuous monitoring of waste collection process and through which to ensure toxic and hazardous wastes are avoided at the landfill Install good storm water and drainage management plan and continuously monitor the performance of the system and if necessary to take immediate corrective measures
4	Liner failure	Up lifting due to groundwater pressure by rise in groundwater level due to heavy rains	Leachate treatment failure – due to increase in leachate quantity Increase in explosion threat due to gas migration through liners	Good liner design with adequate consideration on selection of design storm event
5	Stormwater system failure	Stormwater management structures failure	Increase leachate quantity	Temporary halting of waste transfer operation until the contingency situation is taken under control

			Force to cease filling operation	Good judgement in the selection of design storm event

Table 6.4 Contingency Plan - Railway Transport from KTS to ATS

No.	Type of Emergency	Possible Reasons	Impacts	Framework for the Management Plan
1.	Interruption of railway service	Strike by railway staff, workers Derailments Locomotive breakdowns	Waste cannot be transported at all Disruption to waste transport - Waste carrying train stuck in the middle - Empty train stuck at the middle Odor problems, flies, gas build up Pollution due to seepage of leachate from containers	Adopt & implement procedures to communicate with Operators at Landfill site and the Railways authorities and railway drivers; Use fully closed and water tight containers with pressure release valves from the waste laden compartments Temporary halting of waste receiving and transfer operation until the contingency situation is taken under control Encourage LAs also to have emergency disposal options ready
2	KTS operations schedules goes haywire	Failure to maintain train schedules Item (1) above	Waste built up at KTS RCV movements could get affected Waste collection operation will get affected	Temporary halting of waste receiving and transfer operation until the contingency situation is taken under control Develop and be ready to implement contingency operations plan at KTS

6.1 Contingency Management Institutional Aspect

The Contingency Planning will be a component of the O&M process / procedure. Adherent to these procedures will be mandatory for the operator and it will be ensured through contractual conditions (operation contract), payment procedures, monitoring of operation by the developer. The following components are built into the Contingency Planning.

- Chain of command responsible for identification, communication and response to contingency situations will be established and communicated to respective staff and employees in general

- Train the staff in handling of emergencies to ensure that all elements of the plan are internalized and assimilated by all employees

- Communication paths and persons to be informed of emergency at different stages and based on severity will be established and communicated to responsible staff. These include internal staff, other agencies, including private parties, neighborhood and the general public as applicable

- Evacuation arrangement and locations will be established from the commencement of operations

- Procedures to restore the normal operations after the management of emergency will be established. This includes definition of chain of command responsible restoration of normal operations

- Each emergency situation will be fully analyzed covering: the reason for the emergency, impact of such emergency, including cost to handle the emergency, time taken for restoration, any failure in the response plan, effectiveness of the response plan and adequacy of staff training as well as the effect of the emergency (aftermath of the emergency). The detailed come out of such analysis will be utilized to amend the contingency management plan.

CHAPTER VII

7 MONITORING PROGRAMME

It is important to ensure that the project complies with all the Environmental regulations and take necessary precautionary and mitigatory measures recommended in the IEE and other guidelines that will be developed by other agencies. Environmental monitoring parameters and the relevant monitoring mechanism have been identified in the matrix below respectively for both sites during the construction and operational phases. It is necessary to adhere to this monitoring plan. In this regard, it is important to set up an Environmental monitoring unit that will be directly reporting to the head of this institution. The monitoring unit should be well equipped with the necessary skills training and other facilities to carry out the work entrusted to them.

A monitoring committee to embrace a cross section of the stakeholders will be necessary to ensure proper monitoring of the project at both ends. The composition of the monitoring committee is recommended below.

The monitoring needs to be carried out during the construction and operation of the proposed Transfer Station at Kelaniya and the land fill site at Aruwakkalu. As there are considerable impacts during the construction stage it is necessary to have a proper monitoring system to ensure that there are no violations of the regulations and that conformity to the national standards and guidelines pertaining to Environmental protection and management are maintained.

Therefore, two qualified Environmental officers should be appointed by the project management to ensure Environmental compliance during the implementation and the operation of the project. The local community's satisfaction over the implementation is very important for the sustainability of the project.

Proposed Committee for the monitoring of the implementation of the project

The following is recommended as a set up plan for a monitoring committee for the monitoring of construction and operational activities of the proposed solid waste management system.

i. **Chairperson**: Secretary/ MPWD

ii. **Members:** Representatives of the following institutions

- Representative from the PMU
- Representative from the CEA
- Representative from PEA- NWP
- Any additional representatives appointed by the PEA -NWP
- Representative from Wildlife Conservation Department
- Representative Geological Survey and Mines Bureau
- Representative from Ministry of Local Government

- Divisional Secretary, Kelaniya and Wanathavilluwa
- Representative from Department Archeology
- Urban Council, Kelaniya
- Representative from Urban Development Authority
- Representative from Colombo Municipal Council
- Representative from Railway Department
- Representative from NGOs in the project area
- Additional members could be invited based on the need

This committee should assemble at least once a month during the construction period and the committee should decide the frequency to meet for the operational phase. Any violation of regulations and conditions stipulated by the government agencies and problems identified should be sorted out immediately. Any additional guidelines or conditions may be stipulated time to time by the relevant government agencies with the consent of the monitoring committee to minimize adverse impacts likely to arise from the implementation of the project.

Reporting:

It is strongly recommended that a monthly report be prepared by the project during the construction phase to monitor and report the progress and compliance to the relevant authorities such as CEA and PEA who are in charge of ensuring the Environmental compliance at the two sites.

Pre-Arrangements

The following pre-arrangements should be ensure prior to the construction stage.

1. Appointing a Technical Evaluation Committee to review the project design. The TEC should ensure the project designs, calculation of wastewater and leachate, proposed pollution control methods etc.
2. Appointing the Monitoring committee as indicated above.

a. Environmental Monitoring Programme at KTS (Construction Phase)

Parameters to be monitored	Monitoring Locations	Frequency	Responsible Agency	Arrangements for meeting Cost of monitoring
Soil Investigation – geo chemical testing for the heavy metals	KTS construction site	Pre-construction: once before construction commences Construction: As determined by the Monitoring Consultant / as an when complaints are received	Civil Contractor , External Monitoring Committee	To be included in the Civil Contactor's Budget.
Noise: Leq	Houses surrounding KTS and railway line extension area and within site boundaries specified by the Project Engineer	Pre-construction: once before construction commences (day and night) Construction: As determined by the Monitoring Consultant / as an when complaints are received	Civil Contractor , External Monitoring Committee	To be included in the Civil Contactor's Budget
Vibration PPV with reference to vibration frequencies applicable for different Categories of Structures	Houses surrounding KTS and railway line extension area	Pre-construction: once before construction commences Construction: As determined by the Monitoring Consultant; Also depending on public complaints	Civil Contractor , External Monitoring Committee	To be included in the Civil Contactor's Budget
Dust: PM10 levels	Houses surrounding KTS and railway line extension area (especially where complaints being received)	Pre-construction: once before construction commences (day and night) Construction: As determined by the Monitoring Consultant Also depending on public complaints	Civil Contractor External Monitoring *Committee*	To be included in the Civil Contactor's Budget
Crack Survey	Houses surrounding KTS and railway line extension area (especially where complaints being received)	Pre-construction: once before construction commences	Civil Contractor	To be included in the Civil Contactor's Budget

Parameters to be monitored	Monitoring Locations	Frequency	Responsible Agency	Arrangements for meeting Cost of monitoring
Water Quality Tests- all parameters included in the NEA	At least 2 points of the canal	Pre-construction: At least 6 tests or 6 months before construction commences	Solid Waste Management Project	Rs.600,000/=
Noise: Leq	Houses surrounding KTS and railway line extension area and within site boundaries specified by the Project Engineer	Construction: Once in a month once the construction commences (day and night) Construction: As determined by the Monitoring Consultant / as an when complaints are received	Civil Contractor , External Monitoring Committee	To be included in the Civil Contactor's Budget
Vibration PPV with reference to vibration frequencies applicable for different Categories of Structures	Houses surrounding KTS and railway line extension area	Construction: Once in a month once the construction commences (day and night) Construction: As determined by the Monitoring Consultant / as an when complaints are received	Civil Contractor , External Monitoring Committee	To be included in the Civil Contactor's Budget
Dust: PM10 levels	Houses surrounding KTS and railway line extension area (especially where complaints being received)	Construction: Once in a month once the construction commences (day and night) Construction: As determined by the Monitoring Consultant / as an when complaints are received	Civil Contractor External Monitoring *Committee*	To be included in the Civil Contactor's Budget
Water Quality Tests- all parameters included in the NEA –Tolerance Limit for the Discharge of Industrial Waste in to Inland Surface Waters. (Annex 5.1)	At least 2 points of the canal	Construction: Once in a month once the construction commences (day and night) Construction: As determined by the Monitoring Consultant / as an when complaints are received	Civil Contractor External Monitoring *Committee*	To be included in the Civil Contactor's Budget.
Vehicular emissions / pollutant gaseous	Vehicle yard, Construction Site	Construction: As determined by the Monitoring Consultant Also depending on public complaints	Civil Contractor / Vehicle supervisor	To be included in the Civil Contactor's Budget

Parameters to be monitored	Monitoring Locations	Frequency	Responsible Agency	Arrangements for meeting Cost of monitoring
Socio-Economic parameters: Physical Displacement (Replacement cost)	Based on the survey plan (if additional land is required from the private owners)	Prior to land acquisition if any or demolition of any infrastructure	PMU of the MMP&WD / Divisional Secretary	Depending on the valuations – To be borne by the UDA PMU
Economic Displacements (Replacement Cost)	Based on the survey plan (if additional land is required from the private owners)	Prior to land acquisition if any or demolition of any infrastructure	PMU of the MMP&WD/ Divisional Secretary	Depending on the valuations
Public Safety (Construction Traffic; sudden floods due to obstruction to drainage; other incidents such as disposal of the construction waste)	Complaints of accidents / injuries : public complaints (Grievance Register)	As determined by the Monitoring Consultant Also depending on public complaints	Project Proponent, External Monitoring Committee	To be included in the civil contractors budget
Occupational health and safety of the workers	Complaints of accidents / injuries (Incident accident reports of the construction site: level of availability of PPE and awareness on the safety requirements	As determined by the Monitoring Consultant Also depending on public complaints	Project Proponent, External Monitoring Committee and Monitoring Consultants	To be included in the civil contractors budget

b. Environmental Monitoring Programme at ATS and ASL (Construction Phase)

Parameters to be monitored	Monitoring Locations	Frequency	Responsible Agency	Arrangements for meeting cost of monitoring
Surface waters & groundwater Sources and amount abstracted	To be determined after the sources are confirmed:	Regularly during the construction period	Project Management Unit of the MMP&WD (PMU)	To be allocated based on the requirements of the water providers

Noise: Leq	Boundaries of the project sites specified by the Project Engineer, covering the Siam City Cement office and the Serakkuliya Village	Pre-construction: once before construction commences (day and night) Construction: As determined by the Monitoring Consultant / as an when complaints are received	Civil Contractor , External Monitoring Committee	To be included in the Civil Contactor's Budget
Vibration PPV with reference to vibration frequencies applicable for different Categories of Structures	Boundaries of the project sites specified by the Project Engineer, covering the Siam City Cement office, proposed landfill site and the Serakkuliya Village	Pre-construction: immediate after the approval from the CEA for about 6 months before construction commences Construction: As determined by the Monitoring Consultant; Also depending on public complaints	Civil Contractor, External Monitoring Committee	To be included in the Civil Contactor's Budget
Dust: PM10 levels	Boundaries of the project sites specified by the Project Engineer, covering the Siam City Cement office and the Serakkuliya Village	Pre-construction: once before construction commences (day and night) Construction: As determined by the Monitoring Consultant Also depending on public complaints	Civil Contractor External Monitoring *Committee*	To be included in the Civil Contactor's Budget
Ecological parameters such as : Fauna/Flora species affected Relocation programmes	Areas affected by the construction of the landfills: (As per the ecological Report)	During land preparation and Clarence / as determined by the Monitoring Consultant	PMU	Cost for relocation (if any) Rs. 1,000,000 To be allocated by the PMU
Socio-Economic parameters: Level of community awareness; Reasons for agitations Complaints	Community Complaints / Number of events held for community sensitization ; Community awareness meetings: Awareness materials	Prior to construction	PMU	Approximately Rs. 500,000 ; to be allocated by the PMU

c. Environmental Monitoring Programme during Operational Phase (KTS)

Parameters to be monitored	Monitoring Locations	Frequency	Responsible Agency	Arrangements to meet Cost of monitoring
Noise: Leq due to RCVs and operation at the KTS	Houses surrounding KTS and railway line extension area and within site boundaries specified by the Project Engineer	Regularly as determined by the Project Environmental Consultant	External Monitoring Committee and Project Environmental Consultants	Cost to be included in the operational budget
Dust: PM10 levels	Houses surrounding KTS and railway line extension area (especially where complaints being received)	Regularly as determined by the Project Environmental Consultant	External Monitoring Committee and Project Environmental Consultants	Cost to be included in the operational budget
Vehicular emissions / pollutant gaseous	Vehicle yard, All RCVs received at the KTS	Regularly as determined by the Project Environmental Consultant	External Monitoring Committee and Project Environmental Consultants	Cost to be included in the operational budget
The level, quantities of effluents discharged into the water waterways (Leachate) Water quality tests according to the CEA Parameters of effluent discharge: Water Quality Tests- all parameters included in the NEA –Tolerance Limit for the Discharge of Industrial Waste in to Inland Surface Waters. (Annex 5.1)	KTS and leachate outfalls	Regularly as determined by the Project Environmental Consultant	External agencies (NBRO/ITI/MU etc.)	At least 100,000 for each test
Socio-Economic parameters: Number of local employments provided	KTS staff cadre	Random Check of the cadre requirements and actual appointments	External Monitoring Committee and Project Environmental Consultants	Salaries be included in the operational budget

Parameters to be monitored	Monitoring Locations	Frequency	Responsible Agency	Arrangements to meet Cost of monitoring
Socio Economic Parameters: Landscape improvements and community perceptions	In the close GNDS	At least one time per year through perception surveys	External consultant	Rs. 500,000 for a Survey
Public Safety (Daily RCV Traffic; Rail road incidents)	Complaints of accidents / injuries : public complaints (Grievance Register)	Regularly as determined by the Project Environmental Consultant	External Monitoring Committee and Project Environmental	Cost to be included in the operational budget
Occupational health and safety of the workers	Complaints of accidents / injuries (Incident accident reports of KTS: Level of availability of PPE and awareness on the safety requirements	Regularly as determined by the Project Environmental Consultant	Project Proponent, External Monitoring Committee and Monitoring Consultants	

d. Environmental Monitoring Programme during Operational Phase (ATS and ASL)

Parameters to be monitored	Monitoring Locations	Frequency	Responsible Agency	Cost of monitoring
The level, quantities of effluents discharged into the water waterways (Leachate) Water quality tests according to the CEA Parameters of effluent discharge: Water Quality Tests- all parameters included in the NEA –Tolerance Limit for the Discharge of Industrial Waste in to	ASL and leachate outfalls / Wetland systems and other receiving bodies	Regularly as determined by the Project Environmental Consultant	External agencies (NBRO/ITI/MU etc.)	At least 100,000 for each test

Parameters to be monitored	Monitoring Locations	Frequency	Responsible Agency	Cost of monitoring
Inland Surface Waters. (Annex 5.1)				
Ecological parameters such as : Level of attraction to wild life ; Length of the electrical fence built	Areas affected by the construction of the landfills: (As per the ecological Report)	During land operational phase of the Landfill as determined by the Monitoring Consultant	External Monitoring Committee and Monitoring Consultants	Cost for relocation (if any) Rs. 1,000,000
Gradual rehabilitation of the forest cover, over the landfills, based on annual Maha rains. .	Areas completed after landfilling (As per the ecological Report)	During rehabilitation over a long period and determined by the Ecologist.	External Monitoring Committee and Monitoring Consultants	Cost to be included in the operational budget
Spread of Communicable Diseases (CD)	In the community living areas; workers engaged in the ATS and the quarrying areas	As and when CD outbreak is started / prior to such events	PHI of the area and Environmental consultant	Cost to be included in the operational budget
Occupational health and safety of the workers	Complaints of accidents / injuries (Incident accident reports of ATS: Level of availability of PPE and awareness on the safety requirements	Regularly as determined by the Project Environmental Consultant	Project Manager (ATS)	Cost to be included in the operational budget

e. Sustainability of operation and maintenance

Parameters to be monitored	Monitoring Locations	Frequency	Responsible Agency	Cost of monitoring
Cadre requirements to adequately manage KTS and ASL and the PMU	Both at KTS and ASL, PMU	At the beginning of the operations and each year	MMP&WD	To be included in the annual operational budget

Parameters to be monitored	Monitoring Locations	Frequency	Responsible Agency	Cost of monitoring
Trained staff ; Level of skills to operate KTS and ASL with required efficiency and minimum impacts	Both at KTS and ASL, PMU	Every six months during the operations	MMP&WD	To be included in the annual operational budget
Supporting facilities (Equipment and vehicles for the sustainable operations)	Both at KTS and ASL, PMU	At the beginning of the operations and each year	MMP&WD	To be included in the annual operational budget
Functioning of a regular monitoring Committee as per the suggestions made under the institutional Model.	Both at KTS and ASL,	Every 03 months	PMU	To be included in the annual operational budget
Funds for annual maintenance	Both at KTS and ASL,	Every financial year	MMP&WD	To be included in the annual budget of the Ministry
Ongoing research and continuous improvement and implementing the communication strategy	Both at KTS and ASL,	Every financial year	PMU	To be included in the annual budget of the Ministry
Special studies towards Sustainable financing	Both at KTS and ASL	After the initial operations	PMU	To be determined only upon the necessity

CHAPTER VIII

8 CONCLUSION AND RECOMMENDATIONS

It is the view of the EIA consultants that the proposed project is an important and essential component of the complete management of municipal solid waste. The haphazard and environmentally unfitting disposal of MSW due to lack of appropriate infrastructure is one of the main problems faced in Colombo. In that sense, this is a long overdue part of sustainable solution to waste management in the Greater Colombo in particular in the MCR. The proposed project will provide a long term and environmentally sound alternative to MSW disposal in Colombo Region. Consultants understood that this is not the only solution considered for MSW disposal. Waste management projects in the field of W2E were also mooted. Therefore, the proposed landfill fits in as part of the overall MSW management plan. Sri Lanka is already having positive and proven experience in sanitary landfilling. Hence, the technology is not entirely new to the country. Further, it is well tested and proven technology which is dependable.

After several failures of identifying suitable land, the project sponsors have identified Aruwakkalu for siting the sanitary landfill. Considering the difficulties associated with landfill siting, the Consultants agree that the choice of the area is right, despite its distance to the area of waste generation. Consultants consider that the benefits of having the sanitary landfill overwhelm the distance factor.

In general, EIA studies evaluate alternatives as part of the scope. These include technical alternatives as well as siting alternatives. The opinion of the Consultant in this regard is that such an elaborate evaluation of alternatives in this case may be not necessary. Since late nineteen eighties, many sites have been evaluated for a sanitary landfill for Colombo waste. In addition, numbers of technical solutions were evaluated. The last site chosen was also at Aruwakkalu itself but rejected due to legal and environmental reasons. The proposed site therefore is a culmination of all the previous studies and therefore all the past work related to siting can be considered as study of alternatives in this regard. Technically the proposal is not one off solution but it is one of the solutions among others to manage the MSW problem in Colombo.

The site proposed for the waste transfer station in Colombo at Kelaniya in many ways an appropriate choice as considered by the Consultants. Its proximity to the main railway line and Kandy-Colombo highway are two very positive attributes. Developers have already proposed to incorporate many solutions to address potential environmental issues of the site, such as odor, and flooding. The main issue that requires to be addressed is the traffic. It is recommended in the EIA study to carry out a detailed study, which will combine transport infrastructure improvement in the area together with a traffic management plan to solve this issue.

Waste will be taken to Aruwakkalu by train. Consultants consider that there are no significant environmental issues associated with the choice of transportation method. However, disruption of train service due such reasons as derailments and due to inadequate railway infrastructure (loop) are major concerns. Consultants' recommends providing loops of appropriate length to more stations to minimize delays (or waiting time for trains to pass each other).

Semi-aerobic landfill is proposed at Aruwakkalu. Consultants agree with the choice as it is based on accounting both environmental and economic factors. EIA Consultants consider that the proposed leachate quantities in the design are low. Thus, a higher value is recommended and incorporated. Energy recovery is not considered in the plan. EIA consultants consider that there is a potential for energy recovery and which should be positively considered. However, the Consultants have not observed significant negative environmental impact except for the loss of replanted forest until the replantation recommence after the closure of the landfill. .

EIA Consultants consider that the proposal has many positive factors compared to the negative factors when considered with full understanding of the difficulties faced with siting landfills. Consultants also considers that the negative impacts are relatively minor and can be addressed through the mitigation measures suggested in this report. Consultants are also recommend that the project proponent to pay due attention regarding emergency situations. In this regard the Consultants proposes to develop a sound contingency plan and make it part of the O&M plan. Implementation of O&M plan together with the Contingency Plan should be thoroughly considered in setting up of the operation plan and operating organization. Adequate consideration shall be given with regard to life of the operational plan as the environmental obligations extend beyond the end of landfilling. In conclusion, the EIA Consultants recommend the implementation of the project subjected to the compliance with the proposed mitigation measures and monitoring plan.

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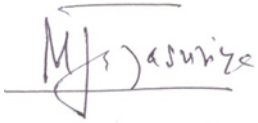
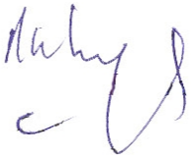
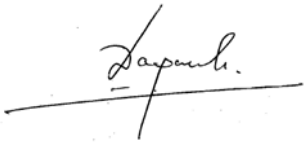
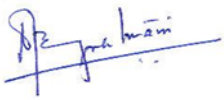
10 Name of the Consultants

Name of Staff	Areas of Expertise	Position Assigned	Signature
Dr Vashantha Sriwardena	EIA, IEE, EA, Solid Waste, Wastewater, Swerage and drainage Management, Institutional Development, Environmental Safeguard	Team Leader (EIA Expert)	
Dr. A H M Jayasuriya	Ecologist	Aruwakkalu Landfill Site	
Campika Bandara	Ecology	Kelaniya Transfer Station site	
Lalith Rajapaksha	Hydrology Hydraulic and Environmental Engineering, Land Reclamation & Development	Hydrologist	
S Premasiri	Air Pollution study and air quality Modeling, Noise and Vibration	Air and Noise Specialist	
Dr. N P Ratnayake	Geology and Soil Investigation	Geologist	
Dayanantha Liyanapathiranage	Sociology, Institutional Development, Social and Environmental Safeguard	Sociologist	
A Rajaratnam	EIA, IEE, EA, Solid Waste Management, Institutional Development, Environmental Safeguard	Environmental Specialist	

12 ANNEXES